THE USE OF LANGUAGE IN MATHEMATICS TEACHING IN PRIMARY SCHOOLS IN MALAWI: BRINGING LANGUAGE TO THE SURFACE AS AN EXPLICIT FEATURE IN THE TEACHING OF MATHEMATICS

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DEDICATION

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ABSTRACT

The aim of this study was to explore how teachers use language in Chichewa medium and English medium mathematics teaching in standards 3 and 4 of selected primary schools in Zomba, Malawi. Chichewa is a local and national language whereas English is a foreign language yet the official language in Malawi. Chichewa is a language of instruction in standards 1 to 4 whereas English is used from standard 5. Both Chichewa and English are subjects of study from standard 1. Issues investigated included: teacher understanding of the use of Chichewa or English in mathematics teaching; teachers' knowledge and use of mathematics vocabulary in Chichewa and in English; and teacher use of language in mathematics lessons.

In this thesis, I develop a sociolinguistic approach to a study of teachers' perceptions and uses of language in mathematics teaching. I demonstrate how we can represent these perceptual structures using sociolinguistic tools and principles, which I use to study how 40 mathematics teachers linguistically organise and structure their teaching of mathematics. I adopt the position that teaching is fundamentally a language activity based on classroom communication activities which are fundamentally sociolinguistic in character, that sociolinguistic structures are dynamic and rational, yet exhibit a level of stability which results in diverse teacher dispositions gelling into conflicting tensions. I develop a theoretical base and iteratively explore this, evolving a description of how we might model what I call the sociolinguistic orientation of mathematics teachers. I construct theoretical, conceptual and methodological frameworks to enable me to study some of the underlying relationships among the tensions, teacher predispositions and the sociolinguistic environment in the classroom.

I draw on a constructivist approach to mathematics education founded in Piagetian and Vygotskian theories and in particular draw on the concepts of coping strategies (Edwards and Furlong, 1987) to deal with the dynamics of classroom communications (Hills, 1969) which result in tensions in the use of language in mathematics teaching Pimm, 1987; Adler, 2001). I begin by educationally, professionally and linguistically locating myself before moving on to looking at how we can understand communication in the mathematics classroom, the role of language in mathematics education with emphasis on bilingual mathematics education. I examine theories for understanding the interplay and interrelationship among teaching, communication, language use, and mathematics and bilingual classroom. Thereafter I look at the sociolinguistic roots of mathematics education in the Malawi Education System, identifying those areas where the current language policy in education does not consider the role of language in mathematics education.

I draw heavily on sequential focus group discussion, interviews, tests and classroom observations and construct a perceptual model for the sociolinguistic orientation of 40 mathematics teachers towards use of Chichewa or English, and explore how these perceptions relate to the actual use of language in bilingual mathematics classrooms. To increase the validity of the data and findings, I used methodological and data triangulation. The findings of the study suggest that the sociolinguistic orientation of mathematics teachers relates to the linguistic nature of mathematics (the desire to teach the technical language as opposed to the ordinary language that pupils will easily understand), mystifying language policy in education (the inconsistency of language policy), dynamic classroom discourse (the multi-functions of language in the classroom) and inconsistent source of language for use in mathematics teaching (different competencies in language for teaching and learning among teachers, pupils and instructional materials). In addition, I illustrate how the teacher sociolinguistic orientation depends on whether the language of instruction is L1 or L2 which rest ideologically on code switching between Chichewa and English as well as marked difference in the patterns of language use between Chichewa and English medium mathematics lessons.

The findings of the study can increase our understanding of the dynamics of mathematics classroom discourse by not only identifying more tensions in the use of language but also the sources of these tensions. These might pave the way to find remedies to reduce the linguistic tensions in mathematics education.

These findings imply that teachers need to be trained and supported in the use of language if they are to improve the teaching of mathematics. It is recommended that a programme be developed to train and orient teachers in the use of language in mathematics teaching, and to produce appropriate instructional materials that would assist teachers and pupils to use language effectively in mathematics.

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CHAPTER 1

INTRODUCTION

1.1 About this study

Although language and communication in the mathematics classroom is seen as an important area of study, the actual language they use has been less systematically studied (Cocking and Mestre, 1988). It may be a popular belief that when teachers have the academic or cultural proficiency of a language, they can ably use it in classroom communication. However, our lack of clarity of the actual way in which language is used makes this belief questionable. Although a number of studies on classroom communication have been conducted (Allwright, 1988), very few, if any, have involved a comparison between the use of first language (L1) with the use of second language (L2) (Cocking and Mestre, 1988; Adler, 2001).

The aim of this study is to explore how teachers use languages in the teaching and learning of mathematics in Malawi Primary Schools. In this study, the languages being studied are English (L2) and Chichewa (L1), which are both used for instruction at various level of education in Malawi. The target sample includes mathematics teachers for Standards 1 to 4 from 10 primary schools in the Zomba district in the Southeast Educational Division of Malawi. The issues studied include teachers' perception of the use of English and Chichewa in mathematics teaching; teachers' knowledge of mathematics vocabulary in Chichewa and in English, and finally the teachers' use of Chichewa and English in mathematics teaching.

I examine how teachers use language when teaching mathematics to young children, given an opportunity to teach in Chichewa (L1) and in English (L2). If we visit a classroom in Malawi schools today, we will find both teachers and pupils engaged in conversation in local languages such as *Chichewa*. A clear look at the role local languages play in everyday life shows that it is used in everyday transactions that involve some mathematics. Yet teachers are prepared to teach mathematics using English with very little mention of the use of Chichewa.

In most mathematics syllabuses for primary schools in Malawi, there are recommendations that young children should be taught mathematics in local languages in the first school grade (Malawi Ministry of Education, 1966; Malawi Ministry of Education, 1976; Malawi Ministry of Education, Sport and Culture, 1982; Malawi Ministry of Education, Sports and Culture, 1991; Ministry of Education, Science and Technology, 1996)because it is a language most familiar to the children and, therefore, it can enhance classroom discussion. This policy is made because of ever increasing research evidence that children perform better when they learn in local languages rather than in foreign languages. Despite all this, it appears some people look down upon the use of local languages in favour of foreign languages (Ziege, 1997). Considering language is one of the teacher's major resources in the classroom (Edwards and Furlong, 1978), and that the local language is the most familiar language to both the teacher and the pupils, one may wonder why research studies on comparing the use of L1 and L2 as a medium of instruction in mathematics are so scarce.

This study is concerned with oral communication such as reading symbols and sentences and also explaining concepts by asking questions, giving instructions, responding to pupils' questions, procedural, giving instructions used in managing and controlling learning processes. The study does not intend to address the purely linguistic aspects such as grammar and tensenot non-linguistic communication such as gestures, laughter, eye contact, and others or semantics.

The methodology involved focus group discussions, interviews, questionnaires, mathematics vocabulary tests and classroom observations. The interviews and classroom observations were audio/video taped. Although case study design was used, both qualitative and quantitative approaches were used in data collection, analysis and reporting.

Coding systems developed by Bellack, et al. (1966) and developed further by Fanselow (1987) were adapted for use in analysing the transcripts from lessons and content analysis by the constant comparative approach was used to analyse transcripts from teacher interviews. Simple descriptive statistics were used to analyse teachers' knowledge about mathematics vocabulary equivalents and also teacher perceptions about the use of Chichewa and English in mathematics teaching. It was felt useful to compare the teacher language patterns between Chichewa medium and English medium mathematics teaching so as to assist policy makers on the formulation of language policy in education in Malawi.

1.2 Introduction to me

I was born in a Chichewa speaking community on 18 June 1959 in a town known as Namitete forty kilometres west of Lilongwe, the capital city of Malawi in the South East of Africa. I did my primary education in my home village between 1967 and 1974.

At the primary school, most of my schoolmates were speaking Chichewa. However, some teachers had problems in speaking Chichewa because they were mainly from the Chitumbuka speaking area. I remember Mr. Chirwa who taught us in standard four could mostly speak to us in English which to most of us was incomprehensible. I remember, one morning, a boy came on transfer from another junior primary school to join our standard 3 class. I remember vividly having seen him stand by the door with a chair in his hands saying to the class "Good morning class". We all looked at him. The teacher looked at him too and then asked. *Good morning ndiye kuti chiyani?* What do you mean by saying Good morning? He confidently answered "*Ndiye kuti zikomo*" it means excuse me. We all laughed and Mr. Chirwa called this boy rude and sent this boy back to the headteacher. From then, I was afraid to say anything in English for fear of making mistakes. I was not sure how to say it in the language that the teacher would understand. As a result the teacher always called me a quiet boy. But I wasn't; it was the problem of language that separated me from my teacher.

I was selected to go to a government secondary school at Likuni Boys in 1974 and where I met Mrs. Murphy, a History teacher. Her approach to teaching was interesting because she did not believe in teachers talking more than the pupils did. She would always ask a student to narrate a historical event from the "Junior Secondary History" textbook. I hated this approach. She was English and she spoke so fast that in most cases students could not follow her, judging from the type of silence that prevailed during her lessons. With the hangover brought from primary school, I was always afraid to talk in class for fear of using a language that no one would understand. I hated her subject such that when I was asked to choose between geography and history, I pretended to choose geography when in fact I chose a geography teacher. The problem was compounded by the fact that most teachers at this school were from Canada. Their English was also difficult to understand and then could not easily understand what I said. This affected my language interaction in the classroom.

In 1978, I passed my O-Level Examinations and got a place at the University of Malawi where I hated all the subjects that involved speaking in English. I studied sciences where I believed students spend much more time thinking rather than speaking. My spoken English suffered during my stay at the University, yet I chose to become a teacher. My perception of a teacher of sciences and mathematics was that one simply works out problems on the chalkboard and pupils copy and work out a few problems from the exercises in the book.

When I became a teacher, my first appointment was to teach at a school that was in a non-Chichewa speaking area. This experience gave me ideas about what role one's home language can play in classroom communication. The first few days I had problems in communicating with the school community. In the classroom, I was forced to speak English all the time, as any attempt to speak my home language would not actually help in communication. Having experienced it in the classroom as a teacher, I became interested in language issues in education.

In 1986, I went to study for a Masters Degree in mathematics education and in my research component of the course I studied how teachers use questions in a geometry lesson in selected junior secondary schools in Malawi. What I saw in the classroom reinforced my wish to do more research into language use in mathematics.

The desire to understand more about language in the classroom was enhanced further by my experience as mathematics curriculum development officer at the Malawi Institute of Education. I was recently involved in writing books for primary mathematics in the local language. This was not an easy task as we were doing this without enough information on what vocabularies to use to describe mathematical concepts. Although we were writing the books in Chichewa, some panel members were non-Chichewa speakers.

I remember arguing at length about the Chichewa equivalent of 'capacity', which in some places is called *Funkha*, and in other places is *Vunkha*. We were not sure which one to use although eventually we used *Vunkha*. The curriculum has since been implemented in standards 1 to 8, and mathematics is taught in local languages in standards 1 to 4 in Malawi and thereafter in English. But still the question of how language of instruction is used in the classroom lingers in my mind.

I took advantage of my Ph. D. to further my knowledge on classroom communication with regard to language influence on mathematics teaching and learning. As a teacher, I not only symphathise with pupils but also the teachers who are asked to teach in a language they may not be comfortable with during classroom communication.

1.3 Structure of the Thesis

In this 'Introduction' Chapter, I introduce myself as a classroom teacher and as one involved in curriculum design development and implementation, classroom research and evaluation of educational programmes, conducting in-service education for teachers, and producing instructional materials. One of my challenges has been to develop mathematics books for standards 1-4 in Chichewa, a local language in Malawi and also to assist teachers in implementing the mathematics curriculum in Chichewa. This was the genesis of this study. I outline here the structure and organisation of the thesis to help the reader follow the presentation. Finally, I provide some hints on issues to be considered when reading the thesis.

In Chapter 2, I review the models for understandingclassroom communication but find that because of the specialised function of the classroom, classroom communication is very complex and many researchers are still looking for the best model to distinguish classroom communication from ordinary communication. I decided to contribute to this search by filling in the gaps by comparing language use between Chichewa medium and English medium mathematics teaching.

In Chapter 3, I look for justification for studying the use of Chichewa and English in mathematics and not other subjects. I examined some of the claims that language plays a specific role in mathematics education and related the claims to a situation where two languages – Chichewa (L1) and English (L2) – are used in mathematics teaching. This led me to locate and describe the research problem as it exists in Malawi Primary Schools – which I discuss in Chapter 4.

The research problem, which guided this study, was *how do teachers use Chichewa and English in mathematics teaching?* I found the language policies in education, asking teachers to use Chichewa and English in mathematics teaching in primary schools in Malawi, quite challenging. It was my assumption that teachers were using Chichewa in mathematics teaching and that they would not be able to use English because of the sociolinguistic demands of the classroom as well as the subject content.

In Chapter 5, I discuss the issues to be considered when identifying the methodologies for exploring classroom communication. My focus was unique because it was comparing the use of L1 and L2 by the same teachers in mathematics teaching. Considering that language is a cultural aspect and that its use is related to the perceptions individuals have of the world around them, I decided to begin my study by looking at teachers' perceptions of the use of the two languages. I also considered one of the enabling aspects of the use of language, the vocabulary, to see if teachers had mastery of the necessary vocabulary in Chichewa and in English to enable them use the language in mathematics lessons. I then followed them into the classroom to discuss how they used the languages in the teaching. It is this conceptualization of the methodology that led me to develop a case study.

In Chapter 6, I describe the research design, sampling, instruments, fieldwork, data analysis and reporting the findings. Considerations and justifications are provided for any action I took in the course of collecting, analysing and reporting data. In Chapter 7 I report the data analysis procedures

Chapter 8 is a report of the major findings about the teachers' perceptions of the use of Chichewa and English in mathematics teaching The data from the three methods – focus group discussion, clinical interviews, questionnaires, teachers' knowledge of mathematical vocabulary equivalents in Chichewa and English were pooled together to develop themes about teachers' perceptions of the use of Chichewa and English in mathematics and and the findings from the discourse analysis.

Chapter 9 interpretes the teachers' concerns, pressures and issues into dilemmas and tensions. I also identify the possible sources of the dilemmas and tensions including the sociolinguistic images of the teachers. I conclude the chapter with the development of a sociolinguistic model of the mathematics teachers.

Finally, Chapter 10 is about the lessons learnt from the study in terms of its contributions to the findings previously made by other researchers on classroom communication especially in relation to bilingual teaching in mathematics.

The thesis closes with a list of references that have helped me to develop my argument through the thesis. However, the other important documents used in this study such as detailed sources of raw data have been put in the 'Appendices' section of this thesis.

1.4 Some considerations about the thesis

Finally there are some considerations to be kept in mind throughout this thesis. First, all the data were collected in Malawi, which is a developing country in Southeast Africa. This is why it was necessary to give as much information as possible about Malawi to substantiate the context of the study. Secondly, the interviews and some mathematics lessons were conducted in Chichewa, a national language in Malawi. However, attempts were made to translate the ideas into English for a wider audience. Therefore, in the text, the excerpts are presented both in Chichewa and in English to allow for an audience familiar with either or both languages to critically scrutinize the research evidence. I have used Italics or bold to emphasise certain words, sentences or phrases because of the special meanings I draw from them.

CHAPTER 2

UNDERSTANDING COMMUNICATION IN THE MATHEMATICS CLASSROOM

> *Classrooms are about work. They are places of purposeful activity even when the purposes of the actual activity taking place are not at all clear.* (Edwards and Furlong, 1978:84)

In this chapter, I discuss the theories and practices of classroom communication framework that guides this study. I hope that I have already given some indication of my own background and values in Chapter 1. Now I turn to examine the basis for a theoretical understanding of this thesis. I will endeavour to do three things in this chapter - (1) to think about teaching and examine the place of constructivism in teachers' use of language in classroom communication; (2) discuss models of communication; (3) to link communication with teaching strategies that explain classroom communication and recent research developments in mathematics classroom discourse that seem to suggest that teachers experience dilemmas and tensions. Exploring these issues is very important because they form the basis for teaching. One major task of the teachers in the classroom is to facilitate the construction of the meaning by the learner in an appropriate way. This chapter focuses on the role of communication in mathematics classroom.

2.1 Thinking about teaching

The role of a teacher in classroom communication is central and cannot be overemphasised. Yet different people see the role of a teacher differently. For example, Cooney (1988) sees a teacher as an *actor on a stage*. He quickly realises how narrow his views are when he further interprets teaching as an *interactive process*, a process of collecting, analysing and synthesising information. Cooney (1988) looks at teaching as an *active process* in which a teacher makes choices regarding what to teach, how to teach, who to teach, when to teach, what materials to use when teaching. No wonder therefore that he also regards a teacher as a decision-maker who gathers and encodes information, generates alternatives, and selects a course of action. But he leaves out whether teachers decide which language to use and how to use it during lesson presentation. This is possibly because his research was undertaken in a monolinguistic context. However, there are parts of the USA where pupils are from multilingual backgrounds (Lewelling, 1991). My research might therefore have some importance outside Malawi, and some relevance to USA for example.

Hough and Duncan (1970) describe teaching as occurring in four phases: *curriculum planning, instruction, measurement* and *evaluation*. They argue that "defining teaching as a four phase activity, each phase of which has distinguishable characteristics is a means by which we can understand this highly complex activity." (Hough and Duncan, 1970: 2) This definition, they argue, provides an organizing framework within which teaching as an abstract activity can be discussed and analysed. Although teaching is a complex, dynamic social activity that does not fit into a single model, it can be described, discussed and analysed. The findings from a study of teaching can be correlated to a particular act of teaching that has occurred or is occurring in the lives of a teacher and their students. This view of teaching allows me to place my study in a specific area of a teaching as a dynamic social process with an emphasis on classroom use of language.

A popularly quoted definition of teaching is the one by Scheffler (1973: 67) who states that "teaching may be characterised as an activity aimed at the achievement of learning and practiced in such manner as to respect the students' intellectual integrity and capacity for independent judgement." The definition suggests that in teaching there is an *aim* or *intention*. When a teacher teaches, does he/she have an explicit intention? If so to do what? What might be the hidden consequences? However, the definition further claims that teaching aims at the *achievement of learning*. Does this mean that teaching *causes* learning? Is there no teaching without learning? The definition claims that teaching should aim at practice in such manner as to respect the students' intellectual integrity. How does teaching take care of this claim? Are students involved in planning for teaching? How much do teachers know about their students before they teach? Providing for independent learning might be said to be one of the aims of teaching. These and many questions may lead me to think that teaching is not just a social activity but a process with communication as a central aim, which needs to be examined explicitly.

2.2 Teaching and constructivism

My research is theoretically based in constructivism. The general perception of constructivism has developed considerably over recent years and a theory of teaching and learning mathematics (Lerman, 1996). My discussion of constructivism will largely trace its applicability in understanding teaching as a communication process with the main focus on the role played by language use in helping pupils in constructing their knowledge.

Constructivism is a philosophical perspective on knowledge and teaching/learning. It has its origin in 18th Century, more recently through the work of Piaget (Piaget and Inheler, 1969) and Ausubel (1968), and has influenced many of the curricula and classroom practices in the world today. The theory of constructivism is generally believed to contribute to the teaching/learning of mathematics to the effect that most of the mathematics curricula in the United States of America and the United Kingdom were based of the principles of constructivism (Jaworski, 1991; 1994). Although the debates are still underway, my study of teacher use of language in mathematics teaching contributes to this debate by raising issues for the teaching of mathematics from a theoretical perspective and elaborating them from a practical perspective.

Modern constructivism is derived from the works of Piaget who was both a constructivistic epistemologist and a developmental psychologist whose work has influenced teaching and learning activities. Piagetian theory of constructivism can be understood through cognitive adaptation in terms of the learner's assimilation and accommodation of experience into action schemes. Piagetian theory appears to me to fit the observed facts about children's learning more satisfactorily than any other theory.

Naturally, not all of the elements of Piagetian Theory are regarded as suitable for explaining how children learn and acquire knowledge. Piaget's work seems to emphasise the learner as individual child rather than as a social being. By emphasising that a learner acquires knowledge through his/her own logicality, Piaget ignored many of the social and contextual implications of the child's thinking. His theory that a child cannot acquire knowledge unless he/she is mature enough to to do tends to work against the principles of teaching. This view has met vehement contradiction from other scholars such as Vygotsky (1962). The importance of mathematical development in a child is indisputable. However, how can teaching foster this especially in the context of language use in the classroom?

The notion of cognitive adaptation is alluded to the theory of constructivism. Based on this notion, von Glasersfeld (1991; 1995) defines radical constructivism as a theory of knowledge based in *philosophy*, *psychology* and *cybernetics* with two principles as

1. Knowledge is not passively received but actively built up by the cognising objects.
2. The function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality.

My main interest in constructivism is in its relation to teacher use of language to help pupils construct mathematics knowledge; I shall pursue those aspects of constructivism, which relate to my area of interest. The first principle says that knowledge is actively constructed from the environment. This principle can be perceived in Ausubelian theory of learning as "the learners' understandings are dependent on prior knowledge and experiences" (von Glasersfeld, 1991).

However, the first principle cannot stand without the second one. Knowledge construction and adaptation are results of cognitive structuring which fundamentally is biological as acknowledged by Piaget's genetic epistemology in two ways. First, the function of cognition is adaptive in the biological sense of the term tending towards fit or viability. Second, cognition serves the subject's organisation of the experiential world not the discovery of an objective ontological reality.

Radical constructivism emphasises that an individual learns by adapting. Knowledge is an accumulation of experience. Every new experience adds to or challenges the previous ones, resulting in reorganisation of the previous state to accommodate the new experience and not to a discovery of a real definitive world.

Thus knowledge results from individual construction by modification of experience. Radical constructivism does not deny the existence of any objective reality, but it does say that we can never know what that reality is. We each know only what we have individually constructed.

These views have major implications for the classroom. First, the teacher, who wants pupils to know, for example, about graphs, possibly because the syllabus requires it, has her own understanding of graphs. It is very easy for her to dwell in an *ontological* state of mind, acting as if there is an object known as graph that he knows and that he wants his pupils to know too. If the pupils do not show the same understanding of the graph, the teaching is said to have failed.

Second, the context in which a statement is made is crucial to the validity of the statement and it is very difficult to say therefore when a statement is true without knowing this context. Teachers may think in terms of challenging a pupil's misconceptions but if there are misconceptions, what are the conceptions? Are there any conceptions in misconceptions? It is in response to such questions that constructivism is seen as the way we come to know rather than knowledge itself. This raises the question of constructivism, meaning and communication.

In constructivism, emphasis is on the belief that knowledge is a personal construct, one's inner reality. The knowledge fits together through the experiences as one encounters them. These experiences include the interactions with other people who have their own constructs of knowledge, the adaptations of the differences in the perceptions of knowledge and a shared knowledge. This view can be complex for a teacher in the classroom. If a teacher encounters a new concept from the pupils that does not fit his structure of the knowledge, should the teachers accept this as new or ignore it and insist that his is the knowledge? Indeed when teaching mathematics, teachers must be aware that their construction of the knowledge is likely to be different from the pupils and different from those of each other. Indeed in teaching, the words used are those of the teachers with meanings of the teacher and pupils in hearing the teacher's words will interpret them according to their meanings.

In constructivism, communication is a process of fitting what is encountered into existing experience and coping with constraints such as dilemmas and tensions in perception. When a teacher attempts to communicate with pupils various sensory exchanges occur. They are likely to listen to each other and observe the gestures in order to interpret the voice, pausing and emphasis, facial expressions, hand movements and so on. Each party speaks; it gets responses, which it tries to make sense of in terms of their own meanings and intentions. Thus the interpretation made would be conditioned by the mutual experience of both the teacher and the pupils concerned. This brings about *prolepsis* a term used in linguistics to describe the way in which a person speaking might presuppose some unprovided information.

In constructivism, teachers and pupils are considered as meaning makers who give contextually based meanings to each other's words and actions as they interact. Because teachers and pupils each construct their meanings for words and events in the context of the on-going interaction, it is readily apparent why communication often breaks down, why teachers and pupils frequently talk past each other. The constructivist's problem is to account for successful communication in the classroom, which requires some attention to the social context of that communication.

The theory of constructivism seems to require a move from a purely individual view of knowledge construction to one in which the social processes of discussion and negotiation have a significant role to play. Ernest (1991) identified two key features of social constructivism- that there is the active construction of knowledge and that there is the essential role played by experience and interaction with the physical and social worlds, in both physical action and speech modes. A third feature suggests that reality is constructed intersubjectively; it is socially negotiated between significant others who are able to share meanings and social perspectives of a common lifeworld (Jaworski, 1994). This view of constructivism recognises among others, the role of language in knowledge construction. In the social environment, other individuals who have a powerful role to play, challenge a human learner. Through use of language and social interchange individual knowledge can be challenged and new knowledge constructed. Moreover there comes a shared or common or intersubjective knowledge.

The status of intersubjectivity is a problem not only with the understanding of how teachers and pupils negotiate access to knowledge in the classroom through the use of language, but also in trying to negotiate for perceptions for the validity of the research findings. In my research, it has been important to reconcile the differing perspective of classroom situation and mathematical perspectives of those participating in the research. Any person's account of the classroom research presents an individual subjective construction of events. When people involved in an event negotiate their individual accounts it is possible to reach some levels of agreement of interpretations of the events; thus common construction results which may be regarded as intersubjective.

The transition from radical to social constructivism can be associated with the transition from the works of Piaget (Piaget and Inheler, 1969) and the works of Vygotsky (1962). Piaget believed that learning results from a child's actions related to the external world. Vygotsky (1962) placed great emphasis on social and linguistic influence on learning and in particular on the role of the teacher in the educative process. He introduced a concept to provide a measure of a learner's development related to instruction offered. Known as "the zone of proximal development", this is an account of how the more competent assist the young and the less competent to reach that higher ground from which to reflect more abstractly about the nature of reality. Vygotsky (1962) believed that with appropriate instruction, there may be potential for a child to reach higher conceptual levels than she would be able to achieve naturally. Some of the Vygotskian tenets that have been subjected to rigorous scrutiny include:

1. *Situated learning*: Learning occurs during situated activity or in authentic setting such as the classroom setting

2. *Socially shared cognition*: cognition is always socially mediated or influenced by others in social interaction. Learning, thinking and knowing arise through collaboration with others

3. *Joint Activity*: For learning to become internalised, mediation must occur during the actual problem solving and joint activity or shared task definition with others

4. *The zone of proximal development*: Learning can be enhanced through sensitive relationships that employ

    - shared responsibility within the learners' zone of proximal development
    - gradations of free reign for experimentation
    - structured, content specific and contingent feedback
    - reflective assessment, or bringing attention to the ongoing action during instruction

5 *Culture, context and cognition*: Culture and social contexts impact upon how and what students think (Samaras and Gismondi, 1998).

According to Jaworski (1994: 27) one of the consequences of these views is that "teachers will realise that knowledge cannot be transferred to the learners by linguistic communication, but that language can be used as a tool in the process of guiding the student's construction of knowledge". Implicit in this belief is that teachers should use language to guide student's construction of knowledge by devising appropriate responses as a result of the language usage. The pupil talking to the teacher and stimulated by the teacher's prompts and responses reveals aspects of awareness, which provide clues about understanding.

Construction of knowledge in the classroom should go beyond interaction between the teachers and the learners to include the interaction among the learners and other sources of knowledge. It is crucial for teachers to realise how mathematics learning is linked to language, social interaction and cultural context. My own experience is that mathematics has been taught using language as if the language itself bore little relation to the acquisition of mathematical concepts, and within social structures without regard to what influence those structures might have on the teaching and learning process. There is a growing literature that addresses ways in which language and social aspects impinge on the learning and teaching of mathematics. This has come through a concern with the language of mathematics and its relationship to issues of language usage in learning more generally, and concern for bilingualism in education (Austin and Howson, 1979; Pimm, 1987; Orton, 1987).

It appears there are still some issues unresolved about understanding how the mind constructs knowledge and this makes it paradoxical to apply the theory of constructivism in classroom communication. Although the major purpose of teaching is to provide an opportunity for the learner to construct knowledge, it is still hazy as to how teachers use language to facilitate knowledge construction. According to Jaworski (1991; 1994) there are some challenges in using the theory of constructivism to understand classroom processes. If cognitive structures are innate and merely fixed or instantiated through experience (Chomsky, 1975), are teachers using language to activate the innate cognitive structures? If so, how? Bruner spoke of *scaffolding* learning. Jaworski (1994: 31) elaborated further this notion of *scaffolding* "in terms of a teacher offering strategies for teaching and learning rather than for grasping a particular skill or concepts". My experience as a mathematics teacher is that teachers offer the scaffolding through use of language. Wood (1988) provides a further explanation of scaffolding which he calls "*contingent instruction*" (Jaworski, 1994) by the teachers - pacing the amount of help children are given on the basis of moment-to-moment understanding. However, scaffolding raises the question of how much contingent instruction should provide and how much is left for the individual to construct.

2.3 Transmission models of classroom communication

In this section, I discuss the place of communication in the teaching process. To do this, I examine what constitutes the communication process by reviewing communication models and strategies, link their elements to the mathematics teaching process and compare the communication models with the theory of constructivism.

It is important to have a common operational understanding of what constitutes communication so as to appreciate its place in teaching. Tarone (1980) views communication as a mutual attempt of two people engaged in communication to have a common understanding of knowledge. This notion of communication presupposes that there are two parties who mutually attempt to seek meaning where one party knows and the other party does not know. The implication of this notion for classroom communication is that teachers and pupils should be considered as making a mutual attempt to agree on a meaning. Perhaps the question is how this is achieved. I believe that actually in the classroom "requisite meaning structures are not shared" (Bialystok, 1990: iv) in that teachers believe they know and pupils do not know.

A number of models of classroom communication have been developed. However, most of them are based on the principles of general communication. In this thesis, I will examine two models of classroom communication, which show the progressive complexity – these are models of Sless and Hills. I will then consider the description of classroom communication as perceived by Edwards and Furlong (1978) and conclude with an assessment of the contemporary direction of research into classroom communication in mathematics education. It is hoped that understanding the general principles of communication will assist in interpreting classroom communication processes in mathematics education being explored in this study.

Sless's Model of Communication

Sless (1986) conceives communication as consisting of the transmission of a message from the source to the receiver through a medium and that the receiver must integrate the message in the mind. Figure 2.1 is the theoretical map showing the relationship between teacher, content, medium and pupils.

Information *Source*	→	Transmitter *Teacher*	→	Medium *Language*	→	Receiver *Pupils*	→	Destination *Mind*

Figure 2.1: The relationship between the teacher, medium, language, content and pupils (Adapted from Sless, 1986:13-15).

To use this model in explaining classroom communication implies that in any teaching and learning process, the teacher is one of the many transmitters of the messages (content) which is contained in a medium (language) (Figure 2.1). Other transmitters are such materials as printed matter. The model suggests that the most common source of the content in classroom communication is the teacher (and the target group is the pupils) who initiates, facilitates and organises the content in a medium that conveys it to the pupils. The teacher has to have the content in the form of mathematical symbols, concepts, principles and relationships. The teacher processes this in an appropriate language that is meaningful to the pupils.

The model also suggests that the major component of any communication is the medium because it has to allow the content to flow freely from the source to the target group. Naturally, in classroom communication, pupils receive the content through language. For the pupils to be active learners of the content, they must be competent enough to use the medium to share and discuss the content. As a result, teachers must recognise pupils' need for knowledge of, attitude to and practices in the language of instruction. Failure of pupils to comprehend either the language used or the content being taught may lead to ineffective learning of mathematics.

The model in Figure 2.1 also suggests that the destination of the learning content is the mental (cognitive) domain. A child has to make sense of or process the context in the medium and store it in the memory. This is what constitutes meaningful learning (Ausubel, 1968; Orton, 1987). Wood (1988) argues that children may fail to solve a problem being set by an adult or misunderstand something being taught or explained to them not because they lack certain intellectual abilities but because they don't understand the language being used. This problem of communication breakdown can be more pronounced where the local languages in mathematics involve simply replacing a refined mathematical language, as Griffiths and Howson (1974) argue, by a crude one without considering that different languages carry to the child different mathematical meanings. The effective use of a language as a medium of instruction in mathematics should take into consideration the differences in knowledge of, attitude to and practice in language between teachers and their pupils (Wood, 1988; Durkin and Shire, 1991). In the case of this study, I am concerned with exploring if the languages - Chichewa or English - used in the classroom are carrying the intended message to the learner who in turn correctly interprets the message.

However, considering that classroom communication serves a special purpose of facilitating learning (Edwards and Furlong, 1978), it is perhaps deceptive to consider communication as so simple and straightforward. Hence the need to explore a model that specifically addresses classroom communication.

Hills' Model of Communication

Hills (1979) provides further understanding of teaching and learning as a communication process. Just like Sless (1986), Hills (1979) looks at communication as the transmission of information between a sender and a receiver. He used a model of communication developed by Shannon in the 1940s to advance his arguments (Fig 2.2):

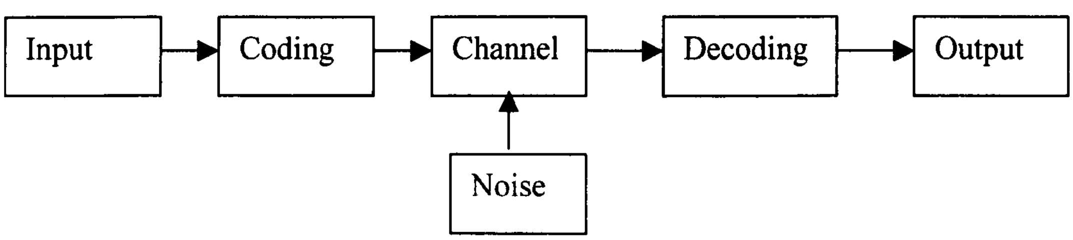


Figure 2.2: Shannon's model of communication.

He argued that there are two main types of persons concerned with communication in teaching and learning: the teacher as sender of the message and the student as receiver of the message. He went on to modify Shannon's model to show the area of direct concern for the sender and the receiver, as in Figure 2.3:

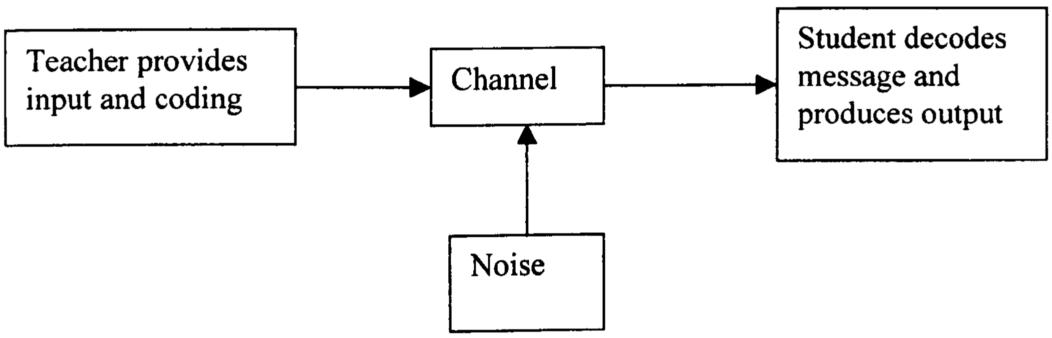


Figure 2.3: Modified Shannon's model of communication.

From this model, Hills (1979) quickly points out the absence of *feedback*, which he emphasised as an important part of the process of communication in education. Teacher input refers to the subject content determined by the curriculum. In teaching, ideas and statements are displayed either in writing or by the spoken word, reinforced by non-verbal messages. By doing all this, the teacher is said to be coding the subject content in a manner that the student will understand. However, feedback ensures that the intersubjective knowledge is being constructed.

Hills (1979: 16) defines coding as "the process of making the desired input visible to the student". He emphasised that "...the teacher needs to be concerned that the coding is such that the student is able to receive the material and will be able to understand and decode it." Hills (1979: 16) describes the process of coding involved in classroom communication when he says that:

> The teacher makes his ideas *visible* [emphasis added] by coding them into the series of symbols, which go to make up spoken or written language, or into common pictorial symbols. The essential condition is that the student should speak and understand the same series of symbols. This includes the specialised symbols associated with particular subjects. Does the student understand the meaning of any special words used in the subject? Is the student's background knowledge sufficient for the level at which the teacher is coding the subject? Without the compatibility of coding and decoding processes there will be no communication, since symbols can only be representations of events and not the event itself (Hills, 1979: 16).

What Hills is questioning here is how teachers can make pupils access mathematical knowledge through language use for language itself is not mathematics.

Hills (1979: 17) describes a channel of communication - referred to as medium by Sless - as a means of conveying the message to a pupil accurately. He points out that the main consideration in choosing the channel of communication is that it should clearly and accurately conveys the message to the pupil. He went on to argue that "the message conveyed by a chosen channel of communication could in no way convey the same message that the actual event itself could convey" (Hills, 1979: 17). This notion suggests that if mathematics knowledge is the message and language use as an event, then the mathematical knowledge is different from the language used to transmit it. His understanding is that "the message conveyed, in addition to being compounded of the choice of symbols selected by the teacher and the way in which they are received by the student, has certain inherent characteristics which are present as a necessary part of the channel of communication chosen" (Ibid: 17).

There is *noise* in the channel of communication that distorts the message. Hills (1979) identifies some of the sources of noise as the teaching environment, the size of the group and the teacher himself or herself. Perhaps missing from this list is how the medium itself can be a source of noise in learning subject content. A noisy medium is that which lacks the mathematical register and thus brings about misconceptions, making application of language skills very difficult. The notion of noise in a communication process makes classroom communication more complex than thought.

On pupils coding messages and producing output, Hills (1979) argues that pupils are expected to demonstrate some behavioural change resulting from interaction processes between them and the teacher and also to demonstrate some knowledge, skills and attitude that the teachers code in the process of communication. This, according to Hills (1979), is what constitutes pupils decoding message and output.

According to Hills (1979: 18):

> feedback is an important part of any self-regulating mechanism and, since human beings are largely self-regulating mechanisms, this must be considered in the context of teaching and learning. ...Instead of the process consisting simply of the teacher passing messages to the student, the communication process should be a dynamic interchange with the student feeding back information on how the teacher's messages have been received; as a result of this he can amplify or extent the communication as necessary" (Hills, 1979: 18).

Hills (1979) then developed his communication model around the three main categories; teacher processes, channel of communication and pupils' processes as in Fig 2.4. The fact that the arrows are pointing in one direction suggests that the model is not interactive and this makes it less suitable for explaining classroom communication.

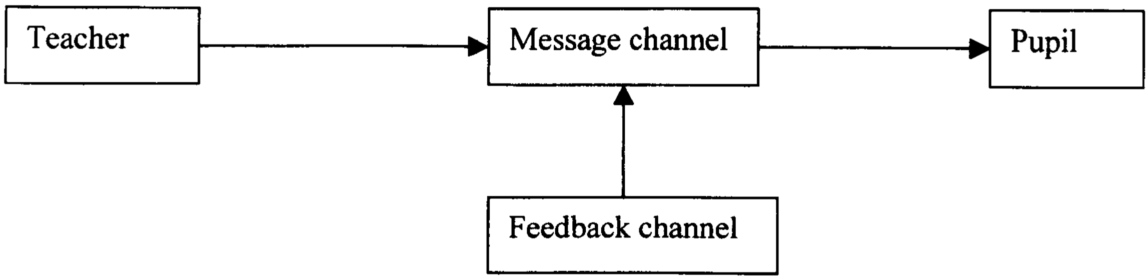


Figure 2.4: Hills' model of communication.

So far I have talked about a teacher talk as a way of sending a message during the communication process. It is also important to understand how students receive the message, as this is essential in ensuring that there is shared knowledge - intersubjectivity in construction of knowledge. Students receive the message through verbal sound by *hearing and listening*. It is important to distinguish between hearing and listening as they stand for different levels of receiving messages. According to Hills (1979: 32), "hearing occurs when sound falls upon the ear. Listening, however, involves more than this. It involves the processing of the message by the listener." Thus hearing is biological whereas listening is cognitive in nature. Hills (1979) considers listening as involving the processes as in Figure 2.5.

On this model, Hills (1979) argues that sound or words may only be heard indistinctly and the listener supplies any missing parts that depend on previous knowledge or experience of the listener - the social construction of meaning. Most verbal communication can often be misheard due to its mismatch with previous experience and knowledge. Clarity of speech and *planned repetition* of the message may be important in this context.

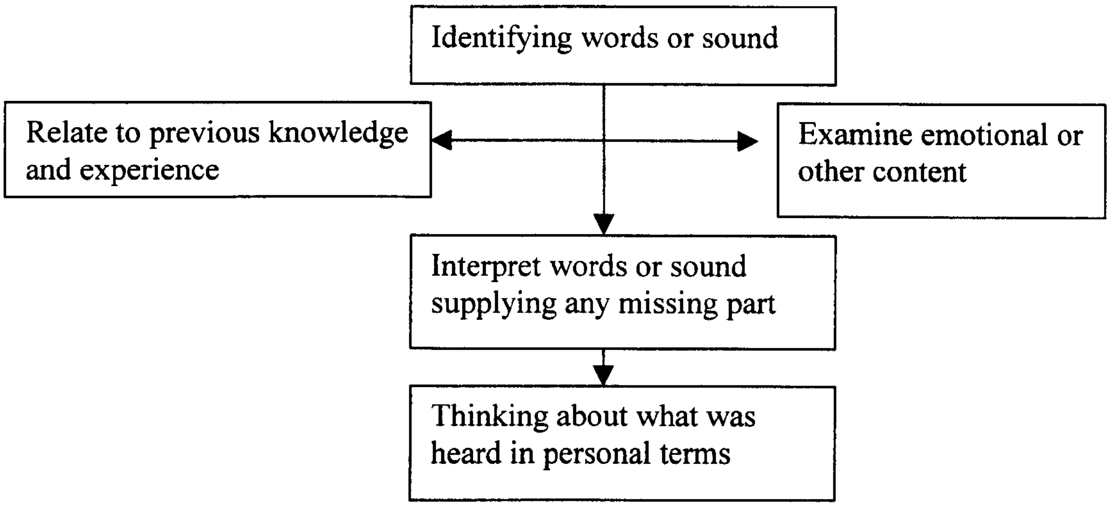


Figure 2.5: Hills' Model of Listening.

Listening can be linked to understanding. As Hills (1979) put it, understanding is an active process involving the interaction of sensory information with our general knowledge of the world. It is important to make sure that the pupil has sufficient background information to be able to listen meaningfully. This calls for an examination of the two languages, Chichewa or English, to find out which one of the two would make the use of language less stressful; thus provide pupils with sufficient background information to be able to listen meaningfully in mathematics teaching.

One other important aspect of verbal communication is *teacher-pupil verbal interaction,* which is achieved when the two people or groups are engaged in a dialogue. Hills (1979) observes that when dialogue takes place people take turns to speak. If the conversation is flowing easily there will be a definite rhythm of length of talk for each person, of speed of reply, the tendency to interrupt, etc. This is a superfluous view of classroom communication because it may not reflect what actually happens during classroom communication. Teachers have to cope with a host of problems so that when a conversation is not going well between a teacher and pupils, there is a great tendency for the teacher to go on talking so that the contact between them is not broken by awkward silences (Edwards and Furlong, 1978). This view of communication may not explain classroom communication because, as Edwards and Furlong (1978) argue, teacher dominance is the required strategy of classroom communication and not an indication of things going wrong. Teacher dominance in classroom communication should not be interpreted as lack of communication skills but something else that needs to be discovered.

2.4 Communication skills and strategies

It is important to distinguish between a communication *skill* and a communication *strategy* if we are to understand why teacher dominance in classroom talks is a desirable characteristic of classroom communication (Edwards and Westgate, 1987). According to Yeung (1991), *skill* is the ability to do something. For example communication skills may refer to the ability to communicate whereas *strategy* may refer to a plan to achieve communication. The argument is that when planning how to teach, a teacher requires both communication skills and strategies to achieve learning.

2.4.1 Communication skills

According to Yeung (1991) generic communication skills are speaking, listening and non-verbal skills. Verbal communication skills are *speaking, observing* and *listening.* In my thesis I am concerned with speaking skills more than those other communication skills. Consequently, in my discussion I dwell much on the speaking skills as they relate to teaching and classroom communication.

Yeung (1991) identifies the speaking skills, which include using survival words and phrases appropriate to the situation to cope with emergency situations and in an order that clearly expresses the thought. Speaking skills should also emphasize speaking loudly enough to be heard at a rate such that the listeners can understand the purpose. In speaking, the speaker should aim at saying words distinctly, stating main ideas clearly and supporting main ideas with important details. Speaking skillfully should also involve *describing* objects, events and experiences, *asking* for given straightforward information and *questioning* other's views.

However, if these language skills are used habitually, they lose meaning. To understand the importance of using these skills, we should begin asking why the speaker is, for example, raising his or her voice or is asking questions. My concern is not just describing what the speaker is doing but more to describe why and how the speaker is doing it.

It is possible to identify and describe the communication skills being used in a particular communication setting. For instance, Yeung (1991) suggests the methods for assessing speaking skills should focus on the use of communication codes such as words, pronunciations and grammar for the situation: use appropriate language, grammar and pronunciation which are understood by others. Use of voice effectively, use of appropriate rate, speaking loudly enough and use of appropriate clarity must also be considered. In identifying communication skills, the oral message must be evaluated -identify main ideas in messages; distinguish facts from opinion; distinguish between informative and persuasive message; recognise when another does not understand your message.

Other basic speech communication skills that must be identified include expressing ideas clearly and concisely; expressing and defending with evidence your point of view; organising messages so that others can understand them; asking questions to obtain information; *answering questions* effectively; giving concise and accurate *directions*; summarising messages. A human relation is one of the communication skills that should be identified. It should involve describing another's view point, the view point of one who disagrees with you, the viewpoint of one who agrees with you, differences in *opinion*; express feelings to others - expressing satisfaction or dissatisfaction and expressing empathy; performing social rituals - *introduce yourself*, requesting an appointment and concluding a conversation.

It is this holistic view of communication skills that is desirable yet challenging in understanding classroom communication. Almost all these communication skills may be practised in classroom communication; but perhaps the focus should be on how they are practised. However, it is too much to explore all these communication skills in a study of this nature. It is the third, fourth and fifth points that relate closely to my thesis. I would like to explore how teachers use communication skills by examining the functional part of every utterance as the function of classroom communication may guide the skills used and the communication strategies employed. But before that, understanding communication strategy as it relates to classroom communication may highlight the language behaviour of teachers and pupils during mathematics lessons.

2.4.2 Communication strategy

What goes on in classroom communication is contingent upon teacher strategy to communicate content. The notion that communication strategies are systematic techniques employed by a speaker to express his/her meaning when faced with some difficulty (Corder, 1977 in Faerch and Kasper, 1983) presupposes that communication is organised around a set of skills that a speaker uses to convey a message. For the speaker to employ such a strategy, he or she must have been confronted with a problem. Corder's (in Faerch and Kasper, 1983) perception of communication strategy raises some questions. Does communication always require a strategy? What strategies are employed in an informal conversation? Do they differ significantly from those employed in a formal setting such as the classroom? Are all communications meaningful? What about teacher classroom-communication - does it carry meaning? Before I attempt to answer these questions in this section, I will examine another view of communication strategies as put forward by Faerch and Kasper, (1983) and also by Stern (1983).

Faerch and Kasper (1983) describe the communication strategy as "potentially conscious plans for solving what to an individual presents itself as a problem in reaching a particular communication goal". The issue of deliberate plan, realisation of the existence of a communication problem and setting out a communication goal become of paramount importance in ensuring that a communication strategy is employed. In trying to communicate, teachers and pupils plan and prepare for classroom communication. Teachers prepare to speak first, more and last whereas pupils prepare to listen, wait for their turns to speak and speak less than the teachers (Edwards and Furlong, 1978).

Stern (1983: 411) considers communication strategies as "techniques of coping with difficulties in communicating in an imperfectly known second language". This notion of communication strategy assumes that communication strategy arise from some difficulty in communicating in a second language. When the speaker is aware of the difficulty, he or she employs a technique. But this way of looking at communication strategy raises some questions as to whether teachers employ communication strategies because there is a difficulty in the classroom. It is also interesting to learn what happens to communication strategies when a teacher uses different languages during communication.

Trying to examine the concept of communication strategies, we meet three features: *problematicity, consciousness* and *intentionality* (Stern, 1983). *Problematicity* is the idea that strategies are used only when a speaker perceives that there is a problem, which may interrupt communication. To understand this we need to distinguish between language strategies and non-language strategies; between *problematic* language use and *strategic* language use. The problem is to communicate the planned content in the planned methods. Teachers do not want to be disturbed from their plans. Therefore, the problem is how to manage and control the learning process (Edwards and Furlong, 1978). The strategy is characterised by what Edwards and Furlong (1978) call 'coping strategy'.

Stern (1983) suggests that *consciousness* occurs when the speakers are aware of the communicative moves. But are they always aware? Consciousness calls for choice, which serves strategic purposes and perhaps avoids potential misunderstanding by the listener. The choices, however, may be made entirely without the conscious consideration of the speaker. Using consciousness as a criterion for communicative strategies has a rather restricted implication that strategy use is available only to those speakers for whom conscious reflection is possible. The plans that speakers develop as a part of the process of language production may or may not be conscious and this consciousness may change on different occasions-that strategies are potentially conscious plans. But without some independent means of deciding which plans could potentially be conscious, one is left to assume that all plans are potentially conscious. Hence there is no means of distinguishing plans that lead to strategic speech from those that do not by virtue of consciousness.

Intentionality refers to the speaker's control over a repertoire of strategies so those particular ones may be selected from the range of options and deliberately applied to achieve certain effects. The assumptions are many. First, the speaker has control over the strategy that is selected. Second, the choice is responsive to the perceived problem that presupposes consciousness.

The knowledge of communication strategies has implications for how to study teacher use of communication skills such as speaking in mathematics teaching. I want to argue here that there would be systematic relations between the user, communication strategies and specific conditions of the communication situation. A speaker would select a strategy according to some relevant sociolimguistic factors such as his/her level of proficiency in the language, the nature of the concept being communicated, the conditions under which communication is occurring.

The preceding discussion is important, if I am to study communication skills in the classroom, there is a need to determine consistent means for identifying communication strategies being employed by the teachers and distinguishing them from what might be considered non-communication strategies within the teaching domain. There is a need to explain this communication process through an analysis of that portion of speech that is deemed strategic to communication. There is also a need to assess the prognosis for communication in the strategies considered being effective so that teachers can improve in their ability to solve certain communication problems.

2.5 Constructivism and transmission theories in classroom communication compared

There are both similarities and differences between constructivistic theory and transmission model of classroom communication. The two are similar in that they are a social behaviour in which language plays a significant role useful in the teaching and learning process. On the other hand, contradictions arise between constructivistic theory of learning and transmission models of classroom communication, as summarised in Table 2.1.

The contradictions that exist between constructivist theory of learning and the transmission models of classroom communication are a challenge to effective mathematics education. Research into mathematics education has recently been focusing on the roles played by the social, cultural and linguistic contexts in the mathematics classroom as well as teachers' beliefs, attitudes and perceptions.

Table 2.1: Summary of the principles of constructivism and transmission models of classroom communication.

Constructivistic theory of learning	**Transmission models of classroom communication**
1. Knowledge is actively built up by the cognising objects.	1. Communication is an attempt to have a common understanding of knowledge.
2. The function of cognition is adaptation and organisational of the experiential world.	2. Knowledge is transmitted from the source to the receiver through the medium/channel.
3. Knowledge is personal construct, ones' inner reality.	3. The function of the cognitive domain is to receive, store and retrieve the knowledge when needed.
4. Individuals learn by adapting.	
5. Learners, understanding are dependent on prior knowledge and experience.	4. Language plays a role of a medium through which knowledge is transmitted.
6. Communication is a process of fitting what is encountered into existing experience and coping with constraints.	5. A teacher is a sender of the knowledge whereas a pupil is a receiver of the knowledge.
	6. Noise and feedback play a significant role during the transmission of knowledge.
7. Teachers and pupils are meaning makers who give contextually based meanings to each others' words and actions as they interact.	7. Knowledge is acquired through hearing and listening.
8. Social processes of discussion and negotiation have a significant role to play.	8. The success of the transmission of knowledge depends on the communicative skills and strategies of both the teacher and the pupils.
9. Knowledge is shared - intersubjectivity.	
10. Knowledge construction is linked to language, social interaction and cultural context .	9. Classroom communication is basically a coping strategy more than knowledge construction.

The use of mother tongue was perceived as a way of achieving high levels of constructivism in classroom communication. However, Bunyi (1997), reporting of the experiences of the use of Kiswahili in place of English in Kenya, argues that regardless of the instructional medium, a transmissional model of classroom communication predominates. The application of constructivism must be based on the realities of the local situations. The similarities and differences between constructivism and transmission theories in classroom communication may arise as a result of teachers' beliefs, attitudes and perceptions as I explore in the next section.

2.6 Studies on teacher beliefs, attitudes and perceptions

Beliefs, attitudes and perceptions influence action. Teaching is an emotional activity that is likely to be influences by beliefs, attitudes and perceptions. There are substantial research findings about the teachers, beliefs, attitudes and perceptions of language of instruction, teaching as a profession and mathematics education. The teacher perception (understanding based on what is observed or thought) and use of language in mathematics teaching is likely to be associated with teacher beliefs (acceptance of something as true or real*)* and attitudes (general feeling about something) towards teaching in general and use of language in teaching in particular. The teacher beliefs and attitudes towards the teaching and learning of mathematics may also influence their perceptions and use of language in mathematics teaching although studies in this area are scarce.

Substantial studies suggest that teachers' beliefs and values about teaching and learning affect their teaching practices. Stipek, et al. (2001) examined teachers' beliefs and practices that were directly related to inquiry - oriented mathematics instruction among elementary school teachers in Los Angeles, USA. The findings showed substantial coherence among teachers' beliefs and consistent association between their beliefs and their practices.

Studies on pre service teachers have indicated that teachers have well-developed set of personal and professional beliefs about teaching and learning (Joram and Gabriele, 1998). The notion that teachers come into teaching profession with prior set of beliefs that influence the way in which they organise their teaching is a key principle in understanding teaching theory. Those concerned with teacher education have also begun to study the beliefs and attitudes of teachers towards use of various teaching techniques.

Joram and Gabriele (1998) define teacher beliefs are implicit often unconsciously held assumption about learners, classroom and content. Teacher beliefs are stable and resistant to change and reflect the nature of the instruction the teacher provides to students. The *nature of teacher beliefs* is such that they:

- sometimes contain assumptions about the existence of entities beyond teachers' control or influence;
- can include conceptualisation of ideal situations that differ from reality;
- rely heavily on affective and evaluative components;
- derive much of their power from memories of specific events;
- are not open to critical examination or outside evaluation;
- may apply to undefined domains of specific beliefs (Joram and Gabriele, 1998).

These properties of teacher beliefs distinguish them from perceptions, the focus of this study.

Many studies have shown that teachers' attitudes about *language use* influence teaching practices. Williams and Naremore (1974) studied teachers' ratings of children's speech and teachers' indicators ratings of expectancies for children of various ethnic groups. Teachers assigned relatively high ratings to Anglo children while assigning low scores to Mexican - American and African - American students that reflected ethnic and language stereotyping. Sparapani, et al. (1995) found that teachers' attitudes towards language use influenced where to teach in Alabama, Michigan, Montana, New York and Washington.

Research on teacher beliefs indicate that a particular set of beliefs on a specific educational issue is always functionally connected to a more generalised belief system, which is highly meaningful in creating change. An emotional atmosphere surrounds beliefs, which influence cognition. In their study, Shechtman and Or (1996) found that teacher beliefs may be altered to some extent, although the task in quite difficult.

In her study of Vietnamese immigrants to the USA Kelly (1997) found that teachers' attitudes significantly affected the content of and interaction around instruction. Byrnes and Kiger (1997) found that teacher attitude towards language use is positively associated with formal training, experience and high teaching qualification. Nettle (1998) conducted a study on the strength of student teacher beliefs on teaching and also orientation towards teaching. The findings indicated that students' teachers were more oriented towards teaching tasks than affective aspects of teaching. It was also found out that student teachers beliefs changed with training as they became less motivated and oriented towards relationship; instead became more activity and structuring oriented.

2.7 Research in multilingual mathematics education

In the opening chapter of her book Adler (2001) contends that research in multilingual mathematics education reported in the 1980s and early 1990s did not focus on classroom practices. She draws examples from Cocking and Mestre (1988), Clarkson (1992), Durkin and Shire (1991) who all took up the issue of bilingualism and mathematics learning and argued that bilingualism *per se* does not impede mathematical learning. Their focus was on cognitive functioning of learners in bilingual settings, and particularly learners whose "mother tongue" was different from the "language of instruction" Some of this research explored the relationship between levels of bilingualism and mathematics performance, building on Cummins' notion of the 'threshold hypothesis' (Baker, 1993: 135). Some explored particular aspects of the mathematics register, like word problems, or logical connectives and reading in mathematics.

Adler (2001) supports Rubagamya's observation made in the early 1990s that there is little known about how things get done in multilingual classrooms. Rubagamya's observation reflected my own experiences and concerns that inspired me to embark on a study in understanding teacher use of language in bilingual mathematics classrooms. My concern with this has gone even further. In addition to not exploring how teachers and learners get things done and none of the research drew directly on practice-based knowledge (Lampert and Ball, 1998), on what teachers themselves knew about the demands of their practices in these settings.

More recently, research has shifted to classroom practices. Analyses have focused on interactions in the classroom, and how learners' main languages interface with the language of learning and teaching and the "subject" (mathematics) being learnt (Cocking and Mestre, 1988; Pimm. 1987; Jaworski, 1994, 2000; Adler, 2001). The shift brings into focus a different unit of study. The cognising individual is replaced by discursive practices. Classroom discourse becomes the focus, and utterances between teacher and learners, and learners themselves, the unit of study. This study has shifted the problem from a deficit in the learner and what treatments might therefore be required for learners to overcome their disadvantage (Kachaso, 1988), to a location of the problem in the wider social order. The study instead has become understanding, describing and explaining a set of complex social interactions and relations in the classroom. There is a related shift in theoretical assumptions from a relatively narrow focus on learning as a function of individual cognition, to a wider conception of learning as constituted in and through social, and particularly discursive practices. Simply, classroom communication and communicative competence of the teacher and the learners should not be taken for granted.

Studies conducted elsewhere have all shown ways in which switching between the learners' main language and English (or French) by learners and the teacher has enhanced the quality of mathematical interactions in the classroom (Ndayipfakamiye, 1994; Setati, 1998; Adler, 2001). The studies reveal that while the relationship between language and mathematics education in multilingual classrooms has a specificity, understanding how teachers [and learners] use language to get things done requires much more than probing learners' access to and proficiency in the English in different context. Adler (2001) argues that it requires working with *language-in-use* in the classroom, and thus simultaneously with *access to English, to mathematical discourse and to classroom discourses.* As I have noted earlier, a three-dimensional dynamic is at play. Strategies used by teachers of focussing explicitly onto mathematical discussion might well be of significance for two reasons. Firstly, the subject-specific discussion is not spontaneous for many pupils in the mathematics classroom. Secondly, the subject is learnt in a context of participation with others (teachers) who translate, model, revoice and probe the contributions of 'newcomers' (pupils) to this kind of mathematical practice.

The more recent studies have focussed on code switching as a teaching and learning resource, and on the teacher's role as a language guide in the mathematics class (Ndayipfumiye, 1994; 1996; Setati, 1998; Adler, 1998; 2001). As key actors on the classroom stage, teachers are more present in these studies. Yet their knowledge of what they do and why, as they manage the dynamic in the classroom practice has remained dormant in most studies. I hope that through this study, some teachers' knowledge of their uses of language in their multilingual mathematics classrooms will not only make a contribution to closing this gap, but in so doing, it will add depth to our increasing knowledge in this field.

In their article on mathematics and language, Austin and Howson (1979) placed language in all its complexity on the research and development agenda in mathematics education. Pimm (1987) has done early and extensive work on mathematics and language. In his book: *Speaking Mathematically: Communication in the Mathematics Classroom,* Pimm (1987) provides extensive theoretical analysis of mathematical language as it has come to be spoken and written in school mathematics practice. He explores Halliday's notion of the mathematics register and learner access to mathematically valued written and symbolic form through day to day classroom communication. Since then the field of mathematics and language has expanded considerably. Pirie and Schwarzenberger (1988), for example, did extensive research into and description of what constituted mathematical (as opposed to other) discussion. Cobb *et al.* (1992) driven by a constructivist standpoint, explored how mathematical meaning came to be co-constructed through learner-learner interaction on mathematical problems.

There are increasing concerns to promote a classroom culture that has pupil-pupil interaction at its centre. To achieve this, communicative competence - a function of the underlying cognitive approach that assumed talk to be a favourable cognitive tool, and that all learners were equally disposed to *talking to learn* - should not be taken for granted. This taken-for-grantedness is further symptomatic of the fact that multilingual sites have not been included in such studies.

More recent experiences have shown that communicative competence cannot be taken for granted. Communication and conversation in the mathematics classroom have come under the spotlight. Unfortunately, research and practice in multilingual mathematics classrooms remain absent from these deliberations, as is practice-based knowledge through the voice, knowledge and practice of the teacher.

The taken-for-granted 'truism' that has emerged in mathematics education is that mathematics can or should be learnt through conversation (Sfard et al., 1998). Sfard et al. (1998) uphold the different theoretical orientations to the centrality of conversation in construction of knowledge. They argue that mathematical conversation has potential as a mode of learning and that the concern is not whether to teach through conversation, but rather how. They acknowledged that planning a productive mathematical discussion or initiating a genuine exchange could be extremely demanding and intricate, thus pointing to a decisive role for the teacher. They emphasised that it is possible only if teachers were taught how to use the conversation.

These challenges are welcome to the mathematics education community but are not new. Hicks (1995: 86) argued a similar point some time ago that educational research had to do more to investigate into how the various voices in the classroom could be used as resource for mathematics education.

For the teachers what counts as mathematical conversation and how this is facilitated and developed in their classrooms is central to their mathematics classroom practice, constituted as it is by multilingualism. Teachers are likely to give communication a great deal of thought. Moreover, they share an acute awareness of linguistic differences in their classrooms and that they need to consider how their language practices enable or constrain not only the class as a whole, but the diverse learners within it.

The point here is that it is precisely the challenge of establishing effective *mathematical* communication - of understanding the *significance of the teacher's voice* and learning how this is done in classrooms where there is *diverse communicative competence* in the medium of instruction that has driven classroom-based research in multilingual classrooms. Here communication skills simply cannot be taken for granted. In the mathematics classroom research discussed above, there has been progress in dealing with the challenge. Yet this research is ignored.

A rejection of a transmission view of knowledge and learning, and so of language as an unproblematic medium of mathematical knowledge which learners then fail to grasp, or teachers fail to deliver appropriately (or both) is a significant move away from a

Vygotskian deficit model of learners and teachers. In addition, there is an increasing shift away from a technical view of mathematical language towards engagement with the complexities of what counts as mathematical language, and the view that mathematics, like language, is a culture, formed and forming in use.

Sierpinska (1998) provides a similar analysis of three distinct theoretical approaches in the field to those identified by Sfard et al. (1998), above, reinforcing the shift towards a focus on discourses and their production of mathematics through classroom interaction. In addition, key messages reinforce the point Sfard et al. (1998) made about the significant role for the teacher in *mediating* mathematical conversations. Sierpinska (1998) discussed Steinbring's notion of the 'epistemological tension in every mediation of mathematical knowledge' (Sierpinska, 1998: 55). Mathematics is difficult not because transmission is impossible, but because the specificity of mathematics itself imposes stringent demands on communication. Mathematics is about relations, and relations cannot be experienced directly. Mathematical communication is dependent on linguistic means. New topics mean new terms, symbols and definitions, all of which require mediation. Bartolini-Bussi (1995; 1998) presents communication in the mathematics classroom as an inconsistency: that meaning can neither be transmitted or simply negotiated. Scientific concepts cannot be created anew but need to be assimilated as products of centuries of culture (Bartolini-Bussi, 1998: 83). The meaning of these concepts is only found when pupils come to share mathematical discourse with others. Dilemmas and tension are inevitable as teachers move between supporting pupils' personal senses and meanings, and established mathematical cultures.

Books on mathematics education make very little mention of access to language focus on the issues involved (Morgan, 2000: 4). The omission of the focus on such important issues in the book raises some questions about the perceptions of the use of language in mathematics classroom. The kinds of practices supportive of mathematical discussion in multilingual classrooms include strategies where the teacher explicitly moulds and shapes learners' mathematical language as well as moments where the teacher is clearly in control of the discussion. Perhaps, as Adler (2001) argues it is because these explicit and directed mediational moves by the teacher run counter to dominant beliefs, attitudes and perceptions as to what counts as a participative mathematics classroom culture and that "too much teacher control is a 'bad thing'" (Morgan, 2000: 95).

Speculation aside, the question remains as to why there is a continuing disjuncture between research on communication in bilingual mathematics classrooms on the one hand, and what could be described as more mainstream research on communication in 'the' mathematics classroom on the other. For the teacher in a multilingual setting, all the issues raised above are simultaneously present and important. I hope that this study, focused as it is on teachers' knowledge of their practices, goes some way to bringing these overlapping yet separate research areas under the same spotlight.

2.8 Teaching dilemmas and tensions in classroom communication

As you will read in Chapter 4 of this thesis, the stimulus for my study lies in the extraordinary diversity and challenge of language policy in education in Malawi. The basis of the study is also deeply personal, emerging out of my many years of experience in secondary mathematics classrooms, first as a teacher and then, and for a much longer period, as a mathematics teacher educator and researcher.

Recent research developments in mathematics classroom communication have led to the identification of some general dilemmas of schooling (Berlak and Berlak, 1981) to more specific teaching dilemmas and tensions that are central to teaching and learning mathematics in multilingual classrooms (Carter and Richards, 1999, Adler, 2001). Carter and Richards (1999) found out that:

> Three common dilemmas are deciding what to pursue, figuring out what to tell students directly and what to push them to figure out on their own, and resolving the conflict between their commitment to student exploration and their felt need to cover materials (Carter and Richards 1999: 74).

These dilemmas and tensions were identified when teachers were trying to use the theory of constructivism in mathematics teaching. It was found that teachers could not implement some of the principles of constructivism because the epistemology of teaching changes with the theory being applied, making teachers and indeed the curriculum redundant.

Reporting on a study in South Africa, Adler (2001) identifies three teacher dilemmas experienced in mathematics teaching. They are called dilemmas and tensions of *code switching, mediation* and *transparency*, and their simplicity masks the complexity of the classroom and research practices out of which they have emerged. A complexity is produced in the interaction between a changing socio-political and educational context, and the dynamics inherent in any mathematics classroom. The substance of my study lies in peeling away layers of interaction among forces of influence operating in ever dynamic multilingual primary mathematics classrooms.

The notions of teaching *dilemmas and tensions* are the key mechanisms that captures and opens up teachers' use of language in elusive, complex and dialectical nature of mathematics education in multilingual classrooms. Teaching dilemmas and tensions are explanatory tools and analytic devices for studying of language in mathematics classroom. They bring out the conflicts and contradiction inherent in teaching; dilemmas and tensions that are both personal and contextual. At the same time a language of dilemmas and tensions can function as a source of praxis. Teachers may be confounded with dilemmas and tensions that reflect on and transform their practices so as to meet the mathematical needs of their linguistically diverse learners. The contribution of this study lies in the identification and elaboration of those teaching dilemmas and tensions mutually constitutive of and constituted by teaching and learning practices in multilingual primary mathematics classrooms in selected primary schools in Malawi.

In Adler (2001), teachers are clear about their dual task during classroom communication. Their first responsibility is to help their pupils learn and pass mathematics. It is also their responsibility to enable their pupils to proceed to further education and employment. For this pupils need to be competent in English, and in mathematical English. As a result of their dual task, they face continual dilemmas and *tension of whether or not to switch languages* in teaching.

Researchers in classroom communication have identified *code switching* as one of the common characteristics especially in bilingual classrooms (Myers-Scotton, 1993; Setati, 1994; Ndayipfumiye, 1994; Adler, 1998; 2001). In linguistic terms, Myers-Scotton (1993: 3) defines *code switching* as "the selection by bilingual or multilinguals of forms from an embedded variety or varieties in utterances of a matrix variety during the same conversation". She argues that code switching may take place on any level of linguistic differentiation, for example language, style or dialects/register. Examining the same concept from a sociolinguistic point of view, Heller (1988) describes code switching as the use of more than one language in the course of a single communicative episode. In an attempt to answer a question "What do bilingual speakers gain by conducting a conservation in two languages rather than simply using one language throughout?" Myers-Scotton (1993) examines the social motivations of language code switching in two African countries - Kenya and Zimbabwe. She points out that language code switching is situational in that it is rooted in social separation of activities each of which is conventionally linked to the use of one of the languages or varieties in the classroom linguistic raportoire. Code switching in the classroom symbolises the social situations, roles and statuses and also attendant to rights and obligations, expectations and assumptions.

Second, Adler (2001) sees mediation as *dilemma* and *tension* of teachers in the use of language in classroom communication. Proponents of constructivism argue that a learner-centred approach pushes teachers to encourage learners to produce their own meanings, with confidence, and argue them. However, the teacher faces an ongoing dilemmas and tension of how to *mediate* the curriculum and at the same time encourage learners to have confidence in their own thinking (Adler, 2001). These dilemma and tension are profound for some teachers and it highlights a key challenge in our contemporary period where we strive at the same time for inclusion and voice and for greater mathematical access. Of course, this is a challenge for all mathematics teachers, particularly in the light of reform movements in mathematics. It is not specific to a multilingual classroom.

Adler's third type of dilemmas and tensions among teachers concerns transparency. Teachers spend some time drawing pupils' attention quite explicitly to different uses of terms within mathematics. However, explicit teaching of mathematical language becomes more complex when pupils are involved in a task-based activity, and generate informal ways of speaking mathematically. Inevitably, mathematical descriptions are partial or quasi-mathematical or sometimes the action is right but the language is wrong (Adler, 2001).

Adler (2001) describes teachers' dilemma and tension between *implicit and explicit language practices* as permeating not only mathematics and multilingual classrooms but also even classroom practices in general, thus pointing to a decisive role for the teachers. She further argues that:

> There is always the problem in explicit language teaching of 'going on too long', of focusing too much on what is said and how it is said. Yet explicit mathematics language teaching appears to be a primary condition for access to mathematics, particularly for those pupils with main languages other than English or for those pupils less familiar with school discourses (Adler, 2001, p 5).

Three concepts that capture dilemmas and tensions in teaching mathematics in multilingual classrooms are *access, voice* and *meaning* (Adler, 1998). The dilemmas and tensions are both personal (a function of the teachers themselves) and contextual (the diverse multilingual contexts in which they work). Under any circumstances, teaching is a complex and sophisticated activity, imbued with dilemmas and tensions arising from the continual need to communicate for educational goals. When a range of main languages are present in a classroom, as with Chichewa and English in Malawi, the challenges of effective communication are highlighted. Increasingly, teachers all over the world are struggling with effective communication in multilingual classrooms.

Dissatisfied with some of the simplistic models of classroom communication, some researchers into classroom communication have described the use of language in the classroom as a *coping strategy*, a more situational model that is functional oriented (Edwards and Furlong, 1978). In their book *The Language of Teaching*, Edwards and Furlong (1978) argue that a classroom is a work place and that any model to explain the classroom communication process must recognise the sole function of the classroom. It is not enough to simply think that in a classroom, teachers and pupils are engaged in a communication process but also to recognise the context in which they are engaged in the communication process. Considering that a classroom has a function of constructing knowledge by the teacher and the learners, Edwards and Furlong (1978) argue that the roles and responsibilities of the two parties must be considered in the model. They consider a classroom as requiring management and control in order to achieve its objectives. The teacher has to exercise some authority over the proceedings of the classroom because he/she is the provider of the learning opportunity. This authority is exercised through language use. As already mentioned, the teacher has to be seen talking first, most and last and the pupils have to wait for their turn to talk. The duty of the pupils is to pay attention and listen. They are required to suspend all their knowledge until they find out what the teacher wants them to know.

It is this notion that makes language use in the classroom different from other communication settings. It is not the same as normal conversation. Teachers use language to manage, control and transmit knowledge. If language is a tool for authority, use of a language is a matter of teachers maintaining their authority. Pupils use language to accept teachers' authority by saying little and only when asked to say something and pay attention to acknowledge that the teachers must talk first, most and last. This perhaps explains why despite the findings by many researchers, that teachers dominate classroom talk.

The use of instructional materials in the teaching and learning discourse makes classroom communication unique. In ordinary conversations, the two parties can end their conversation with very little use of materials to make each other understand the point. In the classroom, the story is different. Teachers have to use and provide a chance for pupils to use the materials in order to construct knowledge. Therefore the role of the instructional materials is of paramount importance in understanding classroom communication.

2. 9 Conclusion

In my study, the communication strategies were seen in the context of the school setting and classroom condition because they were seen to be relevant to communication processes. The way teachers set out to communicate certainly is a function of the teacher and pupil home languages, language policy on education, availability and use of instructional materials and their quality and many more.

Although defining teaching appears to be difficult, there is an increasing emphasis on perceiving teaching as a process of facilitating the construction of knowledge. This is in contrast to the transmission model of classroom communication. However, research has revealed that applying constructivism in teaching is quite challenging. One of the challenges emanates from the use of language in facilitating the construction of knowledge. It appears that language has multiple functions in classroom discourse. Some of these functions are contradictory to each other, and create dilemmas and tensions when teaching such subjects as mathematics. Although some of the dilemmas and tensions have been explored through systematic studies, it appears that the actual sources have not been identified. It is my conviction that some of the dilemmas and tensions may be tied to specific sociolinguistic settings of the teacher, the subject and the classroom. It appears that the successful application of the constructivistic approach to teaching largely depends on the use of language in the classroom communication.

At this juncture, I would like to consider two important but related questions. *What do teachers communicate* and *by what means do they communicate it*? I attempt to answer these questions in the next chapter.

CHAPTER 3

EXPLORING THE ROLE OF LANGUAGE IN MATHEMATICS EDUCATION

> Mathematics Education begins and proceeds in language; it advances and stumbles because of language, and its outcomes are often assessed in language (Durkin, 1991: 3)

The above quotation from Durkin (1991: 3) emphasises that in every sense of life, language and mathematics are interrelated. Yet there are many innovations that usually do not consider the relation between mathematics and language; for many people mathematics is little more than calculations and memorising formulae that look unreadable (Shuard and Rothery, 1984).

In this chapter, I discuss how teachers use language to communicate mathematical content, and I raise issues associated with language and mathematics learning. It is not my intention to describe what language is or what mathematics is; rather I assess what others have indicated as evidence for language and mathematics learning being closely linked.

In Chapter 2, I discussed how to interpret communication in the classroom. In this chapter, I argue that classroom communication has implications for how children learn mathematics *learning*. To do this, I prefer to deal with mathematics *understanding* in place of mathematics. I have also focused my discussion on mathematical concepts as these are closely linked to basic meanings in a language. Knowledge and use of mathematical vocabulary can be an indication of mathematics understanding. However, if this is put in the context of the bilingual mathematics classroom, it becomes more challenging, as one has to learn to switch between languages (termed "code switching"). Reading in mathematics, which is mostly neglected as language use, is also discussed in this chapter.

3.1 Mathematical understanding

One of the major concerns in mathematics teaching is teaching for *understanding*. I begin this section by reiterating that learning of any kind occurs when there is some change in *understanding*. Skemp (1986: 43) defines *understanding* as "the assimilation of something into an appropriate schema". When the formation of a single concept is embedded in a structure of other concepts, the conceptual structure is known as a *schema*.

In her book *Understanding in Mathematics*, Sierpinska (1994) discusses what understanding implies and how it can be achieved in mathematics teaching and learning. She upholds that understanding implies incorporation of new experience into the existing one so that one can use it when needed. She emphasises that language plays a key role in any understandings where communication is involved.

From a constructivist perspective, *understanding* is subjective because it is relative to the previous understanding of the same or similar knowledge and also it can have different meanings in different mathematical situations. According to Gall (1990), children have different stages of understanding because there are different stages of children's thinking caused by the mathematical concept and operations they have. Gall (1990) argues that there are two extremes of understanding. One extreme is where a child demonstrates a primitive level of performance and the other extreme is where a child may have a full comprehension of concepts. What Gall (1990) is implying is that the degree of understanding will be fitted to the maturity of the child and broadly speaking to the immediate needs of the situation in which the child is involved. The level of understanding is therefore a function of experience, yet it is impossible to say what amount of experience is needed for the full attainment of any particular understanding formation.

Skemp (1986) sees understanding differently. He describes the three kinds of understanding as *instrumental, relational* and *logical. Instrumental understanding* refers to the ability to apply an appropriate remembered rule to the solution of a problem without knowing why the rule works. *Relational understanding* refers to the ability to deduce specific rules or procedures from more general mathematical relationships. The operations may be newly encountered concepts, and the goal may be to connect these with an appropriate (relational) schema and to deduce specific methods for a particular problem or specific rules of classes of tasks. *Logical understanding* (formal) refers to the ability to connect mathematical symbols and symbolised notation with relevant mathematical ideas and to combine these ideas into chains of logical reasoning. Logical understanding of the highest level, is the activity to "convince others" as opposed to relational "convince oneself". By this he suggests that understanding is manifested by the ability to communicate, and I agree that understanding is connected to communication in that effective communication implies understanding and visa versa. But deciding when understanding is can be achieved is the discussion in the next section.

3.2 Mathematical concepts

Related to mathematical understanding is the concern for helping pupils construct mathematical concepts. In this section, I want to argue that when children learn mathematics they learn *concepts* which they later can link into *principles*. I want to conclude from this that understanding may imply acquiring and using concepts because as Cooney (1988) states, a student's ability to learn mathematics is directly related to his or her understanding of mathematical concepts and principles. Concepts are the basic building block of thinking, particularly higher level thinking in mathematics. "Knowing the definition of a concept is important since teachers communicate, interpret and name it" (Toumasis, 1995: 98).

Many people have attempted to define a concept. Austin and Howson (1977: 167) said that there is no universally accepted definition of a concept, but associated with a concept is a significant feature of mental process or abstraction from experience and classification. Cooney, et al. (1975) define concepts as kinds of subject matter; from one point of view, they are the most basic learned objects. They are among the first things learned by children. By means of concepts, other concepts and other kinds of subject matter are learned.

How children acquire these concepts has been a focus of learning theories. Although psychologists differ in the ways they claim children acquire concepts, they all agree that language plays a central role in concept development (Wood, 1988). The argument here is that if children are to understand mathematics they have to learn the basic concepts and principles in a language. But how do they learn these concepts and principles during classroom communication? How does the process of classroom communication relate to concept learning? Does the teacher use of language during classroom communication affect the concept formation? Although most of these questions are beyond the scope of this study, but a discussion of some of them will help the interpretation of the findings of the study.

3.3 Language in mathematics education

An equally important issue in mathematics education is understanding the role that *language* plays in mathematics teaching and learning. Some of the problems of mathematics learning are language issues and addressing the issues of language in mathematics education is related to discussing the problems of classroom communication because classroom communication is mostly achieved through language. In their book, *Teaching As a Subversive Activity*, Postman and Weingartner (1969: 103) write, "almost all of what we customarily call 'knowledge' is language" (Postman and Weingartner, 1969: 103). This notion suggests that all we call mathematics is language, for there is no mathematics that exists outside language. That is why they hastily argue that every teacher is a language teacher and that teachers should be conscious about the language they use in the classroom.

Research in mathematics education has focussed on the role of language in mathematics because language is the means by which mathematical concepts (as all ideas) are communicated between the teacher and the learner, either through oral or written materials (Cocking and Mestre, 1988). Language thus plays a central role in the teaching process. That is perhaps why Postman and Weingartner (1969) argue that language is not merely a *vehicle* of expression, it is also the *driver*; and that what we perceive, and therefore can learn, is a function of our *languaging processes*. In fact Cooney *et al.* (1975: 90) state that "communication breaks down when people do not have certain concepts". When pupils do not understand what the teacher is trying to say, then he/she is not communicating. Because concepts enable children to construct knowledge and communicate with others, concepts are indeed important objects of thought.

This notion of the relationship between langauge and concept learning that has been emphasised in psychology of mathematics learning (Skemp, 1971) underscores the importance of discussion in mathematics learning. Research has shown that discussion can facilitate pupils' understanding of mathematical concepts (Pirie and Schwarzenberger, 1988). Pirie and Schwarzenberger (1988: 461) define mathematical discussion as "purposeful talk on a mathematical subject in which there are genuine pupils' contribution and interaction". Yet discussion is less used in classroom communication as Ndaba (1997) found out in his study on the use of language in geometry lessons in Kwa Zulu Natal Schools. Secondary school students were not consistent in the use of words to describe mathematical concepts and principles, suggesting that lack of the language to describe the concepts imply lack of understanding of mathematical concepts.

Chomsky (1962: 167) states that "the birth of a new concept is invariably foreshadowed by a more or less strained or extended use of old linguistic material. The concept does not integrated into the existing cognitive schema until it has found a distinctive linguistic embodiment". How do teachers choose and use language in order to facilitate the acquisition of concepts? In particular, what is the role of vocabulary in concept formation? I discuss this in the next section.

3.4 Mathematical knowledge and vocabulary

Researchers in education have been concerned with the theoretical perspective of how language is related to mathematics learning (Pimm, 1987; Cocking and Mestre, 1988; Orton, 1987; Jaworski, 1999). The central issue has been that mathematical concepts and principles that are the basic learning blocks are communicated usually in a language. In a language there are special terms that describe specific mathematical concepts and they are referred to as *mathematics vocabulary* or *mathematics registers* (Pimm, 1987).

Children learn mathematical concepts through words and symbols. At primary school level, children learn and use symbols like + (add), x (multiply), - (divide) and - (subtract). Letters of the alphabet are sometimes used as mathematical symbols. For example, 2a = 6 and 2x3 = 6. Making combinations of letters or mathematical symbols or both, for example, 22, forms mathematical words. Of course the longer the combination, the more difficult the word is. When presented with an unfamiliar word in ordinary reading, the reader can use word-analysis skills to break the word down into parts. This is not easy in mathematics. The pupils must recognise and understand the mathematical relationship between the components of the word. For example, in 22, the pupils must see the first 2 as 2 tens and the second 2 as 2 ones. Children learn the concepts in mathematics by constantly coming into contact with words and symbols that describe the concepts. My concern is how language of instruction enhances pupils' learning of mathematical concepts through words and symbols.

The potential problems of learning mathematical concepts through vocabulary fall into five broad categories (Orton, 1987): words with more than one meaning; words with specialised emphasis in mathematics; technical vocabulary; varied forms; and abbreviations and specialised symbols (Orton, 1987: 126-128). Many words take on a different or special meaning when used in a mathematical context. A few examples of these include table, plane, volume, power, and group. Therefore, to argue that words in mathematics generally have precise definitions (Pimm, 1987) is to lose sight of the fact that there are words such as degree, square and base that have multiple meanings in mathematics (Orton, 1987).

Words with special emphasis in mathematics include *how many, how many more, the difference, altogether,* which take a special meaning in mathematics. For example, *What is the **difference** between 38 and 74* would mean ***subtract** 38 from 74* in mathematics, which is different from the ordinary use of the words. In ordinary use, '*what is the **difference** between 38 and 74*' would mean describing the physical appearances that make the two numbers different such as one having a three whereas the other one has not.

Technical vocabulary in mathematics may present problems of three different kinds (Orton, 1987). First, the word may entirely be new. The pupils may be unable to pronounce the word or to use word analysis skills. Second, the concept represented by the word may be new. Third, the concept represented by the word, such as 'numbers' and 'addition' may have no simple concrete referent (Orton, 1987).

Another confusing factor in vocabulary development is that basic words can be presented in different forms. The pupil has to recognise different pronunciation as well as identify differences in meaning. An example of this potential problem is found in the variations of the word 'multiply'; that is multiplier, multiplication, and multiplicand.

A final area of potential difficulty is the use of the abbreviations and special symbols. Numbers are all represented by symbols such as 1, 2, 3 and 4. Yet children are required to read, recognise and perceive them as concepts of quantities.

Nicholson (1977) reports the lack of understanding of common mathematical terms employed by 16-year-olds of average ability. The word "multiple" was misunderstood by the majority of pupils and similar misunderstandings occurred with respect to geometrical terms. Nicholson argues that the misunderstanding might have been due partly to the fact that many mathematical terms are used also in colloquial speech. The way language development interacts with the growth of mathematical understanding is another subject to which psychologists have paid considerable attention. Questions have been raised as to whether the growth in linguistic ability follows the development of concrete operational thought or whether in fact the development of adequate terminology is a prerequisite for cognitive development.

Most of the vocabularies are not only new but complex in terms of the concepts they describe. So from the very beginning of mathematics learning, it would appear that a pupil has to have a very good understanding of the meanings of the symbols used, especially those that dealing with operations. Shuard and Rothery (1984) argue that:

> Pupils meet these words only in a mathematical context and their meanings must be learnt from the teacher or the mathematics books. Mathematical words are unlikely to be used at home or in the child's everyday speech, ... (Shuard and Rothery, 1984: 25)

This notion calls for the teacher understanding and using mathematical vocabulary when teaching mathematics. It also suggests that books should be used in mathematics lessons not for merely copying exercises but reading and getting familiar with mathematics vocabularies.

My concern here is that the use of language depends on the knowledge and use of mathematics vocabulary in mathematics teaching. In the next section, I discuss reading in mathematics which is another but related concern about the use of mathematical vocabulary.

3.5 Reading skills in mathematics teaching

Some researchers have been concerned with exploring how reading which is one of the language skills, can enhance mathematics learning. Shuard and Rothery (1984: 1) define reading as "the whole process by which a pupil examines the written word and the pictorial material, and obtains its meaning" in mathematics.

Although most of the studies on reading were done in language classes (Fargan and Eagan, 1986; Schlapp and Underwood, 1988; Saracho and Dayton, 1991; Wong and Underwood, 1996), their findings indicated that reading abilities were positively associated with pupil's performance or intelligence. Although these studies were not conducted with mathematics vocabulary, the implications of these findings on the use of language in mathematics teaching can be felt in that mathematical concepts are embedded in the vocabularies, which if known and used in reading mathematics text, mathematics teaching may become effective.

It is my position to argue that reading offers constructive learning through interacting with the specialised terminology. Donald (1980) perceives reading had to be regarded as a process that was essentially constructive. This is a process where the reader reads for meaning, not for the identification of letters, words or phrases. He therefore, argued that reading is not only an analytic processes but also more importantly a constructivist process as described in Section 2.2 of this thesis. This notion suggests that, in mathematics teaching, reading should not mean merely mentioning the number names and symbols but a combination of words or phrases that make up a mathematical meaning.

I share my concern with other researchers that reading is related to meaningful learning of concepts. Donald (1980) argues that reading involves a process of constructing meanings usually without precision and without identifying the perceptual elements in the signal. Instead, the reader's knowledge of meaning, structure of language, the orthography rules; and the context of what one is reading interact to create information. The process of message construction is regarded as more than mere acquisition of analytic skills but as information processing of a complex and interactive order.

My other concern is that teachers' use of language in mathematics teaching is associated with reading. This concern is raised by many authors such as Shuard and Rothery (1984), Orton (1987), Pimm, (1987), Burton (1992) and Mukuyamba (1996). According to Burton (1992), successful reading in mathematics requires an understanding of 'two languages of mathematics' the *technical vocabulary* and the *specialised symbols*. Mukuyamba (1996) identifies the level of responses in reading as a hierarchy in that reading moves from small units to complete pieces of text or discourse. The reader (pupil) must respond to (a) letters, (b) words, (c) sentences, and (d) discourse.

Pimm (1987) argues that teachers are often unaware of the particular purpose of reading a section of text. Their use of reading skills is hindered when they may ask a child to read all parts of a mathematics text in the same way without realizing the purpose of each part. Reading should be the act of getting meaning from printed language.

Educators have discussed the relationship between reading and mathematics teaching and learning for many years (Orton, 1987; Shuard and Rothery, 1984) claiming that pupils having problems in the mathematics classroom may be having trouble with reading skills, especially those pertaining to mathematics. To some extent this discussion has centred on justification for using English as a medium of instruction in schools. Mukuyamba (1996) argues that the range of text types in English is wider than most of the local languages. So a pupil trying to learn mathematics using English has to cope with the many variations of reading. In reading mathematics, the responses are not the same as in ordinary reading, that is, for example, from left to right. It was observed earlier that the numeral notation used in our schools is adopted from the English, who adopted it from the Hindu-Arabic system. Now because of our place value system, one skims a number in a back-and-forth motion to read it. To read the number 748, for example, one must note that there are three digits, indicating a number in hundreds. One first reads the first digit to the left, and follows it with hundreds. One then observes that the *4* is in the tens place indicating *40*. Then the *8* is observed in the ones column to be added to *40*. Reading *748* as *seven hundred and forty eight*, therefore, is a more complex activity for pupils than we often realise.

Reading out a phrase such as $\underline{3}$/ 12 as *12 divided by 3* requires a similar back-forth motion, which is difficult even for teachers. The following examples illustrate some of the directions and eye movements involved in reading mathematical materials. *Forward backward* occurs where the item $\underline{3\ }$/27 (division sign) may be read as three into twenty-seven (i.e., left to right) or twenty-seven divided by three (i.e., right to left). *Multiple direction* occurs where there are some mathematical sentences that have to be read from either end or from the middle. For example, $3 + \square = 7$ "*What must be added to 3 give a 7?*"

Most books for mathematics are difficult for the average pupil to read (Chimombo, *et al.*, 1990). They are written with very little concern for the learner. They do not encourage pupils' interest in reading. The teaching approach does not encourage pupils to read mathematical sentences. As a result, pupils do not develop reading skills (Chimombo *et al.*, 1990). The mathematics textbooks for young children usually have very little text to be read. However, just like in language books, illustrations put in the books can be used to tell a mathematical story that would prepare children for reading in classes.

It is my concern that although language plays a great role in facilitating mathematics teaching, use of different language may bring about different teacher competencies and calls for an understanding of bilingual mathematics teaching which forms the theme of my next section.

3.6 Bilingual mathematics teaching and learning

One of the major challenges in mathematics education and one facing those of us working in Africa has been the teaching and learning of mathematics in bilingual classrooms (Adler, 2001; Myer-Scotton, 1993; Rubagumya, 1994; Ndayipfukamiye, 1994, 1996). Most education in developing countries including Malawi is offered in multilingual system - the coexistence of more than one language in the system.

Bilingualism can be defined in different ways. Although some people see bilingualism as native-like control of two languages, others see it as someone who would at all times be taken for a native by native speakers of both languages concerned. Saunders (1988) defines bilingualism as the ability to use two languages. He argues that bilinguals possess different degrees of bilingualism, which ranges along a continuum from equilingual to monolingualism. Although some people may be equally fluent in the two languages, in most cases one language dominates the other language.

Certain terms are used to describe the status of language in bilingualism. Sometimes bilingualism is used to mean multilingualism- having more than two languages. Mother tongue refers to the language one learns from parents from birth. Home language is becoming fashionable to use instead of mother tongue because of gender issues as well as the fact that a number of children are growing up without their mothers. Two other terms associated with bilingualism are first language (L1) and second language (L2). The languages that one learns to speak are numbered serially as they occur to an individual. First language is the language, which one learns to speak first and usually it is the mother tongue or home language. The second language to be learnt to use is called the second language (L2) and usually it is not the mother tongue or home language. However, it can be a local language or foreign language.

The use of home language (L1) as a medium of instruction is on the increase in developing countries. In a study done in Britain (Tansley, 1986: 17) the specific aims advanced in favour of the use of mother tongue included:

1. To promote the cognitive and social growth of the young child whose first language is not English, as these are closely associated with language development.

2. To increase a pupil's confidence so that psychological and social benefit may improve learning ability and increase motivation towards other curriculum subjects.
3. To develop the full potential of pupils whose first language is not English which in accordance with broad educational objectives includes development of mother tongue skills.
4. To enhance the value of a minority pupil's culture and language as part of that culture, thereby increasing the language's status, encouraging its maintenance, and reducing social and cultural barriers between English and minority speakers.
5. To increase linguistic minorities' pride in their language and hence their language and hence to enhance their sense of identity through their language.
6. To facilitate communication between parents, children and relatives by maintaining linguistic competence in the first language and to preserve cultural and religious traditions.
7. To enrich the cultural life of the country as a whole by means of diverse linguistic resources utilised in the participation of minority language speakers in social life and in contributing to the economy of the country in industry and commerce.

Although these aims were advanced in a Britain where the type of bilingualism may be different from the kind of bilingualism in Malawi, the aims represent the perceptions of most of those involved in the use of local language in education. However, teachers in Malawi may have their perceptions different from those described in developed countries.

Although my study focus is not directly on bilingualism, the use of Chichewa and English in mathematics teaching in the classroom where both teachers and pupils also bring their mother tongue languages is a typical example of bilingualism – a person being fluent and functional in the use of more than one language. Most commonly a bilingual person is more fluent in one language than the other(s).

There are a number of issues that point to difficulties faced by teachers when teaching mathematics in a second language situation. The first difficulty for a teacher is that of learning the structure of the second language, in this case English. The second is using a language he or she has not fully mastered to teach another complex subject like mathematics. A teacher has to comprehend the mathematical language involved, use interpretive comprehension skills, and translate all the information in mathematical symbols before he/she can teach the mathematical computation requiring to be learnt. All this is done within the time allocated to that particular cycle of education. There are several hurdles for the teacher to overcome. The teacher has to decide the meanings of the numerous words in the new language and their multiple definitions. He/she needs to convey to the pupil the varied forms both in meaning of symbols and words. The teacher also has a duty to convey the translations of the mathematical sentences that are in symbolic form. It suffices to say that the teacher has many concepts to teach, many language skills to use, and all these together make mathematics teaching a challenge. The teacher needs to employ several language strategies to enable pupils to see the importance of learning mathematics in a particular language.

Most countries in Africa, using a second language as an official language of communication, are being urged to research how their mother tongues could be used to teach mathematics (Fafunwa, 1975; Rubagumya, 1994; Omondi and Sure, 1997). They need to create words in the mother tongue, which can explain or define the many mathematical symbols, concepts and skills. As argued in Section 3.4, this cannot be achieved by simply replacing refined words by crude ones as this may distort the mathematics meaning. The ideal here is to find words consistent with conventional symbolism. The problem these countries encounter is the many ethnic groups that exist in each one (Omondi and Sure, 1997).

It must also be appreciated that the teacher's exposition plays a vital role in teaching in a second language. The stress and intonation can help or hinder the child's understanding of the words being said. In a country where English is not the first language, children may have difficulty following the teacher's spoken English, particularly if this is an unfamiliar language or is not the first language of the teacher (Mathematics Association, 1992). Furthermore, the teacher may not be aware of this problem (Mukuyamba, 1996) and therefore, not use the language effectively.

When teaching mathematics in a bilingual classroom, teachers avoid the unprompted use of mathematical language and deficiencies in vocabulary can go unnoticed (Mukuyamba, 1996). For example, teachers may avoid reading mathematical sentences because almost all European languages show irregularities in the naming of some or all of the numbers between 10 and 20 (Kaphesi, 1992). In English, for example, numbers 13 to 19 are spoken back to front compared with the numbers from 20 onwards; so we say 'twenty-four, twenty-five, twenty-six' but 'thirteen, fourteen, fifteen, sixteen' are transposed. Directionality and spatial relationships often cause difficulty in the reading of mathematics. For example, primary school teachers may have pupils who confuse 65 and 56. In each case, the value of 5 has changed according to its position. Therefore, there is no one-to-one relationship between the mathematical symbol and the spoken words used to describe it in everyday language.

As Mukuyamba (1996) observes, teaching in most African countries including Malawi is in a second language be it English or local languages because, Omondi and Sure (1997:100) argues it was seen to be a panacea to education problems. The aim was to produce children who would excel in Science, Mathematics and English thereby enhancing chances of faster industrial development (Omondi and Sure, 1997). However, there are several difficulties, which a child encounters while trying to learn mathematical concepts and skills using a second language. The results have been unsatisfactory and after some time most schools abandoned it. Many parents complained that they had children who left primary school speaking good English but could not write it; neither could they solve mathematical and scientific problems given in English (Omondi and Sure, 1997).

This is even more complicated if, as already said, a child has to cope with the complexities of English, for example, and the new concepts in mathematics, let alone the variety of definitions. Pupils encounter problems in reading in mathematics at each level of reading development. Pupils have problems in decoding mathematical letters, numerals and symbols; recognising technical vocabulary; following sentences and formulae; understanding the difference between mathematical explanations and problems.

3.7 Language and mathematics with young children

In this section, my concern is about communicating mathematical concepts as it relates to bilingual children in Malawi. Discussing this concern is essential because my study was conducted in the third and fourth grades of the primary schools in Malawi. In Malawi, children enter primary school at the age of 6 and they are expected to be in grades three and four at the ages of 9 and 10 respectively. My concern is that although psycholinguists do not agree on how children acquire language they all agree that this is the time children are struggling to learn the basics of language use. They may not hold a discussion because they will not have developed the language needed to express logical thinking; they may not give reasons for their actions. It is for these reasons that sustaining a discussion with pupils in such classes as standards 3 and 4 may be quite challenging.

In Africa, many children enter school when they are bilingual especially whose home language is not a national or official language and also belong to minority language communities (Myers-Scotton, 1993). In most cases they speak a home language, a regional/national language and an official language which is usually a foreign language. According to Saunders (1988) infant or child bilingualism is different from adult bilingualism. He argues that child bilingualism implies successive acquisition of two languages, that is a child acquires first one language with the family and then acquires a second language through other community members (Saunders, 1988) and usually they acquire both their languages with a native or native-like pronunciation. Adult bilinguals (teachers who acquire their bilingualism while adults) usually speak their second language with a non-native accent.

This difference in degrees of bilingualism between teachers and pupils account for the communication problems in the classroom. Children may know the words in one language but fail to apply them correctly in the classroom. For example, children may first learn words for opposites but use them interchangeably. Teachers and pupils may use the same words but with different meanings. Teaching words in mathematics is complex; it has to proceed in stages.

Nevertheless, in most cases, as Street (1984) argues, children are usually introduced to mathematics when children are still learning to use the language, how to think and also how the world around them works. While they could learn from their own experience *bottom-up*, the school provides learning *top-down*. Children use the language in getting to grips with mathematics and the adult language is imposed to increase precision.

3.8 Local versus foreign language: Does it matter in mathematics teaching?

One of my concerns in this study is whether it matters to use first language or a foreign language in mathematics teaching in terms of dilemmas and tensions in teachers' use of languages. It is well researched that sometimes pupils find mathematics learning very difficult because of the language which is being used as a medium of instruction (Cocking and Mestre, 1988; Kachaso, 1988), and that language of instruction makes learning difficult because of the vocabulary, symbols, reading skills and meanings which are fundamental to mathematics learning (Pimm, 1988; Orton, 1987). My concern is how the teachers' dilemmas and tensions are dependent on whether the language of instruction is L1 or L2. This problem is related to the question of using the language that is compatible with other aspects of the subject being taught (Griffiths and Howson, 1974). As argued earlier on, the coding of mathematics should not simply be a question of replacing a refined mathematical language by a crude one. However, the medium of instruction may have to take into account the teacher and student language competencies as well as the nature of the content.

Skemp (1971) claims that mathematics has two systems: symbols and concepts. Symbols are for writing and reading while concepts are for understanding the way symbols relate to each other to express a unit of logic, including its use. In this respect, language functions to operate upon the mathematical symbol system and internalise the concepts. Therefore mathematics teaching requires the use of a language that helps in communicating concepts and principles.

This does not mean that there cannot be classroom communication without a language. However, as much as language may enhance classroom communication, it may depend on the teachers' mastery of the language more than the pupils. There is no doubt that teachers have a greater mastery of the languages of instruction. Therefore, a more familiar language of instruction may enhance classroom communication more effectively than an unfamiliar language. A familiar language may help the teacher visualise diagrammatically the concept being taught, whereas an unfamiliar language may quickly lead to the teaching of mathematical notations without making pupils understand the concept. The correct concept formation taught in an appropriate language inspires the teacher to teach more. It seems the teacher may be highly inspired when the language used is familiar.

It sounds logical for me to choose a language that allows for natural blending of experience and mathematics. "Children develop language in concert with their experience. The experiences are crucial for the language to make sense. In the initial stages of mathematics learning, the quantitative experiences must be closely connected to the language that describes the experiences" (Servas and Varga, 1971:10). Yet many language policies in education seem to pay very little attention to choosing a language that provides appropriate mathematics experience.

It is not a question of Chichewa or English but more importantly the mathematical language. Language use in mathematics teaching becomes a problem because sometimes teachers may speak to their pupils using mathematical *language at different levels*. Lesh and Marshall (1983) pointed out that there are four language levels used. These are:

Mathematician $\longleftrightarrow$ Mathematician

Mathematician $\longleftrightarrow$ Teacher

Teacher $\longleftrightarrow$ Pupil

Pupil $\longleftrightarrow$ Pupil

This relationship is not as simple as it appears in the diagram. Because of lack of knowledge of the importance of language in the classroom, teachers may not use the language effectively during classroom instruction. Teachers may speak to pupils in the language appropriate for mathematician to mathematician, unaware *that the relationship is so complex that it requires translation from one level to another.* This problem may become clear when we compare how teachers use L1 and L2 in mathematics teaching.

Most mathematics lessons take place in a *mixture of ordinary language and mathematical language*. The ordinary language for mathematics purposes is referred to as mathematical language. It constitutes a set of meanings that is appropriate to a particular function of language together with words and structure, which express these meanings. The mathematical language, however, includes the symbols such as 1, 2, 3, = and +, together with the sentences and structures that are represented using such symbols. My concern here is that the choice of the language of instruction must consider a language that blends the use of ordinary and mathematical language in classroom communication.

Notwithstanding this, studies have shown that mathematics has become divorced from real situations (Tregear, 1968). I want to argue that although mathematical ideas are universal, they are expressed differently in different languages. For example $3 + 4 = 7$ is translated *zinthu zitatu kuonkhetsapo zinai zikwanira zinthu zisanu ndi ziwiri* in Chichewa which literally means $3 + 4 = 5 + 2$. This state of affairs poses a problem when it comes to choosing and using a language of instruction in mathematics teaching.

The requirements of the expression of mathematical ideas in natural languages leads to the development of mathematical vocabulary in which the discourse about mathematical ideas, objects and processes can take place. For the English language, this evolution has occurred over many centuries. Once mathematical vocabulary has developed, certain meanings will then be available in the language.

3.9 Conclusion

In conclusion, teaching and learning mathematics seem to depend greatly on language use. The challenges I have discussed in this Chapter may affect the effectiveness of teachers' use of language and consequently the choice of language of instruction. It is my argument that mathematical understanding implies acquiring not only the concepts but also the precise language that descries the concepts. In this way language acquisition and use is central to mathematics understanding. Both teachers and pupils need appropriate vocabulary to access, shared and construct mathematical knowledge. Hence the focus of my study. In this way use of some language skills such as reading has proved helpful in enhancing pupils learning of mathematical concepts. Nevertheless, the role of language in mathematics teaching becomes complex when one considers the bilingual classroom setting common in developing countries such as Malawi. Teachers, pupils and the curriculum including the subject specifics may exert linguistic demands that may be contradictory to each other. The difference in language competencies between the teacher and the pupils and also the linguistic differences between the local, the official and the mathematical language makes it difficult to choose and use the language of classroom instruction suitable for mathematics. That is why the question of which language, local or foreign, should be used as medium of instruction in mathematics is high on the agenda of language policy in education in most bilingual countries such as Malawi. Whatever choice is made, it is important that the choice is based on the empirical evidence regarding what works for mathematics so as to reduce dilemmas and tensions brought about by language use in the classroom.

CHAPTER 4

LOCATING THE RESEARCH PROBLEM

> With immediate effect, all the children will learn in the local languages (mother tongue) from standards 1 to 4 (Ministry of Education, Science and Technology Circular Letter No:IN/2/14, 28th March, 1996, Lilongwe, 1996).

In this Chapter, I discuss the identification of the research problem within the context of the educational system in Malawi and also within the language policy in education not only in Malawi but also beyond. It describes the context in which teachers are expected to use Chichewa (a local and national language) and English (a foreign and official language) in mathematics teaching and why it is important to understand how teachers perceive and use Chichewa and English in mathematics teaching. Therefore, this chapter sets the focus of the study by providing the context of the problem in the Malawi primary education system with emphasis on language policy in education, the statement of the problem, formulation of the research questions and significance of the study.

4.1 Background to the problem

There is a growing concern today in developed and developing countries over the quality of mathematics education being offered to children especially at primary level (Cocking and Mestre, 1988; Cockroft, 1987). One of the problems being faced generally originates from the existence of multilingual societies with many local languages and usually an official language that is, in most cases, a foreign language. This makes it difficult for many countries such as Malawi to provide quality mathematics education in a more effective language. In Africa south of the Sahara, the policy on language of instruction is affected by:

1. multilingual nations with many dialects;
2. dominance of foreign language as official language;
3. the perception of educators that language is irrelevant to the meaningful learning of the subject matter;
4. international communication challenges;
5. undecidedness on the language policy in education;
6. lack of political will to implement language policy (Myers-Scotton, 1993; Rubagumya, 1994; Ndayipfumiye, 1994, Setati, 1998, Adler, 2001).

Consequently, there are usually no clear strategies for implementing language policy in education. Teachers are asked to use languages unfamiliar to either or both the teacher and pupils. "Because of the problems being faced, hundreds of thousands of children in the primary schools are not receiving the quality of mathematics education which will enable them to play an effective role in a constantly evolving world" (UNESCO, 1970: 9).

To address the problems in providing quality education in Malawi, the government established a number of strategies. One of these was the extension of the use of Chichewa as medium of instruction from standards 1 to 2 to include standard 3 and 4 (Ministry of Education, Science and Technology, 1996).

There are basically two languages of instruction in Malawi primary schools. Children learn in a local language all the subjects except English and Chichewa from standards 1 to 4. Thereafter, they learn in English all subjects except Chichewa, which is in Chichewa. Although there are 16 languages in Malawi, the pupils' textbooks for Mathematics for standards 1 to 4 were prepared in Chichewa and their corresponding teachers' guides were prepared in English. Teachers prepare their lesson plans in English and deliver them in local languages, and not English.

There is a particular concern about the implementation of this language policy in mathematics education in Malawi. Yet very little research is done to understand the problems. In the following section I will consider the educational context as it relates to prospects and challenges of the use of Chichewa and English in mathematics teaching.

4.2 Educational context

In this section, I discuss the educational context by examining the primary school system with the focus on children, teacher training, curriculum, and language policy in education as they relate to the teachers' use of Chichewa and English in mathematics teaching.

4.2.1 Primary School System

Malawi adopted an 8-4-4 system of education at Independence in 1964 (Hauya and Kaphesi, 1997). This means that children spend a minimum of 8 years of primary education, 4 years in secondary education and 4 years of undergraduate university studies. The term 'standard' is used to describe each class at primary level.

Although most primary schools have classes up to standard 8 (full primary schools), some schools have classes up to only standard 5 (junior primary schools).

Historically, missionaries such as the United Free Church of Scotland Mission ran the primary schools in Malawi (Rose, 1970; Banda, 1982). Whilst the missions concerned themselves with primary education, the government ventured into post-primary education. Because of the political influence education had, the government started getting involved in primary education. In the 1960s, soon after independence, Malawi took over control of primary education, except the infrastructures, which remained the property of the missions. Today, some primary schools are government owned while others are government assisted (mission schools). There are increasing numbers of private primary schools, some of which do not follow the national curriculum.

Control of missionary standards of teaching was largely nominal. The first official primary school syllabus appeared in 1933, and by 1941 some sort of terminal standardisation was envisaged in the standard 6 examination (Rose, 1970). The primary school curriculum is centralised. All the government and government assisted primary schools follow a national curriculum, and all pupils write a national examination. Although the curriculum emphasises communication skills and numeracy, pupils are also taught basic knowledge of science, social science and humanities with practical skills in home economics and needlework and physical education (Ministry of Education, Sports and Culture, 1987).

4.2.2 Primary school teachers

The role of teachers in classroom use of languages in mathematics teaching need not be overemphasised. The teacher decides what to say and how to say it although with limited choice on what type of language to use in the classroom. Consequently, it is important to shed light on the primary school teachers in Malawi.

Teacher academic qualifications

By 1997, there were 49,234 primary school teachers in 3,488 primary schools. Of these, 16,362 were unqualified teachers and 32,872 qualified (Malawi Government, 1996). The unqualified teachers were those who had had no formal training in teaching. Some of them had had two years of secondary education and passed the Malawi Junior Certificate of Education Examination (JCE). Others had had four years of secondary education and passed the Malawi School Certificate of Education Examinations (MSCE) (equivalent to GCE O level).

Those teachers who have had formal training in teaching are regarded as qualified teachers. They too might have had two or four years of secondary education. The primary school teachers in Malawi are trained to teach any subject on the curriculum at any level of primary school. Any primary teacher can currently be sent to teach anywhere in the country without matching teachers' home language with children's home languages. Clearly this raises problems of language of communication in the classroom as the teacher and pupils are likely to have no common local language. My concern is that they might have been trained to teach in English, without any deliberate effort to train them in teaching in local languages.

Primary Teacher Education

In the previous section, an attempt has been made briefly to present the type of teachers working in Malawi Primary Schools. The present section looks at the modes of training followed in Malawi and their implication for the quality of mathematics teaching in schools. First, an overview of the modes of Teacher Education in Malawi and its objectives is presented.

According to Makuwira (1997), the most recent review of the primary school curriculum, which started in 1987, meant a change in the teacher education programme in Malawi in the philosophy, objectives, content, methods and mode of assessment. Consequently the curriculum for teacher education was also revised to align it to the needs of the primary school curriculum. The revised teacher education curriculum was launched in 1990. Despite the revision, one would want to know whether the revised teacher education curriculum has addressed the issue of the medium of instruction in primary schools because the revision of primary school curriculum included the extension of the use of Chichewa from standard 2 to 4 in all the subjects except English. It is important that the training of teachers includes effective use of the language of instruction in specific subjects such as mathematics as different subjects may demand different language use in the classroom (Cocking and Mestre, 1988). This question is important, as the previous curriculum was silent on the skills needed for the teacher to use a language in teaching.

Modes of Teacher Training in Malawi

According to Rose (1970), before Malawi became independent in 1964, the philosophy behind teaching was that teachers should be exemplary in everyday life. They should be physically fit and spiritually sound. Therefore, in the 1960s the curriculum for teacher training encompassed home hygiene, religious knowledge, leadership and agriculture in addition to reading, writing and arithmetic.

After independence, teacher education was expanded with more colleges built and the curriculum aligned to serve national needs. Up to the early 1980s, Malawi was offering a two-year teacher training programme. The entry requirement was upgraded from primary school leavers to a minimum of a Junior Certificate of Education (JCE - after two years of secondary education, with a pass in at least 6 subjects including mathematics and English), and the Malawi School Certificate of Education (MSCE - after four years of secondary education, with a pass in at least 6 subjects including mathematics and English). Those teachers with JCE as an entry qualification are awarded a T3 grade and those with MSCE as entry qualification are awarded a T2 grade upon completion of the training course.

The teacher trainees include those who got their JCE or MSCE by distance education, which made up more than 60% of secondary school by 1997. The students from distance education centres (now called community day secondary schools) are taught by underqualified primary school T2 teachers, without university education or any specialisation in the teaching of mathematics. This affects the quality of their academic background.

From 1980s, Malawi has witnessed changes in the mode of teacher training for primary schools. Since 1980, four types of pre-service teacher training programmes had been offered. Some of them were offered simultaneously because one of the two was considered as a pilot programme. Some programmes replaced others because they were considered as the most viable and cost effective ones. Despite all these changes of the modes, the entry requirements have remained the same.

The first mode of pre-service teacher education was the two-year residential programme, adopted in the early 1960s and offered up to the mid 90s. It used to recruit secondary school graduates for two-year residential courses in the eight primary teacher-training colleges. It was suspended in favour of a one-year residential programme, which was seen to be more economically viable. This programme was first piloted in one college while the other seven colleges were offering the two-year programme. After evaluation, it was implemented in the remaining colleges. Initially this one-year programme was meant to train the unqualified teachers whom the district council employed (now called district assembly) to satisfy the teacher shortage in schools. The teachers had some knowledge of content in various subjects. Considering that these unqualified teachers had experience in teaching, it was thought that one year was enough to turn them into qualified teachers by providing them with the skills they needed in methodology.

The three-year Malawi Special Distance Teacher Education Programme (MASTEP) was designed to meet the shortfall of teachers. MASTEP was being offered alongside the one-year and two-year residential courses. The course subjects were divided into core and minor, with the core subjects taught through printed modules and residential courses while the minor subjects were taught at seminars. During the courses, the trainees were fully involved in teaching during the school sessions and enjoyed the status and privileges of a qualified teacher.

When Malawi introduced Free Primary Education (FPE) in the 1994/95-school session, pupil enrolment shot up from 1.8 million to 3.8 million, and consequently created a shortfall of teachers. In order to cope with the high demand for teachers, the government suspended all the other programmes and introduced the two year Malawi Integrated Inservice Teacher Education Programme (MIITEP), which, as the name suggests, operates on the philosophy of inservice integrated into the pre-service programme. The entry requirements were the same as those of the former programmes. The student teachers were recruited and posted in schools to teach without any training in the use of language in the classroom.

The programme was organised in three parts. The first part involved the students attending a three-month residential course that covered the basic skills in teaching each subject. After this course, the students returned to their respective schools to continue teaching. The second part was the study of modules by distance education: students were given modules prepared on minor topics in each subject to study while teaching and educational supervisors were asked to assist the students. Workshops were organised in the third phase of the programme for the students to study the other modules during school vacations. Students were required to sit for examinations at the end of the second year. However, the training modules for mathematics did not address issues of use of language in mathematics teaching, thereby teachers would graduate without the basic knowledge of how to use language in mathematics teaching.

Objectives of Teacher Training

Any training session is supposed to serve a purpose to prepare certain people for a job. It is assumed that before training, these people will not have the capacity to do the job because the job demands a particular body of knowledge, skills and attitudes for one to perform effectively. This is not to assume that trainees come into the training sessions without the slightest idea of the profession. For example, when they enter a training programme, student teachers have definite ideas about teaching and learning activities, (Carried and Aloso-Tapia, 1996), and also the problems of language use in teaching (Tansley, 1986). They bring into the training programme beliefs that determine their subsequent learning, receptiveness and retention of what they learn (Lortie, 1975; Zeichner, and Liston, 1996) about teaching mathematics in particular languages. Some of the beliefs could be detrimental to the learning of the profession. For instance, teachers' beliefs and values of the use of Chichewa and English in teaching of a subject may influence the way the two languages are used. This is why any teacher-training programme should endeavour to change the negative beliefs and encourage the more beneficial ones. This effort can be detected in the aims and objectives of any given teacher education programme. Since this study has been conducted in Malawi, it is important to reflect on the aims and objectives of teacher training in Malawi as they relate to teacher use of Chichewa and English in mathematics teaching.

There is an emphasis in the revised teacher-training programme for Malawi to place teachers in the field with a positive understanding of the nature and importance of primary education. The revised programme aims at training rational and adaptable teachers who accept change and can adjust to new demands without jeopardising excellence in education. It seeks to modernise primary education through a critical study of the problems affecting it at present. According to the Syllabus for the Teacher Training Programme (Ministry of Education, Sports and Culture, 1992: 3), teacher training aims, among other things to:

a) develop in the teacher the ability to communicate effectively;
b) help the teacher acquire the basic theoretical and practical knowledge about the teaching profession;
c) help the teacher acquire professional and academic skills to enable him/her to teach the primary school curriculum effectively;
d) develop in the teacher the ability to be imaginative and resourceful;
e) provide through the teacher opportunities for permanent literacy and numeracy in the nation;
f) prepare the teacher to apply mathematical and scientific knowledge and skills in everyday life.

All these aims are of particular interest in this study. However, the most interesting one is aim (a) because it raises the question of how teacher training ensures that teachers gain the necessary skills in classroom communication as they teach mathematics. A close look at the various teacher education courses in Malawi reveals that there is very little on classroom discourse. Teacher educators for mathematics think language use in the classroom will come to the teacher naturally or the language specialists will provide it, which may not be the case. Courses in curriculum development take very little notice of the important role played by language in mathematics education.

The research studies in the use of language of instruction in the classroom have not focused on mathematics lessons in Malawi Primary Schools. Generally studies on the role of language in mathematics education in Malawi have tended to focus mainly on the effects of language on pupils' performance (Kachaso, 1988) and there is very little on how the language is used in mathematics teaching (Kaphesi, 1988).

4.2.3 Characteristics of Primary School Children in Malawi

As discussed in Section 4.2.2, the introduction of the Free Primary Education Programme in Malawi in 1994 saw an increase in enrollment from 1.9 million to 3.2 million pupils (Malawi Government, 1996), although the actual attendance is considerably lower (Hauya and Kaphesi, 1997). The entry age is 6 years, although children as young as 4 years are sometimes enrolled in standard 1 (Makuwira, 1995). All the government schools enroll both boys and girls. A child entering standard 1 at the age of 6 is expected to be through standard 8 at the age of 14 years. However, because of repetition (though unofficial), some children spend 12 years or more in primary school.

In urban schools, children of different ethnic background are admitted into one class. However, in rural schools, most children come from a more or less homogeneous ethnic background. The children are also of mixed abilities; there is no streaming of any sort in Malawi primary schools. Nevertheless, all children are taught in local languages from standards 1 to 4 and in English thereafter.

Pupils are subjected to teacher-made tests at the end of year in all standards except in standard 8 where children sit for standardized national examinations at the end of the year. A pass in these end- of- year tests ensures that the child proceeds to the next class.

However, failure automatically requires the child to repeat the class, even in standards 1 to 4, though against the government policy of automatic promotion. In Malawi primary schools, pupils' performance in mathematics is poor and in many cases failure in one subject may contribute to repetition of children which is very high in the first four standards (Kachaso, 1988). Yet research studies have shown that some pupils fail mathematics because of a failure to cope with the language used in teaching mathematics (Orton, 1987).

4.2.4 Primary school resources

The effectiveness of teachers' use of local languages in mathematics teaching may also depend on available school resources. Printed materials such as books are fundamental to facilitating classroom instruction. Apart from the teacher, books provide most of the mathematical concepts and vocabulary (Shuard and Rothery, 1984). It is therefore important that the situation of school resources in Malawi be understood in order to appreciate why teachers rely heavily on verbal interaction with their pupils during mathematics lessons.

Free primary education brought about various challenges impacting on issues of quality. In addition to wastage, classes have become even more overcrowded than before. It is common to find classes of up to 200 pupils (Malawi Government, 1999). Chimombo (1994) reported an average size of 104, with class sizes ranging from as low as 30 in rural areas to as high as 250 in some urban areas. Some 30% to 40% of classes are conducted under the trees because of the shortage of classrooms. Nearly 70% of schools do not have furniture in classrooms. The situation of instructional materials and school supplies has also deteriorated; up to 5 pupils share one book, making teaching and learning almost impossible. The influx into school prompted the government to recruit 22,000 untrained teachers between 1994 -1996 in order to maintain a 1:60 teacher/pupil ratio (Chimombo, 1994). The government's effort to open access to basic primary education has in the short term affected quality and has further reduced the internal and external efficiency of primary education (Hauya and Kaphesi, 1997). With the limited resources in schools, the teacher is critical in ensuring that the limited resources available are used to the maximum in the learning process. The medium of instruction is one of the resources that the teacher has to use carefully to exploit it to the maximum in the teaching and learning process.

4.2.5 Primary mathematics curriculum

Mathematics provides a context of the study of the instructional languagein primary schools in Malawi. A background to the teaching of the mathematics curriculum in Malawi helps to appreciate what kind of mathematics is being taught in the languages that I intend to study.

Mathematics education has undergone several major transformations since Malawi's independence from Britain in 1964. In 1966, a syllabus was developed to replace the 1961 primary school syllabus. The changes in the new syllabus included the replacement of the nomenclature of arithmetic by mathematics, with emphasis on investigation, experimentation and not merely the rote learning procedures. The 1966 primary school syllabus also emphasised that the material read must be understood by the children and the teacher must ensure by questioning orally or by writing what they understand, as many children fail to solve a problem in arithmetic simply because they do not understand what the examiner wants them to do.

In the late 1960s, the country adopted the modern mathematics syllabus for primary schools. This was short-lived because it lacked clear information, suitably prepared teachers and suitable learning materials (Hau, 1992). Consequently, the country changed back again from modern mathematics to traditional mathematics. The need to revise the primary mathematics syllabus arose again in 1980 in order to accommodate the metric system. The Malawi Ministry of Education introduced SI units in the school syllabus and textbooks in 1980, totally discarding imperial units.

In July 1982, Malawi introduced another primary school syllabus. This was an examination syllabus with emphasis on regulations for the primary school leaving certificate examinations. An arithmetic syllabus was outlined with very little guidance to the teacher in terms of the scope and sequence of activities, objectives, materials, etc. However, it was stated that "the medium of instruction should be local languages for standards 1 and 2 only but with counting in English" (Ministry of Education and Culture, 1982: 5).

In 1987, a major curriculum review was initiated in response to a Ten Year (1985-1995) Education Development Plan (Malawi Ministry of Education, 1985). The new primary mathematics syllabuses for all the standards were published in 1991. The 1991 mathematics-teaching syllabus for primary schools states that the most significant role of mathematics is to develop mathematical skills applicable to solving everyday problems (Malawi Institute of Education, 1990). The 1991 mathematics syllabus thus emphasises problem solving and investigation (Ministry of Education, Sports and Culture, 1991).

The implementation of this syllabus was completed in 1997. Standards 1 to 8 are now using the new syllabus. According to the 1991 syllabus, the medium of instruction for teaching mathematics in standards 1 to 4 is local languages. To enable teachers to teach and pupils to learn in the local languages, the pupils' textbooks for these classes were written in Chichewa (Dunga *et al.*, 1991; Hiwa *et al.*, 1993; Chamdimba *et al.*, 1994; Kalima *et al.*, 1994). Charts too were written in Chichewa. However, the teachers' guides for these standards were written in English perhaps because of the belief that teachers would understand and interpret mathematics easier in English than in Chichewa. Curriculum developers too found it easier to explain mathematical procedures in English than in Chichewa. This notion suggests that even the curriculum developers have a perception of the use of Chichewa and English in mathematics teaching that favours use of English to use of Chichewa (Dunga *et al.*, 1991; Hiwa *et al.*, 1993; Chamdimba *et al.*, 1994; Kalima *et al.*, 1994).

The primary teacher-training syllabus has also been revised alongside the primary mathematics syllabus. The medium of instruction in teachers' colleges is English. All the curriculum documents are written in English, except for Chichewa. While the primary school mathematics syllabuses have consistently stated the language policy in education, it is not clear whether or not teacher trainees are fully prepared to teach mathematics in the local languages. In other words, do teachers gain enough mathematical concepts with corresponding mathematical language to teach mathematics comfortably in both local languages and in English?

4.2.6 Language policy in education

The language policy in education has been an issue for a long time not only in Malawi but also in many developing countries such as in Africa(Siege, 1997; Mchazime, 1995; Banda, 2000) and Hong Kong (Benson, 1997; Lee, 1993; Morrison and Lui, 2000) the concerned is with the dilemma between use of mother tongue and colonial language and not much of the choice among the local languages. Imperialism supersedes educational value in most language polices in education in developing countries. In Europe (Ktra and Szekely, 1993), the concern is about the role of the language of the majority in relation to the minority in education; whether to use the minority language for the limited English language proficiency students. Immigration effects, integration of the immigrants in the society supersedes the educational value of the medium of instruction. In the USA (Lewelling, 1991), the concern is about the effect of language deficiency on academic achievement and how to improve the academic achievement of the limited English speakers.

There are distinct differences in the focus and concerns regarding the policy on medium of instruction between developing and developed countries. The historical and social problems are the major contributing factor in the prevalent situations influencing the language policy in education. Having suffered greatly under colonial power and the colonial language imposition on them, Africans and some countries in Asia are fighting against the language imperialism hoping that this will make education relevant to the needs and aspirations of the society. Use of a colonial language is a reminiscent of oppression and suffering. The use of local language is a continuation of liberating people from colonialism. In Europe immigrants are a cause for concern. They bring with them their language and the language policy in education is geared towards assimilating the immigrants through the displacement of their language by the language of the natives. In USA the focus is to explore the differences on academic achievement between English speakers and limited English speakers so as to find ways of improving academic achievement of the limited English speakers. The assumption here is that meaningful education can be offered in English and that those who do not speak English must be helped to speak it if they are to be educated.

The formulation of language policy in education in general and in medium of instruction in particular is quite challenging. It can be emotional founded usually on the ill of the society. While I recognise the importance of the context in which the policy will operate, it is important that the policy of medium of instruction must focus squarely on educational values. The language of instruction must enhance social, political, technological and economical development. In other words, a sound policy on medium of instruction will be based on multiple factors that affect the life of an individual, institution and the community. Recognition of the effect of the language on academic subjects hence the teaching and learning processes will ruin the educational quality. Specifically, the policy on medium of instruction must reflect, the sociolinguistic factors, the educational theories, values and practices, social goals and aspirations and transformational and developmental processes. They should not be based on the social emotions of regarding language inferiority and language deficiencies rather on positive values of educational, scientific and cultural development.

It is evident (Figure 4.1) that the use of language of instruction in schools largely depends on the overall language policy in a country, which in turn may partly influences teachers' knowledge of and attitude towards the use of language in the classroom. Therefore, one would want to know what kind of language policy is in operation as this study is being undertaken. Malawi is one of the very few countries in Africa that have a national language that is also a local language. Other countries include Tanzania, Kenya and Uganda (Myers-Scotton, 1993). In most countries in Africa, this has been difficult because each time consideration is made to this issue, it has always been misinterpreted as an ethnic issue. A compromise to using a local language as a national language has been to use a foreign language such as English, French, Portuguese (Figure 4.1). This has resulted into either not using local language in teaching or limiting the use of local language to the first two standards at primary level.

According to the Chichewa Board of Malawi (1994), there are 15 languages in Malawi. These are Chiyawo, Chilomwe, Chisena, Chisenga, Chichewa, Chingoni, Chitumbuka, Chilambya, Chitonga, Chibandya, Chisukwa, Chindali, Chinkhonde, Chinyika, and Chinamwanga (Loga, 1972). Though very old, a map of Malawi in Figure 4.1 is the only official document that shows how the languages are distributed in Malawi.

Chichewa is a national language and with five others - Chitumbuka, Chitonga, Chiyao, Chilomwe, and Chisena is used for public communication in the media such as the radio. Currently, only Chichewa and English are taught in schools. However, Chichewa is the most widely spoken language in the country (Kishindo. 1990).

Country	Population	Number of Local Languages	Official Languages	National Language	Regional Languages	Medium of Instructions in Schools	Languages of Study in Schools	Comments
Mozambique	15 Million	20	Portuguese		Makua, Shona, Shangaan, Rouya, Chiyao, Chilomwe and Chichewa	Portuguese from grade 1	Portuguese, Shangaan, Chichewa	In 1993 an experimental project to teach children in Chichewa and Shangaan was launched. Textbooks were written and now pupils are able to read in Chichewa and Shangaan (their mother tongue) in the experimental schools. Indications are that pupils are motivated and the results are encouraging
Malawi	11 Million	16	English	Chichewa		Chichewa grades 1-4 English grades 5 Local languages 1-4	English grades 1 Chichewa grades 1	All other local languages were introduced as medium of instruction in the area they are spoken from grade 1 to 4 in 1996
South Africa			English		Africaan, Sezulu, Xhosa	Mother tongue	English, one regional Language	
Swaziland	1 Million	1	Seswati English	Seswati		Seswati from grade 1 to 2	English grade 1 upwards Seswati grade 1 upwards	There is a trend for parents to ask the children to start learning French right from grade 1
Uganda	20 million	25	English	Kiswahili		Engish grades 5 upwards in rural areas and grade 1 upwards in urban areas Local languages grades 1-4 in rural areas	English grade 1 upwards Kiswahili grade 1 upwards (compulsory)	
Zambia	9 Million	72	English		Chichewa, Chibemba, Silozi, Kukaonde, Chitonga and Luvale	English grade 1 upwards	English grade 1 upwards local languages 4 are taught up to grade 12	There are proposals that the medium of instruction in grades 1-4 should be indigenous languages and that English should be introduced in grade 2 as a subject. English should be used as the medium of instruction in grade 5 onwards
Zimbabwe			English		Shona Ndebele	English grade 4 upwards Shona/Ndebele grades 1-4	Shona/Ndebele and English from grade 1 upwards Selected local languages of the minority	

Figure 4.1: Language policy in education in selected countries in Africa(Adapted from Mchazime, 1995).

Chichewa became a school subject as early as the day when education was introduced in the country (Rose, 1970). It was being taught alongside other languages such as Chitumbuka. In actual practice, during the colonial era, education for Africans in Malawi implied, for most children, two years teaching through local languages. Malawi adopted Chichewa as a national language in 1968 (Kishindo, 1990), and it immediately became a subject of study in all schools. Chichewa was introduced as a subject in the University of Malawi in 1971. Other languages were dropped from the school curriculum, leaving Chichewa only. Since then, pupils have been learning Chichewa as a subject and this has facilitated the spread of Chichewa to all corners of the country. Today, Chichewa is the most widely spoken language in the country.

Since Malawi was once a British colony, it adopted English as an official language even before independence. English remained an official language even after independence. It has been on the school curriculum since education was introduced in the country. In fact passing the English test is a precondition for a certificate in school examinations.

In Malawi, English is a second or third language for all children who enter public schools, except for a very small minority whose parents speak English as a first language. English is a language of study from standard one and becomes a medium of instruction from standard five. From standards one to four, teachers teach in local languages. Therefore, it is important to take account of the local language vocabulary and language structure available to the teacher. It is important that the teachers become more effective in oral work in mathematics to assist children in the development of general language skills. Teachers must use language to make children not only familiar with the language

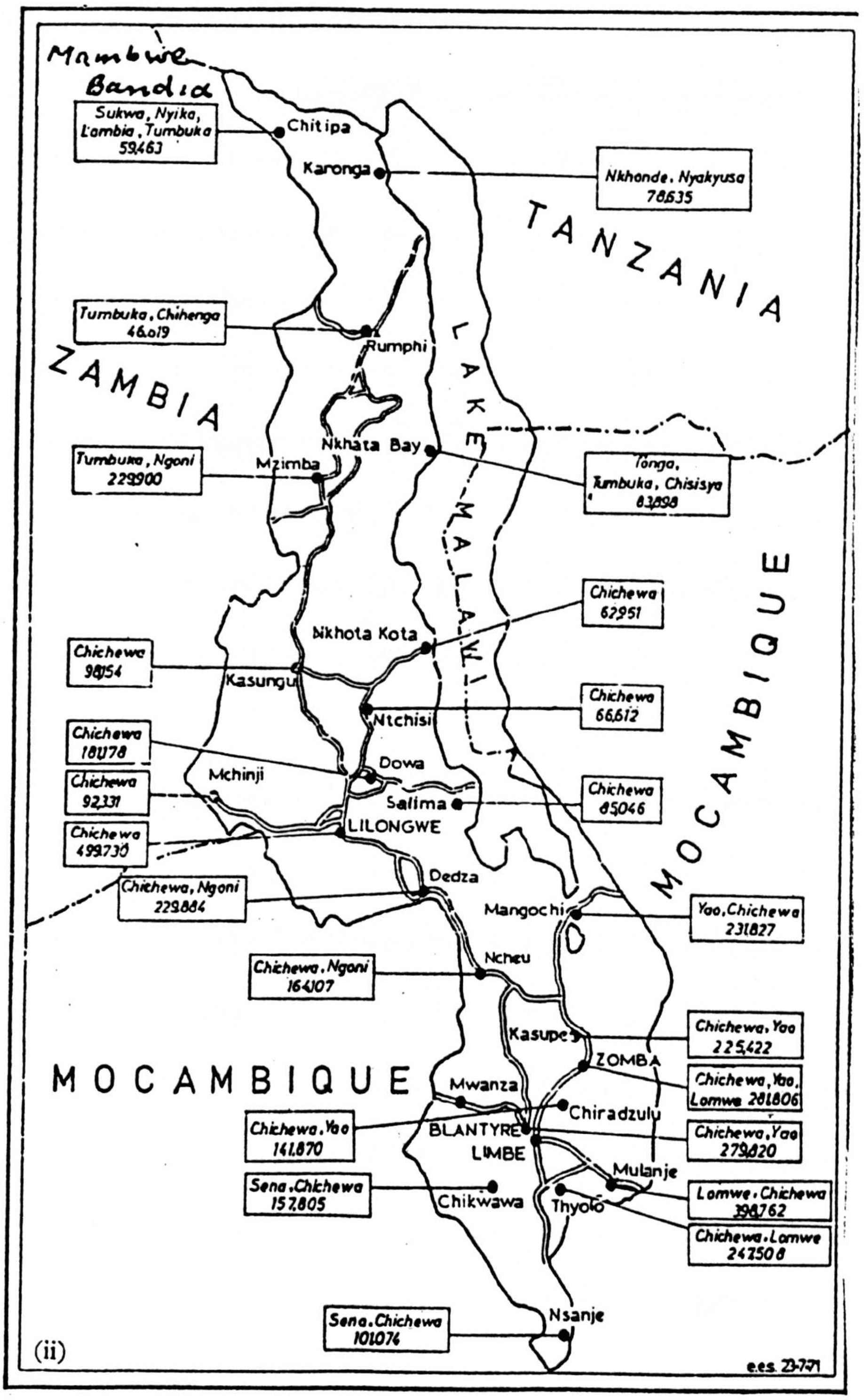


Figure 4.2: Map of language distribution in Malawi (Loga, 1972).

used in mathematics (Cockroft, 1987) but also able to read in order to comprehend what may be called mathematics vocabulary in local languages.

Chiyao is the third largest spoken language in Malawi. A mention of this language is important at this juncture because my study was conducted in the community that was predominantly Chiyao speaking although most of pupils were also fluent in Chichewa, the national language when they entered school.

Often the language of the school is the country's official or national or regional language (Mchazime, 1995) chosen to help bring unity to a political entity but invariably consisting of diverse culture and language groups (Myers-Scotton, 1993; Rose, 1970). Schools are seen as a way of training an elite who will one day lead the country (Rose, 1970). They are also seen as a way of bringing unity to a diverse social entities (Clarkson, 1992).

The introduction of the use of local languages as mediums of instruction in the first four standards in Malawi primary schools has been partly a desire to improve children's learning of new concepts in a familiar language (Ministry of Education, Science and Technology, 1996). As stated in the *Policy Investment Framework (PIF) 1999-2009*, the goals of primary education in Malawi is to improve the quality and enduring nature of primary education by enhancing teacher quality, reducing class sizes and pupil/teacher ratios, ensuring that the curriculum is related to socio-economic needs and that there is effective inspection (Supervisory and Advisory School Visits) (Ministry of Education, 1998).

The policy investment framework for Malawi provides a strong justification for the government to institutionalize the use of local languages as medium of instruction at least in the first 4 classes in primary school. The learner cannot easily learn a mathematical concept in an unfamiliar language. The local languages would enhance concept formation more than a second language. Local languages help the learner visualise diagrammatically the concept being learned whereas the second language may quickly lead to the acquisition of mathematical notation without an in-depth understanding of the concept. However, this role of local languages in mathematics education is usually overshadowed by the role of English in official and international communications. More importantly, the teachers' role is neglected in this venture.

4.3 Research problem

This section presents the focus of this study by raising issues that need to be understood through empirical evidenceand defining the specific research questions that will guide the search for empirical evidence.

4.3.1 Statement of the Problem

Malawi has been trying to address the problem of providing high quality education through, among other things, emphasizing the use of local languages as medium of instruction in standards 1 to 4 and English thereafter (Ministry of Education, 1996). However, some educators have expressed doubts about the wisdom of a local language medium policy in a multilingual country like Malawi in which a language of wider communication such as English is the official language (Kulemeka, 1994; Wingard, 1963). Some critics argue that there is hardly any empirical justification for the superiority of a local language medium over English medium (Mukuyamba, 1996). Nonetheless, studies have been carried out elsewhere, for example, Mukuyamba (1996) which showed that the introduction of English as the medium of instruction from the beginning of school might have the following advantages:

1. the quality of English spoken and written by the pupils in primary schools would be improved.
2. the emotional disturbances which often occur to the child when English replaces the local languages as the medium of instruction after the forth year of primary school, in the case of Malawi, would be minimised.
3. a more flexible command of English sentence structure and vocabulary, which is adequate for pupils' needs in and out of school use, would be developed.
4. learning English at the upper primary level and in the secondary school would be facilitated.
5. the general educational development of pupils would be improved, because the children would be introduced to a much wider range of reading materials at an earlier age than is possible under the traditional method (Mukuyamba, 1996).

However, Mukuyamba (1996) does not substantiate these claims with empirical evidence. It is unlikely that this issue can be resolved easily, as the controversy can hardly be divorced from prejudice that the best education can only be offered in a colonial language. Now that Malawi has decided on a local language medium policy, all arguments about the feasibility of the policy should give way to a consideration of practical way of implementing the policy.

Many studies have been conducted on local language medium in Malawi (Kaphesi, 1994; Chimombo, et al., 1990; Kachaso, 1988). However, it seems the emphasis has been on the cognitive processes rather than the teaching processes. However, the most recent studies on language of instruction in Malawi have focused on a socio-linguistic approach (Mateche, et al. 1996; Kaphesi, 1997) although these studies were not conducted in the classroom. Yet teachers may experience some classroom communication problems, which may impede the use of Chichewa in the classroom. In particular, considering the various teacher characteristics, teachers may have knowledge and practices about the use of Chichewa in mathematics. However, different teachers may perceive mathematics as a subject demanding a different language because different subjects may elicit different linguistic demands. Teachers may also be ill prepared to use Chichewa in mathematics. Teachers' lack of awareness of mathematical register or terminology in Chichewa may make it difficult for them to discuss mathematics in the classroom. Consequently, teachers may have more effective English language skills than Chichewa. These and many more problems may create dilemmas and tensions in the teachers, which may affect the teachers' performance in the use of language in mathematics teaching.

In the absence of research data on the use of Chichewa and English in mathematics lessons in the lower primary schools in Malawi, it is very difficult to ascertain how teachers use Chichewa or Englishin mathematics. How do teachers feel about it? Do they use English better than the local language in teaching mathematics? Does it matter to the teachers whether they use a local language or English in the way they bring to the surface the language skills in mathematics teaching? Many classroom discourse analyses have been done on a single language medium, and in other subjects more than in mathematics teaching process. Therefore, there was a need to conduct a study to find out how teachers use local languages and English in mathematics teaching in the lower primary schools in Malawi.

The purpose of the study is to determine how teachers use Chichewa and English in mathematics teaching in primary schools in Malawi - how teachers use the language in mathematics teaching in the lower primary schools in Malawi. I ask, does it matter whether they use Chichewa or English? What are the teachers' experiences and why?

The study intends to answer the following research question: How do teachers use Chichewa or English in mathematics teaching? Specifically,

1. Do teachers' perceptions of use of Chichewa differ from the use of English in mathematics teaching? If so, how much?
2. Do teachers know mathematical vocabulary equivalents in English and Chichewa? If so, how much do they know?
3. Does teachers' use of language in Chichewa medium differ from the English medium mathematics teaching? If so, how does it differ?

4.4 Significance of the study

Language is one of the tools for communicating about the world. Thoughts are expressed in language. Language is used in everyday life to transmit culture and social knowledge, attitudes and values. It is against this background that adequate understanding of how language is used in schools is perceived to be absolutely essential.

One objective of basic mathematics education must surely be to ensure an understanding of mathematics in the children. In most countries, mathematics dominates the lower primary school curriculum. An adult usually introduces mathematics when the child is still developing language. In order to carry out this objective, educators must first understand how the language of instruction may interfere with the child's learning of mathematics and then investigate how teachers use language to enhance construction of knowledge.

Different languages carry different conceptual meanings in mathematics because concepts develop with the need in the sociolinguistic group. The group develops a language for communicating the concept and the language becomes part of the subject content. This process of developing a language based on the need for use and for communication is different in different societies and it must be understood in the social context of the user.

The use of a language in teaching and learning mathematics will only be meaningful if the underlying implications for pupils' understanding of mathematics are understood. It is essential to study how teachers use language in mathematics teaching so as to relate the findings to how children construct knowledge. A study on the use of Chichewa in teaching and learning of mathematics has not previously been carried out in Malawi. Even the few studies in developed countries in this area have concentrated on the language issue in terms of minority versus majority, immigrants versus locals, advantaged versus disadvantaged, middle class versus low/high class children (Austin and Howson, 1979). It is hoped that the design of the present study will produce clearer evidence of teacher efficiency in using language skills in mathematics teaching.

This study is unique in a number of ways. It is based on my experience in teaching mathematics at school level, designing and developing curricula and curriculum materials for schools, initiating and conducting research in mathematics education in schools, and inservice training of primary school teachers and teacher trainers in mathematics education since 1984. It is partly this knowledge and experience that has formed the basis for raising the research questions for this study.

The scope of the study allows me to critically investigate how mathematics teachers are using Chichewa, a local language, in school and to compare its use with English, the foreign language medium. Research in the area of how a local language is used by both teachers and pupils is scarce. None has ever been done in Malawi. Therefore, the findings of the study are unique and original because Malawi is a multilingual country with a bilingual policy in education together with educational and sociolinguistic contexts different from those in other countries.

This study is also original in that I attempt to:

(a) discover new facts about the problems and prospects of using Chichewa in mathematics teaching where English is used as a second language.

(b) examine critically the existing facts and ideas on teacher efficiency in the use of Chichewa and English in mathematics teaching.

(c) conduct a systematically designed study through a case study approach that included multifaceted methods of data collection. These methods gave me an opportunity to systematically trace a process of language use in mathematics teaching and also examine teachers' perceptions of the use of Chichewa and English.

(d) describe the possible model for understanding how teachers understand and use language in mathematics education.

The findings of this study contribute towards the knowledge of understanding the role of language in mathematics education particularly where a local language as a medium of instruction is replacing a foreign language. They also contribute towards understanding of how best to use language as a resource in mathematics teaching.

4.5 Conclusion

Considering the prevailing educational context in primary schools in Malawi with regard to the language policy in education, there seem to be a problem of understanding and using language to enhance the teaching and learning of specific subjects in the classroom. There is need to explore what teachers think about and do with language in mathematics teaching so as to improve the quality of mathematics education. The problem is to be explored in mathematics classroom because of the persistent poor performance and achievement in mathematics, the linguistic nature of mathematics and the nature of bilingualism that exists in mathematics classroom. It appears that the sociolinguistic orientation of mathematics teachers is not fully understood; thus underutilised by the teachers, the curriculum developers, the teacher trainers and the policy makers. Exploring the problem of the teacher understanding and use of language in mathematics will contribute towards the effective use of language in mathematics education.

CHAPTER 5

RESEARCH FRAMEWORK

Locating the Study

Between appearance and reality falls the shadow
(Edwards and Furlong, 1978: 148-149)

5.1 Introduction

This chapter presents a discussion of the research paradigm (framework) chosen for exploring teachers' understanding and use of language in mathematics. It explores both philosophical and methodological issues. My argument is based on three assumptions. Firstly, the choice of methods ultimately depends on the focus of the study. Secondly, because the focus of the study is classroom communication, a sociolinguistic approach is appropriate. Finally, there are methodological implications on the chosen methods.

When I refer to a theoretical orientation, I am talking about a way of looking at the world; the assumption people have about what is important and what makes the world work. Whether stated or not, all types of research are guided by some theoretical orientation. Researchers construct their theoretical base and use it to guide their data collection and analysis data. Thus I shall examine the theoretical orientation that guided my selecting the research paradigm which in turn determined my research methodology.

After examining literature on theories and practices influencing the use of language in mathematics education in Chapters 2 and 3, three points emerged. First, teaching is a communication process, different from ordinary conversation in that it serves a special function of transmitting knowledge, attitudes and skills. Second, language is central to effective communication in the classroom in that teachers use language to manage and control learning whereas pupils use it to respond to teachers' authority and also to demonstrate their understanding. Third, teachers' understanding and use of language can be affected by the linguistic nature of mathematics such as mathematical vocabularies and other sociolinguistic factors in the classroom such as bilingualism and language policy which lead to complex teaching scenarios. In this one might envisage teaching mathematics is like teaching a language in another language.

Whilst educators generally recognise the importance of language in mathematics teaching, it may not be so for teachers. Linguistic problems in the classroom may be overlooked because of the routine nature of most classroom behaviours. My intention in this thesis is to expose the way teachers' understand and use language not only during classroom communication in general but specifically in interactive mathematics teaching. I am not going to demonstrate how particular perceptions or teacher knowledge of mathematics vocabulary lead to particular teacher classroom language use or pupil performances. To do that would require a research study with a different scope and focus and/or time scale. My aim is to offer a way of describing the teachers' perceptions of the use of language in mathematics teaching.

In this Chapter, I elaborate my own position on the nature and legitimacy of knowledge because a Ph.D. requires me to make a significant contribution towards the development of knowledge. I begin with a claim that by its very nature, my study that is basically educational research, is a social venture derived from concerns and pressures in society. For me the pressures and concerns arise from being a mathematics teacher working in an educational system where language policy does not seem to take into account the implications of dilemmas for classroom practice.

Improving mathematics education requires an understanding and an adequate interpretation of the underlying structure that organises and orients teachers towards mathematics education and classroom communication. I want to look at mathematics teachers and their classes by exploring teacher vocabulary, teacher perceptions and teacher communication from a social point of view. Indeed this has an implication on the methodology I choose to adopt and I shall now discuss briefly the factors that guided my choice.

5.2 Focus of the research methodology

In this section, I examine the focus of the study in order to choose the appropriate research methods. My research focus is threefold: teacher perceptions, teachers' knowledge of mathematics vocabulary equivalents between Chichewa and English, and teachers' use of language in mathematics lessons.

5.2.1 Approach to the study of perceptions

To explore how teachers use language in mathematics teaching, I consider teachers' perceptions of the use of Chichewa and English given the belief that perceptions influence social actions (USAID, 1991). Recent changes in the medium of instruction in Malawi Primary School Standards 1-4 have resulted in downward pressure on teachers to teach mathematics in Chichewa in the first four Standards and in English in the upper Standards. Given also the multilingual context prevailing in Malawi Primary Schools today (Kishindo, 1990); Kulemeka, 1994; Mateche, et.al.1996; Kishindo, et al., 1997) such pressure is likely to result in dilemmas and tensions for teachers, especially mathematics teachers (discussed in Chapter 2), considering the relationship between mathematics and language (discussed in Chapter 3). Such pressure will impact on teachers' perceptions of the use of languages which in turn may guide the teachers' use of languages in their mathematics teaching. Teachers' perceptions may be predictable since they may be in conflict with the theory of constructivistic approach to teaching, the transmission model of classroom communication and the teaching of mathematics. Therefore, teachers may mount a rigorous defense of using one language and not the other. The role of the teachers' perceptions in the use of Chichewa and English is thus central to the way they use language in mathematics and thus may have a far-reaching impact.

Many psychologists involved in understanding perception have tried to describe perception by distinguishing it from sensation. Matlin (1988) distinguishes the two as "sensation refers to immediate and basic experience generated by isolated simple stimuli" whereas "perception involves the interpretations of those sensations, giving them meaning and organisation" (Matlin, 1988: 2). Although there are many definitions of perceptions, many share the fundamental principle that perception is to do with *interpretation* of experiences of the world. Drawing on the findings of cognitive psychologists such as Piaget and constructivists such as Vygotsky, if perception is an interpretation of basic experiences, then surely this interpretation cannot be devoid of the social world, in which language is one of the elements.

The application of a perceptual approach in my study is relevant because, as Goldstein (1999) suggests there are shared or common perceptions among teachers. However, he also alluded to the fact that there are differences in teachers' perceptions because each teacher's perceptual experience is essentially personal to that teacher. It is my belief that teachers may have similar but not identical perceptions about the use of language in mathematics. It is the role of research to explore the similarities and differences in perceptions.

Sekuler and Blake (1990) describe perceptions as representing the final outcome in a complex chain of events, stretching from events in the physical world external to the perceiver, through the translation of those events into patterns of activity within the perceiver's nervous system, culminating in the perceiver's experiential and behavioural reactions to those events. Landau, Sibini, Jonides and Newport (2000) discuss the complexity of perception when they say that perception is not neutral and somehow in one way or another, incorporates the perceiver's understanding of the depicted form. Recognising that perception is complex and yet important in educational research, it is important to find an appropriate methodology to explore and understand the efforts of teachers' perceptions in particular context.

Neumann and Prinz (1990) conclude that there is a relationship between action and perception. They argued that "percepts and acts both refer to events with comparable attribute" (Neumann and Prinz, 1990). My concern in this study is also to relate teacher perceptions to their practice in using Chichewa or English.

The fact that many studies have been conducted to quantify perceptions leads me to conclude that perceptions are observable and that they can be described objectively.

Listening to teachers talk about their feelings elucidate further the underlying nature of the theoretical and methodological orientation. Perceptions are presented in knowledge, and actions. Focussing entirely on what is said without considering by whom, when and why it was said, misses the point in searching for truth about perceptions and actions. There is a need to attend to actions as well in developing an understanding of knowledge and perception.

From the preceding discussion, I would argue that *phenomenological methods* seem to be appropriate for use in studying perceptions of teachers. *Phenomenology* encompasses the attempt to describe the way things appear to participants without any prejudice, biases or theories imposed.

5.2.2. Mathematics vocabulary

This section discusses teachers' mathematical vocabulary equivalents in the language of instruction, which are crucial in language use in mathematics teaching. As discussed in section 2.6, in a *bilingual country* such as Malawi, the teachers' mathematics vocabulary equivalents in *first language* (L1) and *second language* (L2) may affect the teachers' use of language in mathematics teaching. For example, teachers may not be able to give alternative terms to describe mathematical concepts when a child has problems with the language being used. As already argued in section 3.5, mathematics has technical terms or vocabulary to describe precisely mathematical concepts. My concern here is that teachers may not teach mathematics effectively in bilingual classrooms because they may be unable to explain the mathematical concepts in either Chichewa or English when the need arises due to inadequate mathematical vocabulary equivalents. It is also a common practice in multilingual countries that mathematics be taught in the local language especially in the first school years (UNESCO, 1953). Yet teachers may not have enough vocabulary in the local language to transfer the knowledge between L1 and L2. The study of mathematical vocabulary equivalents between L1 and L2 is thus an issue of language uses in mathematics teaching and focuses on pedagogical orientation of classroom communication.

Many studies on vocabulary have tended to address issues of language learning with very little relevance to applied linguistics in mathematics teaching (Carter, 1998). Yet language influences how subjects such as mathematics are learnt. Mathematics has concepts which need to be taught through specific vocabulary. The tendency to perceive mathematics as simply involving skills and knowledge is very incomplete because it leads to neglecting the fundamental way language describes mathematical concepts.

The number and quality of mathematical vocabulary equivalents in a particular language may affect teachers' perceptions and use of that language in the mathematics classroom. For example, when a teacher feels that he/she cannot describe a triangle in a particular language, this may develop a tendency to adopt a negative attitude towards that language. This is why I feel studying mathematics vocabulary equivalents known by mathematics teachers is useful in understanding the language problems in mathematics teaching.

Studies on mathematics vocabulary equivalents between L1 and L2 are rare as many studies on vocabulary focus on language *learning*. The methods of studying mathematics vocabulary equivalents involve identifying teachers' knowledge of the vocabulary equivalents between Chichewa and English. Mathematics vocabulary from the textbooks for standards 1 - 4 is representative of the mathematics vocabulary that teachers need to know and teach. I considered alternative sources of mathematics vocabulary not compatible with my study. For example, sampling mathematics vocabulary from teachers through interviews would fail to give me a wide variety of vocabulary especially those vocabulary equivalents that teachers do not know. Similarly, collecting mathematics vocabulary from classroom talks may not yield enough coverage of the mathematical vocabulary representative of the syllabus.

I want to use the findings of the mathematics vocabulary equivalents to develop my theory that there is a difference in teachers' knowledge of mathematics vocabulary in Chichewa and English and how this difference contribute towards the sociolinguistic orientation of the mathematics teachers.

5.2.3 Teachers' use of language in classroom discourse

To understand how teachers use language in the classroom, it is imperative to observe, record and analyse *classroom discourse*. Classroom discourse is the structure of language interaction in the classroom especially during lesson delivery (Chimombo and Rosebery, 1998). Therefore, this section attempts to describe the classroom discourse and how it can be understood by focusing on the structure of a lesson and subsequent analysis. First, I discuss a *lesson* - the unit of discourse in the classroom communication.

Mathematics lessons

In this study, a lesson is one of the units of study. The other units include mathematics vocabulary and teacher perceptions of the use of Chichewa and English in mathematics teaching. It is important at this juncture to understand the structure of a lesson.

According to Sinclair and Coulthard (1975: 59) the lesson is the highest unit of classroom discourse. Sinclair and Coulthard (1975: 59) argue that there are different ways in which a teacher may deliver a lesson; the lesson may involve *presenting* some information; *discovering* whether the information has been assimilated, and then getting the *pupils to use the information* presented in their own work. Alternatively, the lesson presentation may begin by eliciting a series of exchanges followed by attempts to move the pupils towards a conclusion which will later be elaborated in an informing transaction (Sinclair and Coulthard 1975: 59).

Sinclair and Coulthard (1975: 59) argue that, in most cases, the discourse of a lesson might not proceed according to the teacher's plan. There are a number of factors which can affect the actual discourse such as the teacher's own memory capacity for ordering speech, the need to respond to unpredicted reactions and misunderstandings or contributions on the part of the pupils. In this study, I want to take this further and find out if language difference affects the flow of classroom discourse in mathematics teaching.

Lessons in primary schools are typically characterised by an introduction intended to help the learner to connect the previous lesson with the new one. Thereafter the teacher develops the lesson through activities deliberately sequenced to facilitate learning. The lesson usually ends with a conclusion or summary of what was learnt. However, Sinclair and Coulthard (1975: 59) observe that generalising the lesson structure might be difficult, as there seem to be characteristic lesson structures for different subjects, for different teachers or for different classroom settings.

Lessons are complex because of the many players and materials involved. Therefore, in-depth lesson analysis requires recording, transcription and analysis of classroom talk. However, an observer can summarise types of utterances and sequences of utterances that tend to promote the effective classroom discourse (Sinclair and Brazil, 1982: 2-3). Thus my intention is to observe lessons with the aim of describing the discourse characteristics of Chichewa and English medium mathematics lessons. I shall now discuss elements of classroom talk during a lesson.

Classroom talk

Most classroom communication is achieved through *talking*. Previous research studies have shown that the teacher dominates the talk in quantity, range and degree of control over their pupils (Sinclair and Brazil, 1982: 7). Whilst lesson activities are planned, lesson talk may not be an explicit part of the plan because teachers use talk as a means for managing classroom situations. It is my concern that teachers spend much time planning what to say (subject content) but little attention on how to talk about (language use) in the classroom because they unconsciously expect to decide how to say it right in front of the class.

A comparison of two language settings of professional talk may help clarify my point. Teacher talk is different from the discourse of other professions such as preaching (Chimombo and Rosebery, 1998), because the circumstances are different - the social relations, the physical setting and the jobs to be done. The job of, say, managing fifty small children so that that they absorb some aspects of the culture is different from preaching to over 200 people to advise them on spiritual matters. Whilst preachers and teachers may have very similar accents and voice qualities, outside their professional lives, it may be hard to tell them apart. But their professional discourse is quite different.

Teacher dominance in classroom talk has come to be accepted as normal because it serves its purpose of managing and controlling the learning process (Edwards and Westgate, 1987). During a mathematics lesson, a teacher engages in asking questions, responding to pupils' questions, giving instructions and commands, giving explanations, reading and writing symbols, providing concepts, and so on. Pupils too have their role of assuring the teacher that they are learning. Classroom talk calls for not only the teacher's knowledge of the subject but also most importantly a high command of the language of instruction. However, different teachers may have different vocabulary repertoires in and perceptions of different languages used in mathematics teaching, be it local (L1) or foreign language (L2). Therefore, teachers' use of language during classroom instruction is likely to be varied across the various forms of classroom talk. In this study I want to compare the teacher use of language in two different classroom language setting.

Classroom discourse analyses

In this section, I want to examine in detail how classroom talk can be analysed by considering various classroom discourses developed by previous researchers (Cazden, 1986). Chimombo and Rosebery (1998) view a *discourse* as a process resulting in a communicative act and the communicative act itself as a *text*. They argued that a *text* is commonly thought of as consisting of the written or printed word on a page. However, text may also consist of non-verbal communication communicating the thoughts of a writer, or speaker, on the one hand, or a reader or listener on the other. In addition to words, a text may consist of other symbols, sounds, gesture or sentences in any combination that is intended to communicate information such as ideas, emotional states and attitudes. A text may fail to communicate, but if the intention to communicate is clearly there, it must be regarded as a text (Chimombo and Rosebery, 1988). From this view, it can be concluded that classroom discourse involves everything that takes place in the classroom with an intention to communicate. Classroom communication systems include verbal (oral or written) and non-verbal (gestures, dressing, movements, etc.). Some of the communicative acts can only be understood in a context.

Today discourse analysis is widely used in investigating classroom communication processes (Flanders, 1960; Bellack, et al., 1966; Fanselow, 1987). In examining the work of the previous studies on discourse analysis I wish to identify differences and similarities that would help me adapt one to use in my study. Understanding the categories for discourse analysis developed by other researchers is very important because:

> If the categories are free from any assumptions about the intentions of the actors, then prior acquaintance with them is unnecessary. And if the essential dimensions of the classroom interaction have been identified already, then category systems can be used in (or easily adapted to) almost any classroom, regardless of subject matter or the age and ability of the pupils (Edwards and Furlong, 1978: 43).

The Flanders system consists of ten categories: seven designating *teacher behaviours*, two for *student behaviour* and one for *silence* or *confusion*. The *teacher behaviours* are divided into two types of influence, *direct* and *indirect*. The indirect categories are those which expand the freedom or opportunity of the students to participate (Flanders, 1970: 34). Table 5.1 summaries the Flanders interaction analysis categories.

Table 5.1: Flanders Interaction Analysis Categories (Adapted from Flanders, 1970: 34).

Teacher Talk	Response	1. *Accepting feeling.* Accepts and clarifies an attitude or the feeling tone of a pupil in a nonthreatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included 2. *Praise or encourages.* Praises or encourages pupils action or behaviour. Jokes that release tension but not at the expense of another individual; nodding head or saying 'Um hm? Or 'go on' are included 3. *Accepts or uses ideas of pupils.* Clarifying, building or developing ideas suggested by a pupil. Teachers extensions of pupils ideas are included but as the teacher brings more of his own ideas into play, shift to category five
		4 *Ask questions.* Asking a question about content or procedure, based on teacher ideas, with the intent that a pupil will answer
	Initiation	5 *Lecturing.* Giving facts or opinion about content or procedures; expressing his own ideas, giving his own explanation, or citing an authority other than a pupil 6 *Giving directions.* Directions, commands, or orders to which a pupil is expected to comply. 7 *Criticising or justifying authority.* Statements intended to change pupil behaviors from nonacceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extreme self reference
Pupil Talk	Response	8 *Pupil talk - response.* Talk by pupils in response to teachers. Teacher initiates the contact or solicits pupil statement or structures the situation. Freedom to express ideas is limited.
	Initiation	9 *Pupil talk - initiation.* Talk by pupils, which they initiate. Expressing own ideas; initiating a new topic; freedom to develop opinions and line of thought, like asking thoughtful questions, going beyond the existing structure.
Silence		10 *Silence or confusion.* Pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

Flanders (1970) focuses on the role played by the teacher and the pupils in language use for interaction. He describes who says what and how often and looked for *moves* made together with their *intent* with emphasis on *reacting, soliciting, procedural and responding.* He developed a category for *non-linguistic* communication. However, he did not emphasise the content. Yet communicating content is the basic aim of an educational discourse (Chimombo and Rosebery, 1998), so Flanders (1960) misses one of the major educational values in classroom discourse analysis.

In their study, Bellack, *et al.* (1966) examine a number of transcripts of classroom discourse and came up with four major categories of verbal actions of students and teachers, summarised in Table 5.2. They called the categories *pedagogical moves,* conceptualised as the basic unit of educational discourse. They were classified in terms of the pedagogical functions they perform in classroom discourse. *Structuring* moves serve the pedagogical function of setting the context for subsequent behaviour by either launching or halting-excluding interaction between students and teachers. *Soliciting* moves are designed to elicit a verbal response to encourage persons addressed to attend to something, or to elicit a physical response. All questions are solicitations, as are commands, imperative and requests. *Responding* moves bear a reciprocal relationship to soliciting moves and occur only in relation to them. Their pedagogical function is to fulfill the expectation of *soliciting moves*; thus students' answers to teachers' questions are classified as responding moves. *Reacting* moves are occasioned by a structuring, soliciting, responding, or prior reacting move, but are not directly elicited by them. Pedagogically, these moves serve to modify (by clarifying, synthesising, or expanding) and/or rate (positively or negatively) what has been said previously. Reacting moves differ from responding moves.

Table 5.2: Summary of the coding system developed by Bellack and others (Adapted from Bellack, et al, 1966 pp38-40.

SPEAKER	TYPE OF PEDAGOGICAL MOVE	CATEGORIES OF MEANING	SUBCATEGORIES OF MEANINGS	KEY FEATURES
1. Teachers 2. Students 3. Audio-visual device	1. Structuring 2. Soliciting 3. Responding 4. Reacting	1. Substantive	Subject matter under study by the class	
		2. Substantive-logical	Analytical processes	Defining Interpreting
			Empirical processes	Fact stating Explaining
			Evaluative processes	Opining Justifying
		3. Instructional	Assignment Materials Procedure Statement Logical process	
			Action	General Vocal Physical Cognitive Emotional
			Language mechanics	
		4. Instructional- logical	Analytical processes	Defining Interpreting
			Empirical processes	Fact stating Explaining
			Evaluative processes	Opining Justifying Rating - Positive - Admitting - Repeating - Qualifying - Not admitting - Negative - Positive/negative - Admitting/not admitting
			Extra-logical process	Performing Directing

While a responding move is always directly elicited by a solicitation, preceding moves serve only as the occasion for reactions; rating by a teacher of a student's response, for example, is designated a reacting move.

Bellack, *et al.*, (1966: 5) suggest that pedagogical moves occur in cyclical patterns that they described as teaching cycles. "A teaching cycle begins with a structuring or with a soliciting move, both of which are initiating maneuvers; they serve the function of getting a cycle under way" (Bellack, *et al.*, 1966: 5). They argue that a teaching cycle could not start with a responding or reacting move because these two "are reflexive in nature" (Bellack, *et al.*, 1966: 5). A teaching cycle might also get underway with a structuring move by the teacher in which he/she focuses attention on the topic to be discussed, continues with a question related to the topic, and with responding moves by one or more students.

Teaching cycles developed by Bellack and his colleagues provide a way of describing pedagogical moves in relationship to each other. Using the teaching cycles it is possible, for example, to determine the extent to which solicitation elicits single or multiple responses or the regularity with which reactions follow responses during a lesson. If a single pedagogical move may be compared to a move in chess or a single play in football, then the teaching cycle may be seen as an interrelated series of moves or play. In my study the focus in teaching cycles is on combinations of pedagogical moves and sequences of linguistic events in the classroom.

Bellack, *et al.* (1966) develop further categories of meanings. The proposed four functionally different types of meaning that are communicated by teachers and students in the classroom are *substantive, substantive-logical; instructional;* and *instructional-logical meanings.*

Fanselow (1987) carried on from where Bellack, *et al.* (1966) stopped to develop further the coding of discourse. He named his system **FOCUS** which means "*Foci* for *Observing Communications Used* in *Settings*" (Fanselow, 1987: 19). *Foci* indicate that the system describes more than one characteristic. *Observing* highlights the fact that the purpose of the observation system is to look, not to judge. *Communication* shows that the observation system can be used to describe more than just linguistic messages such as words. *Used* captures the active nature of communication. *Setting* indicates that the system is designed to be applied anywhere, including the classroom.

The system is comprehensive because the terms represent categories of items rather than single items. The categories help show relationships between different items within the system, some of which would remain obscure without the terms. The system also enables each pattern to be seen in relation to the central conceptualisation.

Just like Bellack, *et al.* (1966), Fanselow's categories have five different characteristics of communication (see Table 5.3). The first two characteristics, source/target and purpose of communication or move type answer the question, "*What's being done*?" By noting the next three characteristics of a communication - the medium, use, and content-the question "*How is it being done*?" is answered.

To make a distinction between different sources of communication, the system uses *teacher, student* and *others*. *Teacher* refers both to a person who teaches or anyone who assumes the role of a teacher by acting as if in charge and by showing or telling. A *student* refers to those enrolled in a class. *Others* are used to account for communications from noises, labels, etc.

Table 5.3: Summary of categories for discourse analysis developed by Fanselow (Adapted from Fanselow, 1987: 42).

What is being done?		**How is being done?**		
SOURCE/TARGET	**MOVE TYPE**	**MEDIUM**	**USE**	**CONTENT**
1. Teacher 2. Student (individual, group, class) 3. Other	Structure Solicit Respond React	Linguistic Non-linguistic Paralinguistic Silence	Attend Characterise Present Relate Reproduce Set	Life Procedure Study

Fanselow (1987) argues that in a discourse [teachers] announce and set the stage for what [they] are about to do and he calls these *structuring moves*. Setting tasks by asking questions, issuing commands or making requests are what he calls *soliciting moves*. Replying moves to solicitation is coded as *responding moves* and all the comments made are coded as *reacting moves*.

Fanselow (1987) perceives a larger unit of moves as constituting cycles of moves and sequences of cycles. "A teaching cycle is a series of moves beginning with a structuring or soliciting move that is not preceded by a structuring move" (Fanselow 1987: 26). He distinguishes three characteristics of communication as the *medium*, the way the medium is *used* and the *content* the medium communicates. There are four types of mediums: *linguistic, nonlinguistic, paralinguistic* and *silence*. These categories help in improving the use of mediums in communications. By focusing on media used in a lesson, it is possible to discover that, say, speech is the only medium being used in teacher soliciting. As contrasts in the use of mediums emerge, alternatives may also be sought to address the shortfalls in classroom communication.

The way the medium is used is what Fanselow (1987) calls *use*. Mediums can be used to:

1. *attend to the content*- silent reading and writing, tasting, touching, smelling, looking at pictures etc.
2. *characterize content*- indicating that something is right or wrong, use category labels, comment about people or language.
3. *reproduce content* - repeats, set, copies model, etc.
4. *relate content* - make inferences and generalisations.
5. *present content* - asking questions or stating information directly.

The fifth characteristic of communication is *content* which can be categorised into *life, procedure and study.* If the target content is being communicated as an area of study then it is coded as the content study. To distinguish areas of study communicated in, for example, mathematics classes and other classes, the study can be subdivided into *study of mathematics* and the *study of others areas.*

Life is used to code *personal feelings, greetings, polite expressions, general knowledge,* etc. *Procedure* refers to the content communication such as disciplining students, giving directions or giving a rationale for a particular exercise.

The medium, the use and the content have further subcategories. But the moment we go into the subcategories the system becomes complex. Therefore, in this study, I will not make use of the subcategories.

In an attempt to reflect on the systems put forward by Bellack *et al.* (1966) and Fanselow (1987), one finds more similarities than differences. In fact Fanselow (1987) acknowledges that his work was based on the works of Bellack, *et al.* (1966) and in fact borrows the move type and source directly from Bellack, *et al.* (1966). What Fanselow (1987) calls content is parallel to what Bellack calls "substantive" and "instructional" meanings. Fanselow's uses are parallel to Bellack's substantive logical and instructional logical meanings. Bellack's (1966) instructional meaning is similar to procedural meaning and Bellack's substantive meaning is similar to study. The category of life did not exist in Bellack's system. Fanselow (1987) borrowed it from elsewhere.

Although Bellack alluded to medium, Fanselow (1987) develops subcategories of mediums. Fanselow (1987) borrows Bellack's (1966) definition of the teaching cycle, which means that the whole idea of the teaching cycle originated from Bellack's work.

In my study I adapt the system of categories developed by the Bellack, *et al.* (1966) as well as Fanselow (1987) because they are useful in understanding classroom communication processes. Their discourse analysis systems were planned to serve educational problems in general. The actual codes for analysing mathematics lesson transcripts are presented in Chapter 6. Now I turn to methodological issues.

5.3 Methodological issues

This section discusses the methodological issues I considered when developing the research design and selecting the research methodologies. The nature of the research problem requires that I explore in depth language use in mathematics and particularise the findings to a group of teachers in selected schools. The research design suitable for this research problem is a *case study*. Bogdan and Biklen (1992) view *case study* as a detailed examination of one setting, single subject, a single depository of documents, or one particular event. There are many types of *case studies* but they all focus on particular situations and events. Most importantly, all the types of *case study* require the researcher to study a phenomenon in great depth.

Case study methods may be incorporated into *educational research* to focus on particular settings. In my case is the bilingual mathematics classroom. In my *case study*, I need to sample teachers who would give me the most needed and diversified data. However, to identify such individuals is not easy because of the underlying principle of *small sample size*. Therefore, I will rely on *theoretical sampling* – sampling the focus of the issues I want to explore – commonly used in 'grounded theory' propounded by Glaser and Strauss (1967). This means that I need *different* sample sizes for each research focus within the study. *Theoretical sampling*, sometimes called 'snowball sampling' can be challenging (Strauss and Cobin, 1990). For example through the continuous sampling process, the researcher begins to be familiar with the individuals in the sample. This brings the researcher's own interpretations and perceptions of the situations into the study. Bogdan and Biklen (1992) highlight the shortcomings of *case study* and how they impact on the *validity* of the case study. In my research, from broad exploratory beginnings, I move to more directed data collection and analysis.

Different research methods can be used in case study design (Bogdan and Biklen, 1992). In my study, the research methods include *qualitative* and *quantitative* forms of inquiry, because I view the two methods as not opposing each other but complementing the efforts to understand the case setting.

Within the qualitative approach, I needed to work under the assumptions that there are *multiple realities* in the way the world works. These realities *are socio-psychological constructions* forming an interconnected whole. Therefore, the researcher's view of the world is very important in the qualitative approach to identify and describe how the multiple perspective may be mutually interrelated.

I subscribe to the postulate that the knower and the known are interdependent. I view the role played by values in understanding the world as mediating and shaping what is understood and that events shape each other in the sense that there are multidirectional relationships that can be discovered.

In the *qualitative* approach, I use *focus group discussion, clinical interviews and observations*. Exploring teachers' perception demands provoking teachers to articulate their feelings. To do this, I use two types of *interviews*: focus group and clinical interviews. *Focus group discussion is* where a group of teachers discuss their feelings about the use of language in mathematics teaching. A *focus group discussion* has an advantage in that teachers justify their feelings on the spot, giving me the refined perceptions from the group. However, as I have argued already, most of the perceptions and social constructs are reserved to the individual. It is therefore essential that I hold a second type of interview *-individual interviews* - to probe further some of the hidden feelings.

Teachers may take their behaviour in the classroom for granted (Edwards and Furlong, 1978) especially when teaching becomes routine. Because of this, the relationships between researcher and teachers being studied are crucial. It is important to consider therefore the relationships I develop with the teachers.

In this study, I explore teachers, perceptions and practices through qualitative research methods and the frequency of occurrences of specific behaviour through quantitative methods. While it is a popular belief that in an *ethnographic* approach, the researcher must be a *stranger* to the culture, I believe this has a limit- there is a degree of strangeness. In this study, I was a stranger in the particular context but not a stranger to the culture since I was a mathematics teacher for 6 years and a mathematics curriculum developer and teacher inservice educator in mathematics education for 10 years.

It will not serve the purpose of this study to describe the activity of the individual teachers as if their behaviour was homogeneous. The key focus is variation in knowledge, perceptions and practices between teachers leading to variations in classroom communication. I describe in detail in the next Chapter, the school settings that allowed me to focus in depth upon a small sample of teachers who demonstrated in the diverse communication skill, which brought about challenges in the use of languages in mathematics teaching.

In my data analysis, I look not just at the interplay of what I collect, but also at identifying the *rationale* and lack of it inherent therein. This requires me to not only examine the data and utterances, but also see utterances as selections; to see that by choosing to say something, one chooses not to say something else. It can be an illumination to consider what someone has chosen to say as it is to examine in detail what he or she chooses to say and do.

In this study, I used *quantitative methods* to verify some of the events that emerged during the *qualitative methodology*. The nature of some of the classroom communication events required quantification to verify the frequency of occurrences. I want to emphasise that a quantitative approach emerged from what is initially a qualitative approach.

5.4 Conclusion

The study is an exploration of language in mathematics teaching from the social point of view, through the teachers' words and action. My research focuses on teachers' perceptions, teachers' knowledge of mathematics vocabulary equivalents between Chichewa and English and also teachers' use of language in mathematics lessons. It is the role of research to explore these issues and explain the patterns, trends, similarities and differences. I want to use the findings of the study to develop my theory with regard to the similarities and differences in the sociolinguistic orientation of teachers towards the perceptions, mathematics vocabulary equivalents and the actual use of language in mathematics teaching. In this study I want to also find out if language difference affects classroom discourse in mathematics teaching. It is the purpose of this study to compare teacher use of language in two different classroom language setting.

CHAPTER 6

RESEARCH METHODS

Designing the study

> While such questions are in theory open to empirical investigation, in practice the methodology required to answer them is by no means straightforward (Hughes, 1994: 4).

This chapter describes the research methods with respect to design, selection of sample, development of instruments, procedures for data collection, analysis and reporting used to answer the research questions. As I was searching for appropriate methods to use, I was mindful of what Hughes (1994) said (see the quotation above). The research methods, which are sometimes called research procedures, are very important in any research undertaking. They play a major role in the success or failure of the research study undertaken. The research methods enable the researcher to provide the answer to the research problem at the end of study. Therefore, it is imperative to describe the research methods in detail.

6.1 Population characteristics and sample size

The population comprised primary school mathematics teachers teaching in standards 1 to 4 in the ten primary schools in the Zomba District. Five primary schools from the urban area and five others from the rural area volunteered to participate in the study. Different sample sizes of schools and teachers were used to suit the research design as "in an emergent design the composition of the sample itself evolves over the course of the study" (Maykut and Morehouse 1994: 45). In building a sample, I used *snowball sampling* or *theoretical sampling*, where one research setting led to another (Maykut and Morehouse, 1994; Glaser and Strauss, 1967; Strauus and Cobin, 1990).

According to the Basic Education Statistics for Malawi (Malawi Government, 1996), there were 3,706 primary schools in Malawi. Of these schools, 12 were in Zomba urban and 131 were in Zomba rural. The total enrollment in 1995 was about 2,887,107 and with 49,102 in Zomba urban schools and 141, 995 in Zomba rural schools. The total number of teachers was 49,138 with 32,876 qualified teachers. The pupil/teacher ratio was 59/1 when unqualified teachers were included and 88/1 when excluded. The total number of teachers in Zomba Urban were 353 qualified and 137 unqualified, giving a pupil/teacher ratio of 73/1 when unqualified are included and 92/1 when not included. In Zomba rural schools the number of teachers was 1,791 qualified and 512 unqualified and this gave a pupil/teacher ratio of 62/1 when unqualified were included and 79/1 when not included.

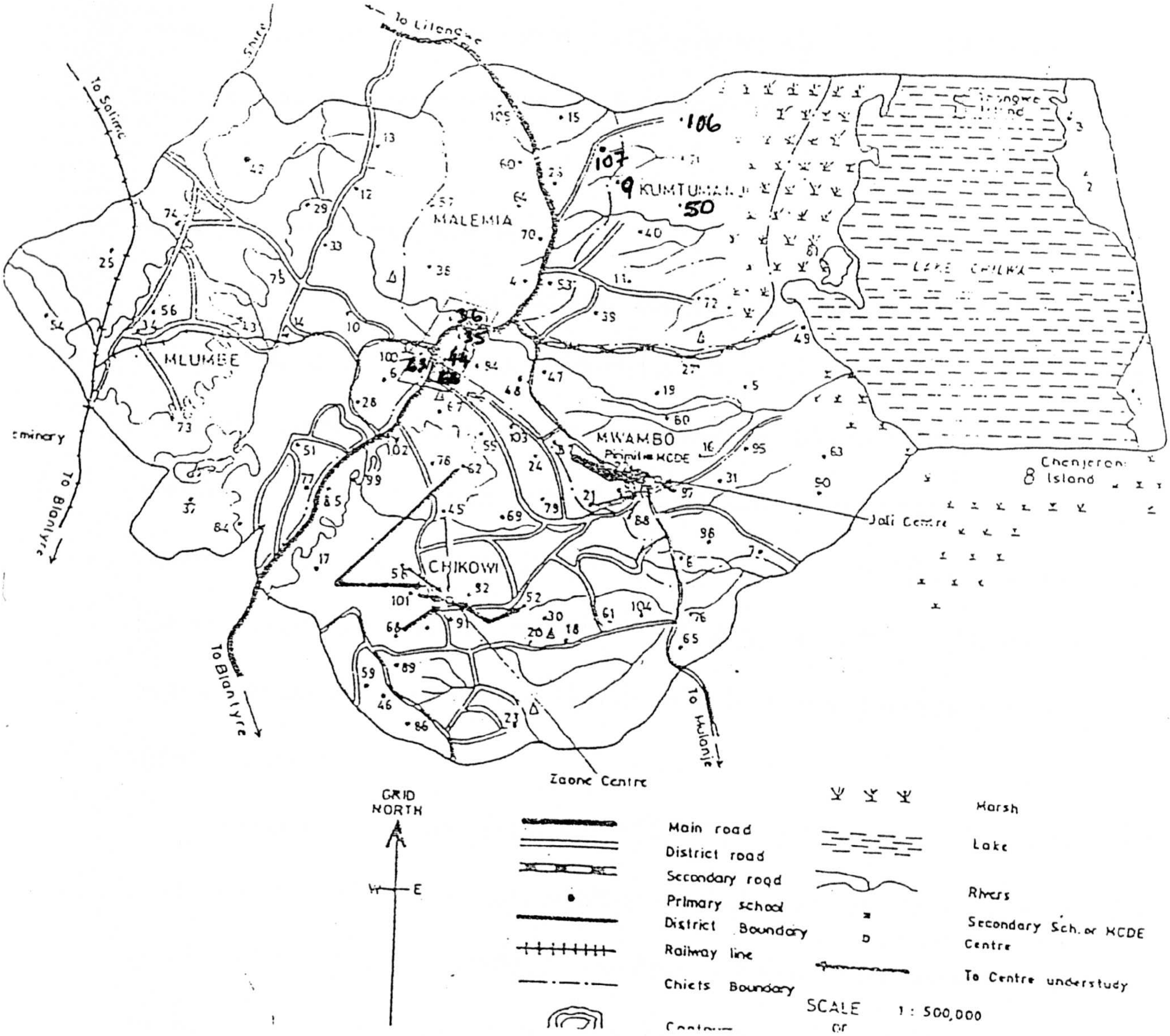
Although the majority of the schools belong to the government, many schools in Zomba belong to the Catholic Church and also the Church of Central Africa Presbytery among other churches. However, the government supplies teachers and other educational materials in all the church schools except in private schools belonging to individual people.

All the Zomba Urban schools and 10 Zomba Rural schools responded positively (see a sample reply letter from one of the schools in Appendix 9). All schools in the urban areas and five schools from rural areas were selected by considering proximity of the schools and accessibility during the rainy season. The schools were:

Zomba Urban	**Zomba Rural**	
1. Mponda Primary School	1	Nsondole Primary School
2. Zomba CCAP primary School	2	Bimbi Primary School
3. St. Joseph Girls Primary School	3	Namitoso Primary School
4. Sacred Heart Boys Primary School	4	Chilanga Primary School
5. Bwaila Primary School	5	Misangu Primary School

The actual locations of the ten schools are shown in Figure 6.1. Some data collection methods involved all the ten schools whereas other types of data collection require a smaller number of schools or teachers, when a method required a smaller number of schools or teachers, I randomly selected them. Random selection involved selecting the schools for a study where every school was given equal opportunity to be selected. Stratifying schools into rural and urban settings, representing the schools by letters ABCDE on pieces of paper, and picking one school at a time with replacement achieved random selection. The actual sample sizes are reported as part of the data collection methods as each method required its sample size.

I decided to reduce the sample of the schools because I wanted to get a deeper understanding of the phenomena within fewer cases, which is a characteristic of the case study approach. Fewer cases allowed me to spend a longer time with each teacher as "extended amounts of time with people in the places they inhabit is critical feature of in-dwelling, fostering the development of both explicit and tacit knowledge" (Maykut and Morehouse, 1994: 45).



Schools

1. Bimbi	50	7. Msangu	106
2. Bwaila	44	8. Nsondole	40
3. Chilanga	9	9. Sacred Heart	83
4. Mponda	35	10. St. Joseph	66
5. Namitoso	107	11. Zomba CCAP	63

Figure 6.1: Map of sample schools in Zomba district of Malawi

To convey more accurately the nature of the primary schools involved in this study, the following is an account of the four primary schools in the 1999 academic year, one school at a time beginning with Bwaila Primary School.

6.1.1 Bwaila Primary School

The Local Educational Authority through the Municipal Assembly runs Bwaila Primary School. The school was established in 1957 and it has standards 1 to 8. Table 3.1 shows the number of classes, enrollment and staff in each class. During the study, the school had a total of 45 classes with 60% of the classes below standard 5. There were 49 teachers of whom all except one were qualified to teach at primary schools. Their academic qualifications ranged from MSCE (24), JCE (24) to PSLCE (1). Their teaching experiences ranged from 2 years to 39 years, with the most experienced ones teaching in the infant classes.

The school had a total enrollment of 2,917 pupils of whom 1,557 were boys and 1,360 were girls. There were more pupils in standards 1 to 5 and the number decreased greatly as they approached standard 8. The decrease was more pronounced for girls than for boys which is a common trend in Malawi Primary Schools (Malawi Government 1996). The school had the following facilities: headteacher's office, storeroom, and 15 classrooms. There was shortage of classrooms at the school. All the classes for standards 1 to 4 were being conducted under the trees. There were 58 pupils per class in standard 3 and 70 pupils per class in standard 4 who were present on the day I visited the school. However, the class register indicated higher enrollment figures (Table 6.1) suggesting that absenteeism was high.

Table 6.1: Number of classes, enrollment and staffing at Bwaila Primary School.

Standard	**Classes**	**Number of teachers**	**Enrollment**		
			Boys	Girls	Total
1	6	6	285	275	560
2	7	7	214	202	416
3	8	8	261	205	466
4	6	9	224	194	418
5	5	5	120	144	264
6	5	6	143	140	283
7	4	3	158	111	269
8	4	5	152	91	243
Totals	**45**	**49**	**1557**	**1360**	**2917**

The school is located at about 1 km from the nearest hospital and nearest school; $^1/_2$ km from the nearest main road and $2^1/_2$ km from the nearest market and the Municipal Centre. The school has a piped water supply, which was not functioning during the study.

Table 6.2 shows that there was acute shortage of mathematics books in standard 4 at the school. Although the people living around the Municipality speak Chiyao, the language of the majority of the pupils and the teachers at this school was Chichewa. The medium of instruction in standards 1 to 4 was Chichewa, and English was used from standard 5 upwards. The major economic activities of the community around the school included people working in government and non-governmental institutions, small-scale business and farming.

Table 6.2: Number of textbooks for Chichewa, English and Mathematics in standards 1, 2, 3 and 4 at Bwaila Primary School.

Standard	Mathematics		English		Chichewa	
	Totals	Pupil/Book	Totals	Pupil/Book	Totals	Pupil/Book
1	350	2:1	415	1:1	355	2:1
2	416	1:1	220	2:1	405	1:1
3	466	1:1	412	1:1	331	1:1
4	122	3:1	297	1:1	302	1:1

6.1.2 Zomba CCAP Primary School

The Church of Central Africa Presbytery (CCAP) runs Zomba Primary School, which was established in 1927. The school has 16 classes and 21 classrooms and the enrollment for 1999 was 1030. The pupil/teacher ratio in standard 3 was about 89:1 and in standard 4 was 59:1. Table 6.3 summarises the number of classes, enrollment and number of teachers in each standard.

The home language for most of the pupils and teachers at this school was Chichewa. The medium of instruction in standards 1 to 4 was Chichewa and English was used from standard 5 upwards.

There were 20 teachers, one headteacher, one deputy headteacher and one assistant deputy headteacher. While all the teachers were allocated a class, one teacher for home economics was a "*floater*" between standards 5 and 8. There were 6 male teachers against 14 female teachers. All the teachers had a teaching qualification except one. Sixteen teachers had MSCE, six teachers had JCE and one teacher had GCE academic qualifications. Their teaching experiences ranged from 3 years to 26 years with the majority between 2 and 10 years.

Table 6.3: Number of classes, enrollment and staffing at Zomba CCAP Primary School.

Standard	**Classes**	**Number of teachers**	**Enrollment**		
			Boys	**Girls**	**Totals**
1	2	2	109	94	203
2	2	2	82	52	134
3	2	2	86	91	177
4	2	2	61	58	119
5	2	2	35	50	85
6	2	2	42	64	106
7	2	3	56	52	108
8	2	4	46	52	98
TOTALS	**16**	**20**	**517**	**513**	**1030**

The school had one headteacher's office, and one staff room. There was no electricity at this school but they had piped water. The school is situated within the municipality of Zomba, 2 km from the nearest hospital, 1 km from the nearest school, market and Municipal Centre and 100m from the main road. The major economic activities included people working in government and non-governmental organisations, small-scale business and farming.

There were about 89 pupils per class in standard 3 and 60 pupils per class in standard 4 on the day I visited the school. There was an acute shortage of textbooks for English in both standard 3 and 4, Chichewa and Mathematics in standard 3 at this school (Table 6.4).

Table 6.4: Number of textbooks for Chichewa, English and mathematics in standards 1, 2, 3 and 4 at Zomba C.C.A.P. Primary School.

Standard	Mathematics		English		Chichewa	
	Totals	Pupil/Book	Totals	Pupil/Book	Totals	Pupil/Book
1	60	3:1	50	4:1	40	5:1
2	40	3:1	43	3:1	26	5:1
3	60	3:1	45	4:1	85	2:1
4	100	1:1	61	2:1	106	1:1

6.1.3 Namitoso Primary School

Missionaries established Namitoso Primary School in 1948. From 1948 solely the Zambezi Evangelical missionaries ran the school until the late 1970s, when the government took control of it. The Local Education Authority, an organ of the government, now runs the school. There are 8 classes and with a total enrollment of 752 against two classrooms. This means that the majority of the pupils were taught under trees or temporary shelters. There were no other building facilities.

There were two boreholes. The nearest main road and market were about 10km from the school. The nearest town is 25 km away, the hospital is about 5 km away and the nearest school is 3 km away. There were 8 teachers all of them except one were male. They were class teachers teaching all the subjects in their classes including mathematics.

Three teachers were JCE holders and qualified primary schoolteachers whereas five teachers were not qualified. Three unqualified teachers had two years of secondary education (JCE) whereas the other two had four years of secondary education (MSCE).

Their teaching experiences ranged from 3 years to 6 years and the majority of the unqualified teachers had 3 years of teaching experience.

There was a shortage of textbooks for Chichewa, English and mathematics in standard 3 but not in standard 4 (Table 6.6).

Table 6.5: Number of classes, enrollment and staffing at Namitoso Primary School.

Standard	**Classes**	**Number of teachers**	**Enrollment**		
			Boys	**Girls**	**Totals**
1	1	1	99	104	203
2	1	1	47	52	99
3	1	1	72	87	159
4	1	1	32	37	69
5	1	1	41	46	87
6	1	1	18	6	24
7	1	1	14	8	22
8	1	1	26	16	42
TOTALS	**8**	**8**	**349**	**356**	**705**

Table 6.6: Number of textbooks for Chichewa, English and mathematics in standards 1, 2, 3 and 4 at Namitoso Primary School.

Standard	**Mathematics**		**Chichewa**		**English**	
	Total	**Pupil/Book**	**Total**	**Pupil/Book**	**Total**	**Pupil/Book**
1	250	1:1	280	1:1	200	1:1
2	50	2:1	50	2:1	80	1:1
3	80	2:1	80	2:1	66	2:1
4	76	1:1	76	1:1	68	1:1

Teachers and pupils did not share the same home language. The home language for the majority of the pupils at this school is Chiyao whereas the home language for the majority of the teachers is Chichewa. The medium of instruction in standards 1 to 4 is Chichewa and English is used from standard 5 upwards. The socio-economic activity in the community around the school is agriculture. People grow cassava, maize, groundnut and rice. They also do fishing in the nearby Lake Chilwa, the second largest lake in Malawi.

6.1.4 Nsondole Primary School

Church of Central Africa Presbytery (C.C.A.P.) established Nsondole Primary School in 1907. It has standards 1 to 8. Table 6.7 shows number of classes, enrollment and staffing position.

Table 6.7: Number of classes, enrollment and staffing at Nsondole Primary School.

Standard	**Classes**	**Number of teachers**	**Enrollment**		
			Boys	Girls	Total
1	3	2	73	133	206
2	3	2	112	110	222
3	3	3	155	140	295
4	2	3	138	102	240
5	2	2	77	70	147
6	1	1	45	38	87
7	1	1	62	38	100
8	1	3	38	22	60
Totals	**16**	**17**	**708**	**653**	**1361**

The school had 10 classrooms, one headteacher office, one playground and one library. It also has a piped water supply and two boreholes. It is located 17 km from the nearest town, 8 km from the nearest market and main road, 3 km from the nearest hospital and school. The major socio-economic activities of the community around the school are farming and fishing.

Most of the pupils speak Chiyao whereas 10 teachers speak Chichewa, 5 teachers speak Chiyao, and 1 teacher each speaks Chilomwe, Sena and Chitumbuka in their respective homes. Nevertheless they all spoke Chichewa fluently. The medium of instruction in standards 1 to 4 is Chichewa and English is used from standard 5 upwards.

Table 6.8: Number of textbook for Chichewa, English and mathematics in standards 1, 2, 3 and 4 at Nsondole Primary School.

Standard	**Mathematics**		**Chichewa**		**English**	
	Total	**Pupil/Book**	**Total**	**Pupil/Book**	**Total**	**Pupil/Book**
1	100	2:1	150	1:1	265	1:1
2	46	5:1	18	12:1	100	2:1
3	225	1:1	32	9:1	300	1:1
4	178	1:1	250	1:1	238	1:1

There was an acute shortage of Chichewa books in standard 3 with 9 pupils sharing one book (Table 6.8). There were 17 teachers; 11 of them were male; 10 were qualified; 11 of them with two years of secondary education; and 8 of them with four years of secondary education. Their teaching experiences ranged from 2 years to 30 years with the mode of 5 years.

In summary, the four primary schools described so far show some common characteristics that would affect the teacher use of Chichewa and English in mathematics teaching. The schools lacked necessary materials and facilities to enable them to use Chichewa in mathematics. Using a tree shade as a classroom did not allow for charts to be posted for pupils to read and the floor was too dirty for the use of textbooks. The average ratio of textbooks to pupils was 1: 2 in the urban schools and 1:1 in the rural schools, indicating that there were enough books for every pupil in rural schools but not in urban schools. Yet urban schools are nearer to the District Education Office, which distributes the school materials including textbooks.

Most teachers' home language was Chichewa in all the four schools. Consequently they were all fluent in Chichewa for mathematics lessons. However, in the rural schools, the majority of the pupils speak Chiyao and Chichewa at home as well as at school outside the classroom whereas in the urban schools the majority of the pupils speak Chichewa both at home and at school. The common language in the classroom was Chichewa in all the schools in urban and rural areas.

Most of the pupils come from farming and fishing communities in the rural areas and working class and business communities in the urban areas. This difference provided for differences in exposure to English as a language for communication. Those pupils in the urban setting were expected to have more exposure to English than the pupils in the rural schools.

The majority of teachers in the rural schools were not formally trained in teaching whereas in the urban schools the majority of the teachers were trained and had less than 10 years of teaching experience both in the rural and urban schools. Pupil/teacher ratio was too high for a teacher to attend to individual pupils' needs in all the schools.

The preceding information is useful for my study because it forms the basic conditions under which languages are used in Malawi primary schools. The school together with the physical and social surrounding forms the context in which teachers operate.

6.2 Data collection methods

The data collected through qualitative inquiry in this study were mostly teachers' words and action, which "requires methods that allow the researcher to capture language and behaviour" (Maykut and Morehouse, 1994:46). To collect this data, I used tape-recorded focus group discussions, observations and clinical interviews. Because I did not have prior hypotheses about what vocabulary teachers know, how teachers feel about the use of Chichewa and English in mathematics teaching and how they actually use language in mathematics teaching, I decided to make some preliminary data collection visits to schools before the main study was conducted. Analysis of the preliminary data indicated some areas of research interest. I selected three areas that interested me most because of my work experience in curriculum development and mathematics teaching. The three areas, which featured highly during the preliminary study, included perception of use of Chichewa and English in mathematics teaching; problem of mathematics vocabulary; and problem of use of language during mathematics lessons. I operationalise the three areas into research questions as presented in Chapter 4. To answer the research questions, I planned to explore the teacher mathematical vocabulary equivalents in Chichewa and in English; the teachers' perceptions of use of Chichewa and English in mathematics teaching; and the teacher use of Chichewa and English in mathematics teaching. Next are the procedures, which were followed in collection of the data.

During data collection, I viewed the teachers as "essential collaborators who together with [me] mutually shape and determine what we come to understand about them and their situation" (Maykut and Morehouse, 1994) regarding language use in mathematics teaching. Therefore, each time I identified teachers to work with, I briefed them on the study. Their role and my expectations were defined; the use of the data and the confidentiality of the findings were explained without jeopardising the study. Pupils were also informed of the aim of my frequent visits to the schools, especially their classrooms; that is, to learn how children learn mathematics. Permission was sought from the management to ensure that the teachers were not disturbed from teaching mathematics in those classes during the study. I also consider the teaching and learning equipment, materials and physical infrastructure as providing the necessary context in which teachers use language in mathematics teaching.

The methods used in collecting data relevant to the research questions are basically five: focus group discussions, clinical interviews, classroom observations, questionnaires, and tests. I now discuss each of them in detail.

6.2.1 Focus group discussion

Focus group discussions were used to explore the prospects and challenges met by teachers in using Chichewa and English in mathematics teaching. I used focus group discussions because focus group discussions have "often presented us with the unexpected interactions, insights, ideas, and information" (Maykut and Morehouse, 1994: 103). The purpose of using focus group discussions was:

> to bring several different perspectives into contact....to understand what people experience and perceive about the focus of inquiry, through a process that is open and emergent" (Maykut and Morehouse, 1994: 103).

The use of focus group is to gain responses from a subgroup in a population. Basch (1987) describes the focus group as an interview to obtain data about feelings and opinions of a small group of participants about a given problem, experience, service or other phenomenon. Morgan and Krueger (1993) reiterate this by contending that focus groups provide a clear view of how others think and talk; suggesting that it is a powerful means of exposing professionals to the reality of teaching. Nyamathi and Shuler (1990) suggested that focus groups are critical for obtaining insights, perceptions and attitudes, when used alone as part of a research study. Nevertheless, it does not provide quantitative data and can therefore not be used to generalize.

In this study, a focus group discussion was seen to be "a group conversation with a purpose... that emphasizes dynamic group interactions, among other things" (Maykut and Morehouse, 1994: 105).

Researchers seem not to agree on the size of group suitable for interview (Morgan, 1988). However, "the outside limits appear to be no fewer than four and generally no more than twelve" (Maykut and Morehouse, 1994: 107). Morgan (1988) also argues that the range of the group of participants is generally between 4 and 12. Considering that teachers in the focus group were drawn from different schools, the focus group was, as Maykut and Morehouse (1994: 106) put it "small enough to ensure that everyone was able to be part of the discussion, and large enough a group that contributed to diversity in perspective."

Basch (1987) explains that the outcome from a focus group may then be followed up, using a quantitative approach to determine conviction and generalisability. This he suggests has been a popular method in education research. Focus groups, however, are used differently by different groups of people. There are commonly used in evaluation and academic research world or as a method of exploring.

The use of focus group discussion gave me an opportunity to listen to selected groups of teachers discussing the topics that I was most interested in; teachers also had a chance to listen to each other's contributions, which sometimes sparked new insights or helped them develop their ideas more clearly. Thus I was able to explore a topic that was new to me and for which I had scanty information; and provided me with the opportunity to check out if I was pursuing an area that would yield desirable responses.

6.2.2 Clinical interviews

Immediately after classroom observations were undertaken, I conducted a clinical interview - sometimes called a reflective interview - with the teacher. My clinical interviews consisted of a set of questions with the aim of enabling the individual to reflect on the experience of any event with the aim of diagnosing the source and extent of discomfort in the use of language in mathematics teaching. The aim of the clinical interviews was to find out how teachers felt about the use of language in mathematics teaching by referring to the immediate experiences they had gone through. Clinical interviews provide useful information to cross check what a teacher perceives against what the teacher does during a lesson. In short, clinical interviews helped me to match teachers' actions with teachers' perceptions of the use of language in mathematics teaching.

I decided to observe lessons first and conduct clinical interviews later because "the interview itself can exert quite a significant influence on events" (Wragg, 1978:8). Again, because the clinical interview was conducted immediately after the lessons, teachers were able to reflect on what actually happened during the lesson delivery. I was able to compare it with the teachers' perceptions of the use of language in mathematics teaching before the lessons.

6.2.3 Classroom observations

To collect data on how teachers use language in mathematics teaching, I used observation techniques. However, Foster (1996) levels limitations to observational research methods. The environment, event, or behaviour of the interest may be inaccessible and observation may simply be impossible. People may consciously or unconsciously change the way they behave because they are being observed and therefore observational accounts of the behaviour may be an inaccurate representation of how they behave naturally. Observations are inevitably filtered through the interpretative lens of the observer. Observation is very time consuming and therefore costly when compared with other methods of data collection.

Nevertheless, observational methods remain popular as a research tool for a number of reasons. Information about the physical and social environment can be recorded directly without having to rely on the retrospective or anticipatory accounts of others. The observer may be able to see what participants cannot see. Observation can provide information on environment and behaviour of those who cannot speak for themselves or cannot take part in interviews or fill in a questionnaire. The information given by people about their own behaviour in interview can be compared with observation of a sample of their behaviour.

There are different types of observations. However, they range from very structured with strict guidelines to be followed, to very unstructured without any guidelines to be followed. Whichever observational method is adopted in a particular research depends on the nature of the problem or the issue being investigated, the theoretical and methodological orientation of the researcher, various practical considerations and sometimes the stage that the research has reached. I came up with an observational guide with the focus on language uses and their impact on the whole lesson delivery because I want to describe the teacher use of language in mathematics teaching.

I entered the classroom simply to observe as a non-participant observer and note how the teacher was using the language while teaching mathematics. I did not participate in the actual lesson delivery. The classroom observation and the descriptions of the lesson activities gave me an opportunity to relate what actually happens in the mathematics lessons to the coding systems used in other studies so that I could adapt one system for use. I used the observation schedule to record the incidences of use of language during the lessons.

Considering that there is more than our senses can record in teaching activity, two things were done to maximise recording the data during the observation. First, I planned in advance for what to observe and how to record it and then designed an observation guide which was flexible enough for me to note and collect data on unexpected dimensions of language use during the lessons (Appendix 7). There was also a need to decide on the details of the recording and also the nature of the measures to be recorded. Second, I planned to use audio/video recorders during observations (Bogdan and Biklen 1992). Use of video recorders in recording lessons sometimes brings about anxiety in the classroom. However, because I used the procedure with the same classes several times before the actual recording, the anxiety was reduced.

The recordings themselves were not data as they were another set of activities of the event to be observed. Such recordings needed to be followed by transcriptions and transcript analysis. Though I had the advantages of replaying the event at a controlled speed and thus increase my accuracy of observation, the amount of work in developing and analysing transcripts was enormous.

6.2.4 Questionnaires

Keats (2000) argues that another very common method of obtaining people's beliefs, attitudes and opinions is the questionnaire. I used a questionnaire to triangulate some of the perceptions that emerged during the focus group discussions. A questionnaire was a set of written questions on paper requiring a respondent(s) to write answers. There were different ways of preparing the questions for the questionnaire; but what was important was that they were made easy enough for the respondents to provide answers. Questionnaires can be administered by posting to the subjects or researchers taking them to the respondent. Posting questionnaires has a low return whereas taking the questionnaires can be laborious and costly. In my study I personally administered all the questionnaires. Questionnaires were ideal in my study because the respondents were literate and fluent in writing both in Chichewa and in English.

6.2.5 Teacher mathematics vocabulary equivalents tests

I used a test to collect data on teacher mathematical vocabulary. Like a questionnaire, a test is a set of questions on a specific subject content for a respondent to answer. There are different purposes of tests but usually they are used for determining what the respondent can remember or do. In my study, teachers were asked to give the Chichewa equivalents of the forty mathematical terms selected from the curriculum for standards 1 to 4. As I already explained in Chapter 4, Chichewa is a local and national language that is mostly used in education activities.

I administered the test to 40 primary school teachers who were teaching mathematics in standards 1- 4 during the time of the study. The 40 teachers were drawn from the ten primary schools, which were involved in the study during the entire period of the study. I gave each teacher a test paper to answer individually. The test took about 30 minutes to complete. I collected the answers immediately after completion.

6.3 Development of research instruments

The nature of the phenomena under study necessitated that a number of instruments be used in this study. By the nature of the qualitative research design, "the main research instrument was the researcher himself" (Maykut and Morehouse, 1994: 46) in all phenomena. However, I included formal instruments such as tests and questionnaires to guide me collect the selected data to help me become more focussed in my exploration of the issues. The development of the formal instruments involved mapping out areas of concern, drafting, evaluating and pilot testing the instruments at Domasi Government Primary School in Zomba.

Developing the instruments was carefully planned and conducted (Maykut and Morehouse, 1994). The steps followed when developing the instruments for my study included:

1. writing out my focus of inquiry.
2. identifying words phrases, concepts, questions, topics that related to my focus of inquiry.
3. classifying and grouping the similar words, phrases, concepts, topics, questions together to form the potential categories of inquiry.
4. deciding which categories of inquiry to be included in the instrument, the form and format of the instrument, the form and format of the items including sequencing the items in the instrument.
5. Preparing an instrument that included at the beginning a personal introduction, purpose statement, statement of confidentiality and instructions on how to respond to the questions.

6. giving the instrument to two other experts to vet and make necessary amendments.
7. piloting the instrument and making all the necessary amendments.
8. producing final instruments.

When developing guidelines for focus group discussions (Appendix 6) there was a need to start with a general and less focussed issue of interest and this was teachers' use of language in mathematics teaching-what teachers say they feel, experience and do. This then was put forward to the group of teachers to discuss. There were follow-up questions which essentially were meant to find out why they feel, experience and do it that way.

Because of the openness of the questions and discussions, I needed an audio-recorder to record the discussion. Thus, the instruments for focus group discussions were myself, a statement of a general issue of concern and an audio recorder although the follow-up questions are also included in the instruments as guidelines.

The classroom observation guide (Appendix 7) was developed by identifying aspects of a lesson that would demonstrate use of language in mathematics. These included reading, writing, use of textbooks, and other language behaviours that emerged in the classroom. I chose to describe the sociolinguistics aspects of the lesson qualitatively because I feel there could be some teacher behaviour that would enlighten me on how teachers use language in mathematics teaching through action.

As for clinical interviews, my instrument was merely an exploratory question to find out how teachers felt about the use of Chichewa and English in mathematics teaching immediately after they had taught using the two languages. There were follow up questions especially asking the teacher to justify their views. Clinical interviews were also designed to cross check on some of the things observed during the lesson.

When developing the questionnaires (Appendices 3 and 4) I mapped out areas of focus within the researcher's interest as follows:

- Personal information regarding gender, mother tongue, education, training, and teaching experience.
- Teacher perceptions of the use of Chichewa and English in Mathematics.
- Opportunities for training in the use of Chichewa and English in Mathematics.
- Support for use of Chichewa and English in Mathematics.
- Constraints/barriers in the use of Chichewa and English in Mathematics.

When developing a test on mathematics vocabulary equivalents between English and Chichewa I identified the vocabulary from the textbooks for standards 1- 4, discussed them with some teachers during focus group discussions, had them vetted by one language specialist and one mathematics educator before the final test paper was constructed. The instruments consisted of a list of 40 terms that are used in mathematics for specific mathematics meaning such as triangle, four, profit, addition, etc. Two parallel instruments were developed; one for teachers to give the Chichewa equivalents and the other one for teachers to give the English equivalents.

6.4 Pilot study

In this study, I was concerned with whether two researchers independently studying the same setting or subjects and using the same procedures and instruments would come up with the same findings. There was a need for all the instruments and techniques used for this study to be valid and reliable. To guarantee *reliability* and *validity*, there was a need to pilot test the instruments and all the techniques. During the pilot testing, I looked for the reliability of the instruments and techniques to assess whether they were dependable as measuring instruments throughout the study. *Reliability* is:

> basically the degree to which an instrument and techniques consistently measure whatever it measures. The more reliable an instrument and technique are the more confidence we can have that the results obtained from the administration of the instrument are essentially the same results that would be obtained if the instrument was readministered (Gay, 1987: 135).

Apart from reliability, the instruments need to be valid. *Validity* deals with the question of whether or not the instruments and techniques measure what they are supposed to measure. It is the quality of data gathering instruments or procedures that enables the instruments to measure what they are supposed to measure. To validate the data collection procedures and instruments, it is important that they are tried before the study began (Borg, 1987).

In qualitative research, the expectation exists that there will be consistency in results of observations made by different researchers or the same researcher over time. Qualitative researchers do not share exactly this expectation. They believe that research settings are dynamic and the researchers' focus changes. Therefore, when using qualitative approach my concern is with the accuracy and comprehensiveness of my data. I tend to view reliability as a fit between what I record as data and what actually occurred in the setting under study rather than literal consistency across different observations. As already indicated in Section 5.3, two researchers studying a single setting may come up with different data and produce different findings. Both studies can be reliable. One would only question the reliability of one or both studies if they yield contradictory or incompatible results.

The techniques used in focus group discussions, classroom observation, interviews, tests and audio/video recording were validated through pilot testing. Therefore, before use, all possible controls and safeguards had to be employed if I was to obtain reasonably reliable and valid data. During the pilot testing, it was established that the research design was measuring what it is supposed to measure and also the consistency in measuring the variables. Borg and Gall (1983) also support the use of pilot study by arguing that:

> After a prototype of the [data collection instrument] has been developed, the researcher should try it out in a number of situations similar to those to be observed in the research and correct any weakness he discovers (Borg and Gall, 1983: 475).

The assumption made by Borg and Gall (1983) is that once a strategy works in one setting, it can work in other setting as long as the settings are similar. One thing that they overlook is that no two social settings can be entirely similar and that there should be a constant adaptation of instruments for use in different social settings.

The main purpose of conducting the pilot study was to evaluate and improve the instruments and data collection techniques. Borg (1987) contends that conducting a pilot study indicates that the study had been carefully carried out with an acceptable degree of clarity or ambiguity of the questions used in the data collection techniques. During the pilot testing, I tried out the audio/video recorders to see how effectively they would record the interviews and the lessons, including the condition of the recorders, type of tapes to be used, positioning of microphones.

During the pilot study, I also identified areas worth pursuing further. To achieve this, I formulated research questions by reflecting on what teachers believed they do and did with Chichewa and English in mathematics teaching. Then I reflected on why they believed and did what they did that way. This process led to constantly redefining the problem and redesigning the methodology in order to collect evidence for the phenomena under study. The results of the pilot study were a set of refined research problems, questions and methodology.

There was a need to pilot test the instruments and techniques in an environment similar to the intended one. In this case the pilot study was conducted with teacher and pupils in standards 1 to 4 at Domasi Government Primary School in Zomba. Different sample sizes were used for piloting different instruments and techniques.

Three experts, one in language education, one mathematics educator and the researcher as well as two primary school teachers were used during the pilot study to comment and try out the instruments and the techniques. In this way, instruments, administration procedures, scoring routines and data analysis techniques were refined. The research design was modified as a result of the pilot study and in some cases it was completely overhauled. For example, some of the changes made as a result of piloting included removing or modifying those items that did not sound like perceptions but reasons and also those questions which did not hold for both Chichewa and English. Therefore, it was worthwhile as it contributed towards the validity and reliability of the study.

6.5 Data collection procedures

This section is a description of the actual procedures followed in collecting the research data. Every method employed had its own procedure specifications, which necessitated that the discussions be divided along the methods used. However, the section begins by looking at the importance of negotiating access to the relevant data before fieldwork is conducted.

6.5.1 Negotiating access to research data

Before conducting any research in an institution the researcher must negotiate access into the institutions, as the institutions and the subjects will only do the researcher a favour by providing the information the researcher wants (Maykut and Morehouse, 1994; Bogdan and Biklen, 1992). It is with this understanding that I sought permission from the Malawi Ministry of Education to conduct the study in the selected schools in their respective districts (Ministry of Education, Sports and Culture, Circular Letter No IN/2/8B). Then I went to the District Education Officer (DEO) to seek further clearance to use the schools for the study and also to discuss the procedure for the study. Because of the previous acquaintance with my work as a curriculum developer working with schools, the DEO's office in Zomba only gave a go ahead by word of mouth and assisted me with information regarding the locations of the schools and other relevant information. Then I wrote letters to the selected schools asking them of their willingness to participate in the study which they accepted (Appendix 3). Then, I obtained relevant information on the school calendar and other details, which enabled me to plan and implement the fieldwork.

6.5.2 Field work

As I indicated in Section 6.2, the data of qualitative inquiry in this study were mostly teachers' words and actions, which "requires methods that allow the researcher to capture language and behaviour" (Maykut and Morehouse, 1994: 46). Therefore, I used tape-recorded observations and interviews. Tests and questionnaires were used to triangulate the data collection methods and also provide initial data.

Amidst numerous visits I made to the schools, there were basically five data collection visits; other visits were meant for procedural matters such as follow-ups and to arrange for the next data collection activities. The first one was when I conducted a baseline survey during which I collected information regarding the schools, the teachers and the pupils to be involved in the study and how teachers feel about the medium of instruction in the classroom.

During the second visits to schools I collected data through the teacher focus group interview guide (which included identification of mathematics vocabulary commonly used in standards 1 to 4 mathematics curriculum). The third visit was aimed at collecting data through questionnaires (teachers' personal data, perceptions, training, support and constraints regarding the use of Chichewa in mathematics teaching) and the English/Chichewa Mathematics vocabulary test for teachers. During the third visits I collected data about classroom discourse in mathematics lesson through observation guide and through video recording of mathematics lessons. The fourth visit was aimed at collecting data through questionnaires (teachers' personal data, perceptions, training, support and constraints regarding the use of English in mathematics teaching) and Chichewa to English Mathematics vocabulary equivalents test for teachers. Finally I visited the schools to collect data through classroom observation and clinical interviews. I now discuss how each data collection procedure was implemented in the field.

6.5.3 Conducting focus group discussions

I prepared a statement of focus and formulated probing questions as the discussion progressed. I found this approach very helpful in guiding the group discussion. The procedure for conducting the discussion was as follows:

- *Identify a room for discussion:* a quiet room usually an unused classroom was identified for use. At one school, a church was used.
- *Set up the recording equipment*: check that the tape was wound back to the beginning; power was available; machine placed at the opportune place; etc.
- *Welcome the participants*: state the purpose of the discussion; what was expected of the teachers; confidentiality of the discussion recordings; etc.
- *Seek individual's approval to audio tape the discussions.* Most of them asked to listen to the tape at the end of the recording.
- *Introductions:* so that teachers would know each other by name, school and class they teach, where they come from; etc.
- *Opening question*: "You have been teaching mathematics at primary level for sometime now, how do you feel about teaching mathematics in the language you use in your respective classes?"
- *End of recording*: Only the discussions on perceptions needed to be recorded because it was unstructured therefore difficult to record using a free hand.

- *Most used mathematics vocabulary*: 'The following terms are most used in mathematics books for standards 1 to 4. They are in English and I would like you to discuss and give me the Chichewa equivalents.'
- *End of the discussion*: reconfirmed confidentiality; thanked them all for participating.
- *Listening to the tapes*: The tapes were replayed for those participants who wanted to listen to what was recorded. After satisfying themselves, they dispersed.

The focus group discussions were conducted in a natural school setting involving 10 primary school teachers from 10 different schools who volunteered to participate. The teachers involved in the discussion were those teaching mathematics in standards 1 to 4 during the 1999 school year who were teaching in the primary schools at the time of the study.

I conducted the teacher focus group discussions in February 1999 in the middle of term one of the school calendar. The ten teachers were divided into two focus groups by considering their school locations of urban/rural. One group consisted of five teachers from rural schools and met at Nsondole Primary School for the group discussions. The second group of five consisted of teachers from Zomba Urban schools and they met at Mponda Primary School.

The discussion was conducted in Chichewa, which the participants preferred to use. The interviews took approximately one hour each and were audio recorded. The recorded discussions were transcribed in Chichewa .

The teachers were asked five major probing questions focusing on

- awareness of classroom instruction;

- opinion on the language being used in relation to mathematics;
- preferred language of instruction in mathematics;
- easy and difficult areas of mathematics;
- perceived merits and demerits of the use of Chichewa in mathematics to the teacher and to the pupils and suggestions for improvement.

The focus group discussions concluded with a discussion of the most used mathematical vocabulary in English and Chichewa. The data obtained from the group interviews were used to probe further into English/Chichewa mathematical vocabulary as well as teacher perceptions of the use of the vocabulary equivalents in mathematics teaching. The data were used in construction of questionnaires and mathematics vocabulary tests as well as in the final analysis of data to answer the research questions.

6.5.4 Administering questionnaires

Two parallel questionnaires on teacher perceptions were administered to the same teachers at two different times. One focussed on teachers'' perceptions of use of Chichewa and another one on teachers' perceptions of use of English. Using teacher questionnaires on perceptions of the use of Chichewa in mathematics teaching, I collected data from 40 teachers teaching in standards 1-4 in the ten schools in February, 1999. In February 2000, I collected data from the same 40 teachers in the same schools on similar issues using a parallel questionnaire on teacher perceptions of use of English in mathematics teaching. The data were used to answer the question: How do teachers perceive the use of Chichewa and English in mathematics?

6.5.5 Administering Mathematics vocabulary equivalents tests

This data on mathematics vocabulary was collected using two parallel tests. Teachers were asked to give the Chichewa equivalents of the 40 mathematical terms selected from the curriculum for standards 1 to 4. This was conducted in February 1999. In the second test, teachers were asked to provide the English equivalents of the same 40 concepts in Chichewa and this was administered in February 2000.

The aim of the tests was to find out the amount of mathematical terms Chichewa and in English known by teachers. I administered the test to 40 primary school teachers who were teaching mathematics in standards 1- 4 during the time of the study. The 40 teachers were drawn from the ten primary schools, which were involved in the study during the entire period of the study. I gave each teacher a test paper to answer individually. The test took about 30 minutes to complete. I collected the answers immediately after the completion.

6.5.6 Classroom observation

Classroom observation was divided into two parts. The first part consisted of observing language related activities in mathematics lessons and the second part focussed on recording classroom talk. The two parts were done simultaneously. To collect data on how teachers use language in mathematics teaching, I used non-participant observation techniques. I entered the classroom simply to observe and note how the teacher was using the language while teaching mathematics. I did not participate in the actual lesson delivery.

Between June and July 2000, I observed a total of 16 mathematics lessons, eight in standard 3 and four in standard 4. Out of the eight lessons in each class levels four were taught in Chichewa and four in English. The lessons were observed in four primary schools, two from urban areas and two from rural areas. I spent one whole working day at each school. I made sure not to disrupt the lesson periods by making the observation during the official time for the lesson.

Before going to their classes, I briefed the teachers on the purpose of the observation; that was to learn how mathematics was being taught in their classes. I did not mention that I was specifically interested in language use for fear of prejudicing the teachers' use of language. Then we agreed which class - Chichewa medium or English medium - would be observed first. When it was time for the lesson, I went into the classroom, greeted the pupils and briefed them on the purpose of my visit into their class; that is to see how they learn mathematics. I told them that I was a teacher just like their teacher and that they should not fear anything. This was done in order to dispel the pupils' fear of an intruder in their classroom.

I used the observation schedule to record the incidences of use of language during the lessons. However, because my study involved analysing the discourse, I needed to record as much of what the teacher said as possible. So I used video tape recorders to record mathematics lessons. As discussed in Section 6.3.1, use of video recorders in recording lessons sometimes brings about fear and discomfort in the classroom. However, because I used the procedure with the same classes several times before the actual recording, the dilemmas and tensions were reduced.

6.5.7 Conducting clinical interviews

Immediately after classroom observations were done with each teacher, I conducted a clinical interview with the teacher. The aim of the clinical interviews was to find out how teachers felt about the use of language in mathematics teaching by referring to their immediate experiences with the use of Chichewa and English they had gone through. Clinical interviews provided useful information where I wanted to cross check what a teacher perceived against what the teacher did during a lesson. In short, clinical interviews helped me to match teachers' actions with teachers' perceptions of the use of language in mathematics teaching.

I decided to observe lessons first and conduct clinical interviews later because "the interview itself can exert quite a significant influence on events" (Wragg, 1978: 8). Again, because the clinical interview was conducted immediately the teacher had an experience teachers were able to reflect on what actually happened during the lesson delivery and compared it with what the teacher perceived about the use of language in mathematics teaching.

6.6 Data analysis plan

In this study, data analysis served two main functions. First it was used for aggregation and synthesis of masses of data that were obtained, into meaningful depiction of the teacher use of Chichewa and English in mathematics in primary schools in Malawi. Secondly, it was used for verification of facts, variables, and relationships among the variables and factors being studied (Bogdan and Biklen, 1992). An early and on going data analysis technique was employed to ensure that data analysis helped to fine tune and make the research design more focused at all stages.

Basically two types of data analyses were employed - qualitative and quantitative data analyses. I discuss how each set of data was analysed using specific data analysis techniques.

Qualitative data consisted of transcripts from focus group discussions, clinical interviews and narrative data from classroom observations. Analysing qualitative data in this study meant systematically searching and arranging the data I accumulated through focus group discussions, clinical interviews and classroom observations to increase my understanding of them and to enable me to present what I discovered in the data to other people.

According to Bogdan and Biklen (1992):

> Analysis involves working with data, organising them, breaking them into manageable units, and synthesising them, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others (Bogdan and Biklen, 1992: 153).

The constant comparative methods were used to analyse qualitative data through two techniques into three main groups: *intuitive and procedural* techniques. I used the *intuitive* techniques to analyse the data available to verify what actually was happening in the schools and especially in the classroom in terms of the use of Chichewa and English in mathematics teaching. While in the field, I speculated on what was happening; vented by talking about the ideas with friends and colleagues; wrote memos, comments and texts; and marked the data up (Bogdan and Biklen, 1992).

Verification was achieved by generating predictions and hypotheses from the interpretation and checking their responses against field notes and through further data collections. This process was a kind of pattern matching in which many aspects of the patterns demanded by the theory were available for matching with observations.

I used the procedural technique to transcribe the audio and video recorded interviews and observation data before interpretation. Transcribing audio/video recordings can be challenging especially if the researcher does not know how to type and also if he or she is not familiar with the language used during the discourse. Because the first audio and video recorded data were in Chichewa and the second set was in English, in both of which I am fluent, there was no major problem of language during the transcribing process. Field notes on incidences of use of language in mathematics teaching collected through observation methods were also analysed qualitatively using the constant comparative method described earlier.

6.6.1 Preparing transcripts

It is important to explain the transcript conversion used in this study for various reasons. First, because the data are in the transcripts of the focus group discussions, clinical interviews and classroom observations. Second, because during the focus group discussions, clinical interviews and classroom observations, notes were taken which were included to enhance the transcripts. The note taking was of importance when teachers made non-verbal linguistic behaviour during the recording sessions; there are actions which could not be recorded. Third, because all through the description of the coding system and results, examples were constantly given. Thus a substantial part of the data from the focus group discussions, clinical interviews and questionnaires are presented in turn beginning with focus group discussions.

The qualitative data from focus group discussions, clinical interviews and classroom observations were transcribed to create files for teacher focus group discussions, clinical interviews and classroom discourse transcripts. The transcribing process required that I listened to all the tapes, typed them, correcting typing errors, adding missing words and statements to help in understanding the discourse outside the context in which it was created.

Spoken language is usually different from written language. In spoken language people do not care much about grammar or orthography rules and this makes it difficult to understand when the spoken language is transcribed - removed from the social context. Lack of understanding of the transcripts can affect its analysis and interpretation. That is why I corrected all the words according to Chichewa and English orthographic rules; but I did not change the grammar or sentence structures.

After making the corrections, I organised the files on focus group discussion and clinical interviews according to the questions. There were five categories created on interviews based on focus group discussions and 6 categories on the number of questions used in the group interviews. That is, a section was composed of a question and all the responses from the entire interview to a particular question.

The transcription from classroom discourse consisted of teachers' and pupils' utterances that were clearly marked and numbered. In all, there were 8 transcripts for classroom lesson observations taught in Chichewa and 8 transcripts for lessons taught in English.

6.6.2 Coding data from the transcripts

I used two approaches to coding the data from the transcripts. The first one involved using predetermined codes to develop meanings of issues raised in the transcripts. From the words, phrases and sentences, I derived some codes. In this way the codes were grounded in the transcripts and I prefer to call this *non-criterion* data coding. The non-criterion coding approach was used to code transcripts from teachers' focus group discussions, clinical interviews and lesson transcripts when I looked for deep meanings in what teachers and pupils said with an open mind.

The second approach involved using predetermined sets of codes such as those for discourse analysis, which I used for analysing patterns of language use in mathematics lessons. I prefer to label this approach as criterion coding approach. The lesson transcript analysis was aimed at exploring how teachers use language skills in mathematics teaching. C*oding* was from the viewpoint of the observer, with pedagogical meaning inferred from the speaker's verbal behavior. *Grammatical* form gave a clue, but was not decisive in coding. For example, soliciting (SOL) was found in declarative, interrogative or imperative forms. Likewise, responding (RES) may be in the form of a question - frequently indicating tentativeness on the part of the speaker. All *missed statements* and all non-codable statements (e.g. er, ah, mmm, well... etc) were coded as "missed". Partially missed statements were coded only if there was enough information to code the pedagogical move, the substantive-logical meaning and/or the instructional meaning and instructional-logical meaning. Those moves immediately following a move coded "missed" were coded as usual, if the context was clear and unambiguous. If alternative codes were clearly possible, these moves were coded "missed" also.

When developing the system of coding the lesson transcripts to analyse teacher language use in mathematics teaching, the following issues were considered:

- Who is speaking?
- What is/are he/she/they saying?
- How is/are he/she/they saying?
- Why is he/she/they saying?

Who is speaking?	What is/are he/she/they saying?	How is it said?	Why is he/she saying?
• Teacher/Pupil (T/P) • Pupil/Teacher (P/T) • Teacher/Class (T/C) • Class/Teacher (C/T) • Pupil/Class (P/C) • Class/Pupil (C/P • Pupil/Pupil (P/P)	• Structuring (STR) • Soliciting (SOL) • Responding (RES) • Reacting (REA)	• Explaining (EXP) • Defining (DEF) • Describing (DES) • Commanding (COM) • Asking (ASK) • Answering (ANS) • Justifying (JUS) • Interpreting (INT) • Praising (PRA) • Rejecting (REJ) • Accepting (ACC) • Instructing (INS) • Action Physical (ACP) • Reading (RDG)	Mathematics: • Concepts (CON) • Principles (PRI) • Relations (REL) • Algorithm (ALG) • Numbers (NUM) • Measuring (MEA) • Drawing (DRA)

Figure 6.2: Categories for coding lesson transcripts for discourse analysis.

The actual system of categories for coding the transcripts is summarised in Table 6.6. The process of coding the transcripts involved the use of two other people apart from the researcher. The use of the people in the coding process helped me to establish the reliability of the results by establishing a level of inter-coding agreement of above 80% (Bellack, *et al.*, 1966). I also coded the same transcripts twice and achieved an intracoding agreement of above 80%.

The issue of checking for reliability when coding is emphasised by both Fanselow (1987) and Bellack (1966). Bellack and his colleagues worked in teams to code the work and discussed their results to check on the degree of agreement among the groups of coders. Fanselow (1987) reiterates this as the surest way of high reliability and accuracy. Fanselow (1987) concedes that with his system of categories, given the ambiguity of communication, 100 percent agreement in coding the moves is rare. Fanselow (1987) sees having difficulty in classifying the move type of communication as not an issue. However, he recommends that practice coding is one way to keep coding consistent and to clarify move used in communicating in a range of settings. He further recommends that "if you, after you do the coding, want to check the percentage of agreement you count the total number of agreed upon items and divide it by the total number of items coded" (Fanselow (1987: 29). He emphasises that practice coding, constant reliability checks and the establishment of coding ground rules counting multiple examples of communication coded in each category are the only ways of maintaining consistency and accuracy in coding. Though inter coder and intracoder agreement varies a lot and can be as high as 100%, an average of 80% was considered by Bellack et al. (1966) as acceptable. Reliability checks in transcript coding provide support for the degree of agreement between researchers necessary to make the results acceptable as well as ensuring accuracy.

In fact Fanselow (1987) goes further to say that a percentage of agreement of 80 and above is acceptable for reliability. He concluded with a caution by saying that:

> It is critical to realise that there are no definitive or best categories. It is also important to remember that any categories we develop limit our perception. FOCUS like any category system, is simply a lens that reveals some characteristics and obscures others. Using subcategories or subscripts is one way to reveal more than the major categories. Another way is to develop or use a totally different lens (Fanselow, 1987: 51).

6.6.3 Analysing data from questionnaires, tests and frequencies of categories

Quantitative data consisted of questionnaire ratings, scores on mathematics vocabulary and frequencies on language uses obtained through discourse analysis. Simple statistics were used to analyse the quantitative data where simple comparisons of frequencies and means were required. A few hypotheses were generated to guide the choice and use of the appropriate statistical analysis procedures. Evidence from the competencies, perceptions and use of language in mathematics teaching were pooled during the analysis according to the themes that emerged from the data. However, qualitative data analysis was applied where the respondents were asked to write their feelings.

6.7 Data validation: Triangulation

The major concern in my research undertaking was to produce reliable data that would lead to discovery and verification of knowledge. From the description of the research methods, it is clear that I used a number of strategies to obtain information of teacher use of language in mathematics teaching. To achieve this, triangulation, a combined strategy for data collection was used on the same variable. "*Triangulation* refers to the use of more than one method of data collection and analysis within a single study" (Hitchcock and Hughes, 1989: 104). Hitchcock and Hughes (1989) describe two types of *triangulation: between-methods triangulation* and *within-methods triangulation*. *Within-methods triangulation* refers to the replication of a study using the same technique as a way of checking on the reliability of the study and the nature of the theories generated. *Between-methods triangulation* refers to the use of more than one method of data collection within the same study (Hitchcock and Hughes, 1989: 105). In this study, *between-methods triangulation* was used to check on such issues as teacher perceptions, teacher mathematics vocabulary and *within-methods triangulation* was useful in validating the coded and analysed transcripts of teacher use of languages in the classroom.

Triangulation is important as "Triangulation [is] cross-checking of data using multiple data sources or multiple data collection procedures" (Fraenkel and Wallen, 1990: 483) as well as data analysis procedures. Triangulation was useful in this study because it helped me to collect reliable data which when analysed led to valid conclusions. It enriched the research data and the results, in so doing, increasing the understanding and credibility of the phenomenon under study (Fraenkel and Wallen, 1990).

6.8 Data reporting

The process involved in producing the report was a complex one. The strategies were not in any strict order, but were interwoven as the research progressed. This meant continuously moving backwards and forwards among the data. This process is similar to that described by Glaser and Strauss (1967) as the development of 'grounded theory' the production of analysis and explanation, which is grounded in the data. This required moving consciously between the emerging explanation (Hitchcock and Hughes, 1989: 98). The process of data collection and analysis had the researcher at the centre of activities leading to the production of a final report. The final report, in this case, is this thesis.

6.9 Reflections on methods

There were a number of challenges I encountered during the data collection exercise. The rescheduling of the school calendar affected my schedule of activities. Instead of opening the term on 4th January 1999 the schools opened on 25th January 1999. Consequently I started my visits to schools in February instead of January 1999. Our postal services are poor. Letters take an unnecessarily long time to reach the schools especially in the rural areas. This caused delays in getting replies from schools and the Ministry of Education.

Visiting the schools during the rainy season was a problem especially when we experienced heavy rains. Teacher mobility within the school and between the schools caused a loss of 4 teachers. Two teachers were assigned to teach other classes within the school and to get them back to the study classes proved administratively difficult. Two other teachers, one in a rural school and another one in an urban school got posted away to another school, and there was nothing I could do to get them back. One teacher participated in 1999 and gave up in 2000. Those teachers who dropped out on the way had their data removed from the study. Therefore from a sample of 45, I remained with 40. However, because this happened before choosing the eight teachers to be observed and that I had 45 teachers in my initial sample, this did not affect the sample size.

Challenges were also experienced during data analysis and reporting. Because of the case study approach, sample sizes in some cases were so small that some statistical data analysis procedures could not be applied even if it was felt that its application would help discover more evidence to support the thesis. There was also some overlaps among the categories of issues in qualitative data analysis. Subjectivity in qualitative data analysis and reporting was inevitable, as the researcher was the main instrument and interpreter of the phenomena. Contradictory data collected from individual subjects at different stages of the study were difficult to analyse.

6.10 Conclusion

There were three categories of issues explored in this study: mathematics vocabulary, teacher perceptions and classroom discourse. The data from the study were collected through case studies conducted in ten primary schools in the Zomba district in Malawi. I personally conducted the case studies between January 1999 and October 2000.

The population involved in the study were all teachers currently teaching mathematics in standards 1 and 4 in Zomba. In all, there were 40 teachers. To collect data, I visited each school. I first collected preliminary data that enabled me to refocus the study as it progressed. Five strategies (questionnaire, Mathematics vocabulary tests, focus group discussion, Clinical interviews, and lesson observations) were used to collect data:

1. Focus group discussion was used to collect data on teacher perceptions and mathematics vocabulary in Chichewa. Two focus group discussions of five teachers each were conducted.

2. Clinical interviews with each teacher whose lessons were observed were conducted to collect data on teacher perceptions of teacher use of language in mathematics teaching. Eight teachers were interviewed immediately after they delivered their lessons, first in Chichewa and then in English.
3. Likert scaled questionnaire was used to collect data on teacher perceptions about the use of Chichewa in mathematics. The questionnaire was administered to 40 teachers currently teaching mathematics in standards 1 to 4 in the 10 primary schools.
4. A mathematical vocabulary test was prepared and administered to teachers.
5. Classroom observation involving video recording mathematics lessons was conducted. Sixteen mathematics lessons were observed and recorded in the four schools.

Despite the limitations of the study, I had the opportunity to collect and analyse an issue previously unexplored. Through questionnaires, tests, interviews and observations I had the opportunity to uncover some of the prevalent situations related to the use Chichewa and English in mathematics teaching in primary schools in Malawi. Since a single issue was being studied, the revelatory nature of the study justified the use of a single case study design. The questionnaires, tests, interviews and classroom observations were conducted and audio/video recorded to collect qualitative data that revealed the real situation about the use of Chichewa and English in mathematics in primary schools in Malawi.

I report on the data analysis in Chapter 7, the major findings in Chapter 8, sociolinguistic model of mathematics teachers in Chapter 9 and before providing the final discussion and conclusion in Chapter 10. The information regarding the instruments, raw data and procedural documents were placed in the Appendices section.

CHAPTER 7

DATA ANALYSIS

> Taken together, these perceptions [and actions] provide some important insights into what is currently happening in our education system (Hughes, 1994: 1)

7.1 Background to data analysis

In this chapter, I begin to analyse and introduce the findings from the data collected through focus group discussions, clinical interviews, teacher questionnaires, classroom observation and discourse analysis conducted in order to find out how teachers perceive the use of Chichewa and English in mathematics teaching. The data collection and analysis procedures are described in Section 6.5. I focus on one of the research questions: *Do teachers' perceptions of the use of Chichewa in mathematics teaching differ from their perceptions of the use of English in mathematics teaching? If so, how do they differ?*

Initially, I decided that the discussion and interviews should be conducted in English for two reasons. First, since the thesis was to be written in English, conducting interviews in English would save translation time and also misrepresentations that may arise from trying to provide literal meaning through *translation.* Second, considering that all teachers had a secondary education, which they studied in English and also English was one of the subjects, I assumed that teachers were fluent in English. However, in spite of this, teachers chose to have the focus group discussions and clinical interviews conducted in Chichewa, except for one teacher who opted for the use of English during the clinical interviews. I translated excerpts of the transcripts into English to enable English readers to follow the thesis. Translation is not literal but interpretive in the sense that I have tried to give the meanings in English of what I believe was said in Chichewa. This is not an exact translation; but I have included both the literal Chichewa and my English translations so that my claims are open to scrutiny and verification.

The purpose of using a variety of methods in collecting data on teachers' perceptions and use of language in mathematics teaching were to triangulate the data as well as to have an in-depth understanding of the phenomenon under study. The importance of triangulation was discussed in Section 6.7. The data analysis procedure was progressive and iterative because the findings at each stage were incorporated into the model being developed.

In this chapter, the data analysis procedures are presented in 5 main sections. Section 7.1 is the data analysis from the focus group discussions. Section 7.2 is the data analysis from the clinical interviews. Section 7.3 is the data analysis from the questionnaires. Section 7.4 is the analysis of the data from observation and section 7.5 is the discourse analysis procedure.

A constant comparative method was used in analysing the data from the transcripts. It involved identifying units of issues from the utterances, grouping the similar units together and creating categories, and then relating the issues within each category to develop the themes which represent the predisposition of the mathematics teachers.

The process of constant comparison is illustrated in Figure 7.1.

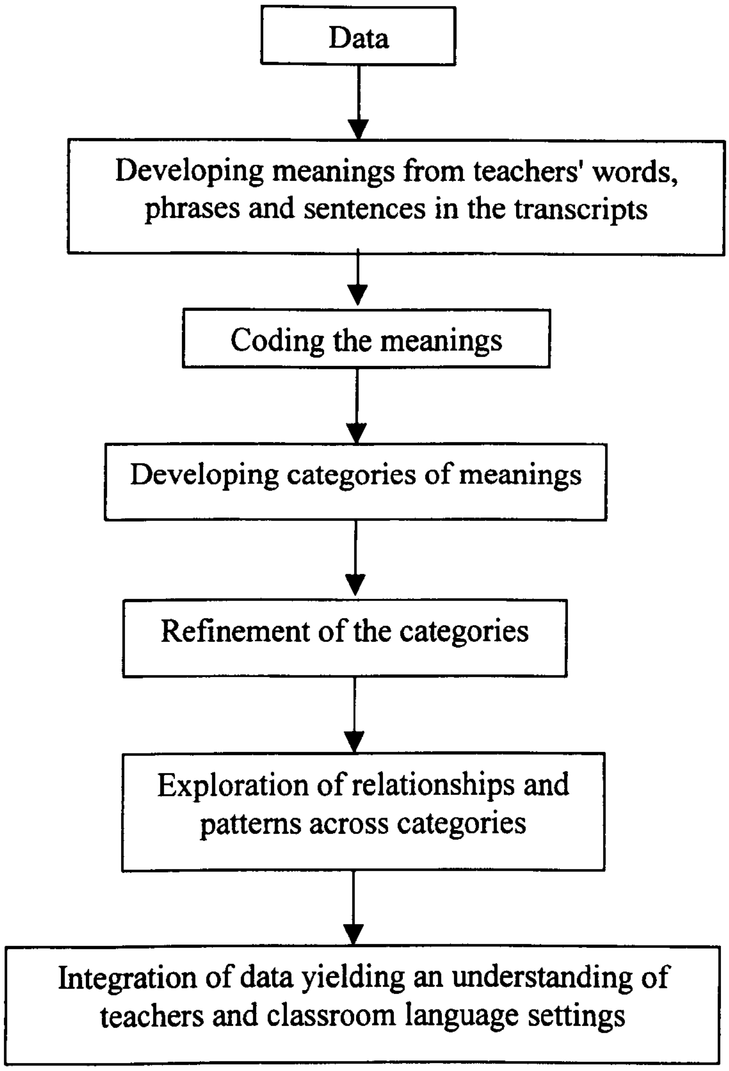


Figure 7.1: The process of data analysis.

Identifying issues from the transcripts involved identifying and underlining all the words, phrases and sentences that had a message about how teachers felt about the use of language in mathematics, which were then grouped into themes.

When analysing the data, I first elaborated the coding system. I coded one focus group discussion from the pilot study. Afterwards, the coding system and two transcripts for focus group discussions were given to an independent researcher who had no previous knowledge of the study. He was asked to code the transcripts using the given coding system. After comparing both analyses, and discussing it with the independent researcher, an intercoder agreement of 81.5% was achieved. Consequently, I considered my coding system to have a sufficient strong level of reliability.

In deconstructing the data, I identified from the teachers' words and actions evidence of their concerns with regard to their use of language in mathematics teaching and labelled them as *issues*. Developing *categories of issues* involved classifying similar issues together and finding a common label that described the category. The issues were read several times to make sure that they were put in the appropriate categories. Thereafter, I explored the relationships and patterns across categories so as to develop propositional statements that connect issues in different categories and labelled them under single *theme* representing a subject for discussion.

7.2 Analysing data from focus group discussions

The main purpose of conducting focus group discussions with teachers was to detect their group response on the use of Chichewa and English in mathematics teaching. *Group response* meant that the group subjected the individual responses to scrutiny; individual contributors were asked to explain if their responses were not clear to other members of the group.

There was one general question presented to the group that focussed on how teachers felt about the use of Chichewa and English in mathematics teaching. Some probes were used to make individual teachers explain the reasons for their viewpoint and also to guide the focus of my research interest. On the basis of the focus group discussions, it was possible to construct a model from each group of teachers of their perceptions and reasons for holding the belief they did. Each code, which was generated from the data, is described and several examples are given in order to justify the coding system adopted.

7.2.1 Identifying issues from the transcripts

To show how I conducted the analysis and interpretation of data from focus group discussions, I have used the following excerpt from the actual data transcript in which I highlighted parts of the utterances that led me to identify issues. The excerpt was typed in a two-column format with a transcript on the left and room for comments on the right.

Q1: In what language do you teach mathematics in your class?	
T1: Ndimaphunzitsa masamu m'Chichewa	*Language actually used by teachers is Chichewa*
T2: Ine mkalasi mwanganso ndimaphunzitsa Chichewa kuti ana amve bwino	
T3: Ine mkalasi mwanganso ndimaphunzitsa m'Chichewa	
T4: Ine mkalasi mwanganso ndimaphunzitsa m'Chichewa kuti ana amvetsetse bwino.	*Teachers use Chichewa for pupils' understanding of mathematics*
T5 Ineyo mkalasi mwanganso ndimaphunzitsa m'Chichewa ndi cholinga choti ana amvetsetse bwino. Komanso ngati mau ena oyenera kuwatchula m'Chingelezi timatha kuwachula. Monga mkalasi komwe ndikuphunzitsako ndi ya wana motero kuti Chingelezi sanafike mozindikira kapena kuzolowera. Tsono chifukwa chake cha chimenecho ndiye kuti ana aja ayenera kuphunzitsidwa m'Chichewa chifukwa ndi chiyankhulo chimene munthu aliyense ayenera kuzindikira ndi kuyankhula	*Teacher uses Chichewa for pupils to understand mathematics* *Teachers code switch between Chichewa and English* *Pupils don't speak English* *Chichewa is a common language*

Q2: *What are your views about mathematics teaching in the language you use in your class?*

1. Maganizo anga monga standade 1 ndi 2 sipakhala vuto lenileni chifukwa mawu wonga amene achizunguwa samakhala ovuta kwenikweni. Koma mmakalasi enawa mawu achizungu amavutirako pang'ono kuti anawa asiyanitse chizungu ndi Chichewa komabe nthawi zina zake anawa amamvetsa pang'ono chifukwa ku English amaphunziranso zomwezo. Koma system imeneyo yophunzitsa ana math mChichewa yikuonetsa kuti ndiyabwino chifukwa ana ena akutha kumvetsetsa bwino amene amalephera kuti adziwe masamu amenewa pa Chingelezi.
2. Ndikuona ngati kuti ndi bwino pophnzitsa 3 ndi 4 kumaphatikiza ndi Chizungu chakuti akapita ku standade 5 kumakhala kosavuta kuti azindikire.
3. Inenso ndikugwirizana ndi mayi J kuti mmakalasimu monga 3 ndi 4 ndibwino kumasakanizako chilankhulo cha Chingelezi ndi Chichewa chifukwa chakuti standade 5 tikudziwa kuti ndi likulu la kapena chiyambi cha senior. Tsono mwana ngati akuphunzirabe Chichewa throughout chikakhala chovuta kwa iye kuti akafika standade 5 akathe kudziwanso kuti mawu timaphunzitsa mChichewa aja atembenuka tsopano ali m'Chingelezi.

Teacher use of language depends on class level Use English in Stds 1, 2 and 3; Teachers code switch between Chichewa and English.

There is little understanding of mathematics when English is used.

Pupils understand some English because it is a subject of study.

Language policy in education is good; use of Chichewa helps pupils understand maths.

Teachers code switch between Chichewa and English to prepare pupils for further education.

Code switching to prepare pupils for further education.

Children's needs: Change of medium of instruction in upper classes.

7.1.2 Coding the issues

Using the codes from the transcripts, I grouped them into categories of issues, which I believe represent a model of what teachers felt were important concerns about the use of language in matheatics teaching. I grouped the issues into the following categories.

- There were themes that were indicating the limited number of languages that teachers could use, these I labeled **limited range of languages (LRL).**
- Issues that were based on pupils' home language, I labelled **pupil home language (PHL).**
- Issues that pointed towards teacher competencies in a particular language were labelled **teacher language competencies (TLC).**
- Issues that indicated teachers' failure to stick to one particular language -the use of two or more languages during mathematics lessons - were labeled **language code switching (LCS)**.
- Sometimes teachers gave meanings that were based on the language used in the textbooks, and these were labeled **mathematics instructional materials (MIM).**
- Issues that indicated that the teaching and learning materials influenced the language use were labeled **teaching and learning materials (TLM)**.
- Issues that were based on mathematical terms were labeled as **range of mathematical vocabulary (RMV).**
- Issues that pointed to classroom practices were labeled **teaching and learning practices (TLP).**
- Issues that were based on the subject matter were labeled **mathematical content (MC).**

By considering the coding of all the transcripts, I began to see the similarities and differences among the issues from what teachers said. I developed categories of the issues based on the similarities and differences. It is important to note that what I began by calling issues at the beginning of the analysis turned to represent concerns that teachers experience as they use language in mathematics discourse. Thus teachers' perceptions were interpreted as teachers' understandings which were in turn represented as concerns in the use of language in mathematics education.

Issues derived from the focus group discussion transcripts were coded as follows:

1. Money is enjoyable to teach in Chichewa because of the everyday use of concepts of money that bring about familiarity to the teachers and the pupils.	*Relevance of mathematics content.* *Applicability of mathematics content.*
2. Geometry, graphs and measurements the topics they found difficult to teach in Chichewa.	*Limited mathematical discourse in Chichewa.*
3. Mathematics teaching is made easier when Chichewa is used as the medium of instruction.	*Language for mathematics discourse.*
4. Use of Chichewa in mathematics teaching is interesting because the *words* used are familiar to the children.	*Pupils' language competence.*
5. The Chichewa terms used are difficult for the young children.	*Mathematical discourse.*
6. Use of Chichewa is not suitable for mathematics because mathematics is full of technical terms that are difficult to translate into Chichewa.	*Limited mathematical discourse.*
7. It was difficult to explain some mathematical concepts in Chichewa.	*Limited mathematical discourse in Chichewa.*
8. There was need to use correct words to describe mathematical concepts in the books.	*Unsuitable mathematical discourse in instructional materials.*
9. It is difficult to use English in mathematics teaching because most pupils do not speak English.	*Pupils' language competence.*
10. Chichewa should be used in mathematics teaching because it is a subject of study in schools.	*Language of study.*
11. The use of Chichewa results in poor preparation of pupils towards change of medium of instruction to English in upper classes when Chichewa was used in mathematics teaching.	*Dual function of medium of instruction.*

12	The teachers' choice was limited because they do not speak other local languages.	
13	Chichewa is the only language shared by the teacher and their pupils in most classrooms.	*Limited range of languages.*
14	The use of Chichewa was possible because the majority of teachers speak it.	*Language competence.*
15	Chichewa should be used in mathematics teaching, as introducing another language would only confuse pupils.	*Teacher language competence.*
16	When Chichewa is used in mathematics teaching, some pupils experience problems when the medium of instruction changes to English in the upper classes.	*Limited range of languages.*
17	Teachers use Chichewa in mathematics teaching because it is the home language for pupils in the school community.	*Dual function of medium of linstruction.*
18	Teachers were not sure which language, Chichewa or English, should be used in mathematics teaching.	*Dual function of medium of linstruction.*
19	Teachers speak with confidence so that the pupil will understand and so that the pupil will pick it up quickly.	*Uncertainty of medium of linstruction.* *Teaching competence.*
20	When Chichewa is used in mathematics teaching, pupils' performance in mathematics is improved.	*Pupils' performance.*
21	Lessons conducted in Chichewa were mostly successful.	*Evaluating lesson procedure.*
22	The use of Chichewa enabled the pupils to discuss mathematics during the lesson.	*Discussing mathematics.*
23	The use of Chichewa in mathematics teaching assists pupils to answer questions easily.	*Answering questions.*
24	The use of Chichewa helped pupils to understand what was taught.	*Understanding mathematics.*
25	Teaching methods used in mathematics are not suitable for the use of Chichewa in mathematics teaching.	*Unsuitable teaching methods.*
26	When Chichewa is used, some teachers do not take the lessons seriously.	*Teacher dedication to teaching.*
27	Lack of teachers inservice courses in the effective use of Chichewa in mathematics hindered the use of Chichewa in mathematics teaching.	*Teacher support.*
28	Supervising teachers on the use of language in mathematics teaching was perceived as one way of improving the use of Chichewa and English in Mathematics teaching.	*Teacher support.*

7.2.3 Developing categories of issues

It was not easy to relate issues to form categories because the criteria for relating the issues were not straightforward, as some issues would fall into more that one category. Forming categories therefore involved shifting the issues across the categories until the suitable category was found. I also considered whether the language and the structure of the issues were similar to each other and if the responses for one language are similar to those for the other languages. The categories of the issues can reveal what sort of concerns teachers have, actions teachers take and reasons teachers have for the actions they take in the use of language in mathematics teaching. The issues and the categories of the issues that emerged from the data analysis are presented in Table 7.1

Table 7.1: Categories of issues from the focus group discussion.

Categories of issues	**Issues derived from the focus group discussion transcripts**
The linguistic nature of mathematics ▪ Relevance of mathematics content. ▪ Applicability of mathematical content. ▪ Limited mathematical language in Chichewa.	▪ Money is enjoyable to teach in Chichewa because of the everyday use of concepts of money that bring about familiarity to the teachers and the pupils. ▪ Geometry, graphs and measurements are the topics teachers found difficult to teach in Chichewa ▪ Mathematics teaching is made easier when Chichewa is used as the medium of instruction. ▪ Use of Chichewa in mathematics teaching is interesting because the *words* used are familiar to the children ▪ Use of Chichewa is not suitable for mathematics because mathematics is full of technical terms that are difficult to translate into Chichewa. ▪ It was difficult to explain some mathematical concepts in Chichewa.
The mystifying language policy in education ▪ Language policy in education. ▪ Pupils' home language.	▪ When Chichewa is used in mathematics teaching, some pupils experience problems when the medium of instruction changes to English in the upper classes. ▪ Teachers use Chichewa in mathematics teaching because it is the home language for pupils in the school community ▪ The use of Chichewa result into poor preparation of pupils towards change of medium of instruction to English in upper classes. ▪ Teachers were not sure which language, Chichewa or English, should be used in mathematics teaching
The dynamic classroom discourse ▪ Teaching confidence in Chichewa. ▪ Improved learning in Chichewa. ▪ Improved mathematics discussion in Chichewa. ▪ Lack of teaching seriousness.	▪ Teachers speak with confidence so that the pupil will understand and so that the pupil will pick it up quickly ▪ When Chichewa is used in mathematics teaching, pupils' performance in mathematics is improved ▪ Lessons conducted in Chichewa were mostly successful. ▪ The use of Chichewa enabled the pupils to discuss mathematics during the lesson. ▪ The use of Chichewa in mathematics teaching assist pupils to answer questions easily, ▪ The use of Chichewa helped pupils to understand what was taught. ▪ Teaching methods used in mathematics are not suitable for the use of Chichewa in mathematics teaching ▪ When Chichewa is used, some teachers do not take the lessons seriously.
Divergent source of language for use in mathematics classes ▪ Pupils' incompetence in English. ▪ Language of study - Chichewa and English. ▪ Limited source of language. ▪ Competence in Chichewa. ▪ Lack of teaching competencies. ▪ Lack of support and supervision.	▪ It is difficult to use English in mathematics teaching because most pupils do not speak English ▪ Chichewa should be used in mathematics teaching because it is a subject of study in schools ▪ The teachers' choice was limited because they do not speak other local languages . ▪ Chichewa is the only language shared by the teacher and their pupils in most classrooms ▪ The use of Chichewa was possible because the majority of teachers speak it ▪ Chichewa should be used in mathematics teaching, as introducing another language would only confuse pupils. ▪ Lack of teacher in-service courses in the effective use of Chichewa in mathematics hindered the use of Chichewa in mathematics teaching. ▪ Supervising teachers on the use of language in mathematics teaching would be one way of improving the use of Chichewa in mathematics teaching. ▪ The Chichewa terms used are difficult for the young children. ▪ There was need to use correct words to describe mathematical concepts in the books.

7.3 Analysing teacher clinical interviews

Teachers' clinical interviews were conducted to provide teachers with an opportunity to reflect on the use of language immediately after lessons. As expected, certain themes were going to emerge because I had deliberately set out to explore them. My intention in analysing the teacher clinical interviews was to identify more themes and sub-themes about teachers' perceptions of the use of Chichewa and English in mathematics teaching. Teachers' clinical interviews were meant to reflect on the actual use of Chichewa and English in mathematics lessons. Certain themes or aspects of the previously established themes re-emerged because the interviews were focused on language use, which I intended to explore.

7.3.1 Identifying issues from the interview transcripts

In the analysis of data from clinical interviews, I identified patterns in responses, underlying themes and tendencies that highlighted the teacher use of Chichewa and English in mathematics teaching. An example of an annotated transcript is below. What was clear from the outset was the recurring of some of the themes of concerns that emerged from the analysis of data from focus group discussions. Although this did not surprise me, I was encouraged by the emergence of yet other new categories and themes and of concerns.

R: Oh ndikalasi iti imene ana anatha kufotokoza maganizo awo momveka bwino ndilankhulidwe chimene inu mmaphunzitsira.

T: Naona kuti chichewacho kumafunso amatha kukamba bwinobwino monga mtafunsa mwachitsanzo kalasi imene yachichewayi ndinafunsa kuti ndakana nagwiritsa ntchito yanji anatha kundiyankha timagwiritsa ntchito pogulira zinthu pamene kuchizungu ana ambiri anaoneka ngati kuti ayankhule Chizungu chenicheni chabwinobwino zinakhala ngati zimavuta pang'ono nayenera kuwatanthauzira m'Chichewa kuti ndalama magwiritsa ntchito yanji.

Pupils answering question using Chichewa medium lessons.

Pupils had difficulty to speak English.

Teacher helping pupils in English medium lessons.

R: Kodi ndaona kuti nthawi yachiChewa ija simunalankhule mau achizungu kwambiri koma nthawi yachingerezi ija panali nthawi ina yake ndithu ka minute kamatha kukufotokoza zina zache mChichewa tandiuzani chinachitika ndi chiyani.

T: Kungoti ya Chizunguyo pokhala iwonso ndiana sungathe kulankhula Chizungu chokhachokha umayenera pena pake uyuzepo mother tongue pama words ena oti mwina sangamve bwinobwino umayenera kuwayankhulirapo mchichewa pamene kuchichewaku pokhala ndichiyankhulo chawo ndiyo sinathenso kuika mau achizungu chifukwa nanga silesson yaChichewa basi ndangophunzitsa Chichewa yonse.

Desire to code switching between Chichewa and English.

Code switching not necessary in Chichewa medium lessons.

7.3.2 Coding the issues from clinical interview transcripts

Using the coding from the transcripts, I grouped the data into categories of themes, which I believe represent the teachers' concerns about language use in mathematics as there were more contradictions than similarities in teachers' understandings of use of language in mathematics teaching. However, because the coding system was grounded in the data, it was flexible enough to allow for new themes to emerge from the data. The evidence for concerns was sought from the transcripts by reading and underlining all the words, phrases and sentences that appeared to me to suggest language use in mathematics (see Table 7.2). All the issues raised were restated to show my own understanding of the dilemmas and tensions.

7.3.3 Developing categories of the issues

All the issues were sorted and grouped into categories. The propositions in each category were compared and constructed to develop the themes. The issues, which were derived from the data on clinical interviews, were related to each other and categories were formed as shown in Table 7.2.

Table 7.2: Categories of issues in the data from clinical interviews.

Categories of issue	Issues derived from the clinical interviews
1 The linguistic nature of mathematics	**There was lack of mathematical vocabulary equivalents between Chichewa and English**
2 Dynamic classroom discourse	
• *Successful lessons.*	1. The lessons in Chichewa were more successful than those in English. 2. Pupils were more relaxed in Chichewa medium lessons than in English medium.
• *Lack of teaching experiences.*	3. Teachers would teach the pupils in English only if they have enough time to practice with them. 4. Teacher lacked experience to teach mathematics in English because they were used to teaching in Chichewa .
• *Mixed language competencies.*	5. Pupils could not speak English . 6. They found it easier to communicate with the pupils in Chichewa medium than in the English in the use of Chichewa. 7. Pupils were more active in Chichewa medium lessons than in English medium lessons. 8. Chichewa is their mother tongue and they easily understood it, unlike English. 9. Teachers found it difficult to teach mathematics in English because English was not their first language
• *Using mathematical vocabulary.*	10. There were some concepts that I could not express in Chichewa for example say 'number'. 11. Teachers used English because they were able to find most of mathematics vocabulary in English. 12. Teachers felt that English was more appropriate than Chichewa in mathematics teaching.
• *Helping pupil.s*	13. Pupils needed more help in the English medium lesson than in Chichewa medium lesson because of communication problem.
• *Tri-lingual code switchin.g*	14. Teachers were whispering to individual pupils in Chichewa during English medium lesson when providing some individual help because they wanted the pupils to understand what was said. 15. When you speak in English only, some children don't understand the English forcing you to speak in Chichewa.
3 Mystifying language policy in Education. • *Source for using English of Chichewa.* • *Use a language which is common to teacher and pupils.*	16. A mixture of Chichewa and English should be used in mathematics teaching for the responses that Chichewa is a common language. 17. English is a medium of instruction in the upper classes. 18. Teachers use of English should begin in standard earlier than standard 4.
4 Divergent is sources of language for use in mathematics. • *Materials suited for English medium.*	19 The materials were best suited for English medium lessons than Chichewa medium lessons because the names of the items were mostly in English.

The clinical interviews seemed particularly rich and illuminating. Each teacher articulated his/her experiences more clearly than during the focus group discussions on various levels of uses of Chichewa and English in mathematics lessons by drawing on more practical experiences. In coding the interviews, although no new categories emerged, new concerns emerged and greater and deeper details began to emerge on the themes developed from the analysis of data from focus group discussions.

The analysis of data from clinical interviews was used to extend the themes developed from analysing data from focus group discussions. However, no new themes arose from the analysis of clinical interviews but added some dimension to the model I developed from the analysis of data from focus group discussions.

7.4 Analysing data from questionnaires

Again, after the preliminary analysis of data from focus group discussions, I arranged to administer the questionnaires to some teachers in the sample schools. My initial work in the first two approaches to data collection had brought to the surface a number of issues that I wanted to explore in a deeper and more elaborate manner. These along with the emerging model and theoretical framework formed my two questionnaires one focusing on use of English and another on use of Chichewa. Teachers were asked to rate the items that represented different concerns and the ratings were analysed using both qualitative and quantitative methods.

7.4.1 Designing the questionnaires

It was becoming clear to me that there were many concerns in the teachers' use of language in mathematics and different methods of data collection and analysis were yielding different layers of concerns. Consequently, I wanted to find out more about teachers' concerns in the use of Chichewa or English and extend further my exploratory model I have already started developing. Hence the questionnaires would magnify individual teachers' concerns. To get some insight into how the theoretical framework actually held together and operated into practice, I needed to begin to explore where the various elements occurred in the organisation of teachers' thinking of use of language and how they interacted with each other.

In particular, I needed to explore where teachers stood in relation to the dominant issues that were emerging and in particular how each teacher rated each issue that emerged from the focus group discussion and clinical interviews. This notion of triangulation of data findings was discussed in Section 6.9.

Furthermore, I needed to explore the underlying degree of concerns that teachers held and which informed and permeated teachers' practices in mathematics teaching. I also wanted to uncover those deep structures of thought, distilling across themes and contexts exploring interconnections.

I also needed to compare the perceptions between Chichewa medium and English medium in mathematics teaching to bring out the aspects of bilingualism in the classroom. Comparing the teachers' perceptions of the use of the two different languages is the basis of this study. Therefore, I organised my questionnaires, which consisted of the following key areas.

What are the teachers' perceptions of the use of language in relation to the nature of mathematics?	Used as a way of determining the aspects of mathematics which teachers consider as critical in the use of language in mathematics teaching.
What are the teachers' views about the language policy in education?	This question was used to explore the elements of perceptions that may be related to language policy in education; thus setting conditions for language use.
How do teachers view the role of languages in the dynamic classroom discourse?	This question allowed me to put the teacher in the classroom and reflect on what the language can do to the classroom discourse. This could serve as a window into the processes of classroom discourse
How do teachers perceive their language competencies and those of the pupils and the role they play in the use of language in mathematics teaching?	Already language competencies have been identified as an issue. To what extent do teachers perceive it as an issue?
What are the teachers' views of their teaching competencies and how they influence their use of language in mathematics teaching?	Is teaching competency an issue in the use of language. How do teachers rate the role of their teaching competencies in the use of language in mathematics teaching?
How do teachers view the support they get in the use of language in mathematics teaching?	Teachers operate with minimum resources. They may also be aware of their needs. To what extent do they view the support they receive and need for them to competently use Chichewa or English in mathematics teaching?
To what extent do instructional materials impact on the teachers perceptions of use of language in mathematics teaching?	Teachers use different materials, which assist in the teaching and learning of mathematics. To what extent do the materials help the teachers' use of language in mathematics?

The issues arising from the data I collected through focus group discussions and clinical interviews influenced many of the issues included in the questionnaires. In addition, given the importance I placed on the data from the focus group discussions and clinical interviews, I also wanted to ensure that I was able to explore issues that featured in those settings in their on right. I wanted therefore to make sure that my questionnaires had the flexibility for the teachers indicate the extent to which they view the use of language in mathematics, and also the intention of looking for specific issues. (For the actual questions, see Appendix 3 and Appendix 4).

The questionnaires were extensive and wide-ranging, and as with interviews, certain themes were going to emerge because I had deliberately set out to explore them. My intention in the analysis was to identify patterns in ratings, underlying themes, threads and predispositions. I wanted to explore the degree to which teachers agreed or disagreed with some of the concerns that emerged from the focus group discussions and clinical interviews.

What was clear from the beginning – even during the focus group discussions and clinical interviews – was the difference in the teachers' concerns in the use of English and Chichewa in mathematics teaching. Although this did not surprise me, I was encouraged by the clarity of some distinctions. From the focus group discussions and clinical interviews, I felt that teachers had very strong views; that they felt fervently about what they were saying. They spoke with emotions when emphasising some of their feelings. They often used both physical and verbal means to stress and emphasise a point. But when the same issues were presented to the teachers in the same schools through questionnaires, the ratings indicated that they emphasised somehow different things with regards to language use in mathematics.

My data analysis involved finding the frequency of ratings of each item and separated those for Chichewa medium from those for English medium. Then the means and standard deviations of the ratings for each perception were computed using the Statistical Package for Social Sciences (SPSS) program. In order to make this process of analysing and interpreting data from the questionnaires transparent, I have given in Table 7.3 and Table 7.4 the detailed computed data.

Item by item analysis of the questionnaires was used to compute the frequency of ratings, the means of the ratings and the standard deviations of each item. This helped me to explore the patterns through the frequencies, means and standard deviations to reveal which perceptions where most frequently rated and by what rating. The standard deviation helped me discover the spread of ratings among the teachers for each item. Thus the three aspects of statistical analysis helped me to identify patterns of degree of agreement to the perceptions of the use of language in mathematics discourse. I was also able to compare the perceptions of use of Chichewa with those for use of English in mathematics discourse.

Table 7.3: Frequencies, mean and standard deviations of ratings of teachers' perceptions of Chichewa medium in mathematics teaching.

Perceptions		Frequency of ratings					Sample size	Mean ratings	Std dev
		1	2	3	4	5			
1	Pupils are motivated and attention is sustained throughout the lesson	3	4	3	15	15	40	3.88	1.24
2	A greater number of pupils are reached equally at the same time	4	4	7	11	13	40	3.68	1.33
3	Individual pupil learning needs are supported	6	5	5	17	7	40	3.35	1.33
4	The teachers' instructional effectiveness are increased	7	4	7	11	11	40	3.38	1.44
5	Teachers' misconceptions about certain mathematical concepts are reduced	3	8	6	12	11	40	3.50	1.30
6	Pupils' misconceptions about certain concepts are reduced	4	2	7	10	16	40	3.78	1.33
7	Pupils are helped to relate mathematics to their culture	6	5	4	13	11	40	3.43	1.43
8	Communication problems between the teacher and pupils is reduced	0	4	4	18	14	40	4.05	0.93
9	An effective way of evaluating pupils learning is provided	4	7	4	16	9	40	3.48	1.30
10	The content of the lesson by drawing examples from everyday life is enriched	3	1	4	14	14	36	3.97	1.18
11	Pupils are able to apply mathematics to solving everyday problems	4	4	4	11	17	40	3.83	1.38
12	Implementing the use of Chichewa in mathematics lesson is very costly	9	9	5	7	6	37	2.84	1.48
13	The degree of teacher-pupil interaction is reduced	5	8	10	12	4	39	3.05	1.21
14	Teachers will be out of job due to change of medium of instruction to Chichewa	19	6	6	3	5	39	2.21	1.45
15	For some subjects the use of Chichewa instruction is NOT conducive to effective learning	7	4	5	16	8	40	3.35	1.39
16	More time is consumed because pupils tend to dominate the classroom talk	11	11	7	8	2	39	2.46	1.25
17	The quality of education is lowered	3	6	6	10	14	40	3.63	1.33
18	Pupils do not take the lessons seriously	8	8	9	10	5	40	2.90	1.34
19	Pupils sometimes experience difficulties in understanding the message expressed in Chichewa because of cultural irrelevance of the content	4	11	6	10	9	40	3.23	1.35
20	Textbooks prepared in Chichewa provide distorted information about mathematics and in so doing confuse the learners	4	12	9	8	7	40	3.05	1.26

Note: The sample sizes were not the same for all the items because some subjects did not give the ratings for that particular item.
Key: 1 = Strongly disagree, 2 = Disagree, 3= Not sure, 4 = Agree, 5 = Strongly agree

Table 7.3: (Continues).

Perceptions	Frequency of ratings					Sample size	Mean ratings	Std dev
	1	2	3	4	5			
21 Mathematical vocabulary in Chichewa is usually not available for use during classroom instruction	9	0	7	10	12	38	3.42	1.54
22 Medium of instruction is imposed upon the teacher	5	4	12	8	8	37	3.27	1.30
23 There are no teaching/learning aids prepared in Chichewa	12	3	9	9	6	39	2.85	1.48
24 There are fewer textbooks for mathematics written in Chichewa	11	4	10	2	10	37	2.89	1.58
25 Most teachers do not speak more than one local languages	8	7	8	7	7	37	2.95	1.43
26 Most teachers do not speak Chichewa	6	8	6	10	6	36	3.06	1.37
27 Most pupils do not speak Chichewa	13	6	9	6	5	39	2.60	1.43
28 Teaching several subjects makes it difficult to prepare for use of Chichewa as medium of instruction	10	3	11	7	8	39	3.00	1.47
29 It is difficult to understand mathematical concepts because the Pupil's Book is written in Chichewa while Teacher's Guide is in English	4	2	12	7	13	38	3.61	1.31
30 The long syllabuses and immediate time make it difficult to teach mathematics in Chichewa	4	3	13	6	13	39	3.54	1.32
31 Because of inadequate knowledge of the subject area, it is difficult to identify the appropriate vocabulary for the lessons	3	5	12	8	10	38	3.45	1.25
32 There is no training for teachers to use Chichewa as medium of instruction	9	3	9	6	11	38	3.18	1.54
33 There is lack of professional assistance from the supervisors when Chichewa is used	7	2	6	4	19	39	3.64	1.58
34 Using Chichewa distorts the issue of mathematical concepts	7	6	9	1	16	39	3.33	1.58
35 There is no mathematical vocabulary that I know which could best be explained in Chichewa	8	3	8	5	13	38	3.30	1.56
36 There are no reference books for mathematics that could help teachers use Chichewa in mathematics teaching	11	2	9	6	11	39	3.10	1.59

Note: The sample sizes were not the same for all the items because some subjects did not give the ratings for that particular item.
Key: 1 = Strongly disagree, 2 = Disagree, 3= Not sure, 4 = Agree, 5 = Strongly agree

Table 7.4: Frequencies, mean and standard deviations of ratings of teachers' perceptions of English medium in mathematics teaching..

Perceptions	Frequency of ratings					Sample size	Mean ratings	Std dev
	1	2	3	4	5			
1 Pupils are motivated and attention is sustained throughout the lesson	3	14	2	13	7	40	3.18	1.30
2 A greater number of pupils are reached equally at the same time	7	16	6	6	3	39	2.49	1.21
3 Individual pupil learning needs are supported	7	10	6	10	7	40	3.00	1.40
4 The teachers' instructional effectiveness are increased	3	4	8	15	11	40	3.68	1.21
5 Teachers' misconceptions about certain mathematical concepts are reduced	7	6	5	10	12	40	3.35	1.49
6 Pupils' misconceptions about certain concepts are reduced	5	8	9	8	10	40	3.25	1.37
7 Pupils are helped to relate mathematics to their culture	12	10	8	7	3	40	2.48	1.30
8 Communication problems between the teacher and pupils is reduced	6	9	3	17	5	40	3.15	1.33
9 An effective way of evaluating pupils learning is provided	2	9	11	16	2	40	3.18	1.01
10 The content of the lesson by drawing example from everyday life is enriched	4	10	7	17	2	40	3.08	1.14
11 Pupils are able to apply mathematics to solving everyday problems	8	5	5	18	4	40	3.13	1.34
12 Implementing the use of English in mathematics lesson is very costly	13	11	8	5	2	39	2.28	1.21
13 The degree of teacher-pupil interaction is reduced	8	11	4	14	3	40	2.83	1.32
14 Teachers will be out of job due to change of medium of instruction to English	19	14	3	1	2	39	1.80	1.06
15 For some subjects the use of English instruction is NOT conducive to effective learning	7	8	8	13	4	40	2.98	1.29
16 More time is consumed because pupils tend to dominate the classroom talk	11	10	9	7	3	40	2.53	1.28
17 The quality of education is lowered	16	13	1	6	4	40	2.22	1.39
18 Pupils do not take the lessons seriously	12	12	3	10	3	40	2.50	1.36
19 Pupils sometimes experience difficulties in understanding the message expressed in English because of cultural irrelevance of the content	4	4	4	18	9	40	3.65	1.25
20 Textbooks prepared in English provide distorted information about mathematics and in so doing confuse the learners	9	10	7	11	3	40	3.40	1.34

Note: The sample sizes were not the same for all the items because some subjects did not give the ratings for that particular item.
Key: 1 = Strongly disagree, 2 = Disagree, 3= Not sure, 4 = Agree, 5 = Strongly agree

Table 7.4 (Continues).

Perceptions	Frequency of ratings					Sample size	Mean ratings	Std dev
	1	2	3	4	5			
21 Mathematical vocabulary in English is usually not available for use during classroom instruction	8	8	3	12	8	39	3.10	1.48
22 Medium of instruction is imposed upon the teacher	5	6	8	9	9	37	3.30	1.37
23 There are no teaching/learning aids prepared in English	8	7	9	7	9	40	3.05	1.44
24 There are fewer textbooks for mathematics written in English	9	3	9	3	16	40	3.35	1.61
25 Most teachers do not speak more than one local languages	15	3	17	2	3	40	2.38	1.25
26 Most teachers do not speak English	9	2	15	6	8	40	3.05	1.39
27 Most pupils do not speak English	3	7	5	6	19	40	3.78	1.41
28 Teaching several subjects makes it difficult to prepare for use of English as medium of instruction	6	7	9	5	14	40	3.30	1.47
29 It is difficult to understand mathematical concepts because the Pupil's Book is written in Chichewa while Teacher's Guide is in English	4	3	4	9	20	40	3.95	1.36
30 The long syllabuses and immediate time make it difficult to teach mathematics in English	6	6	7	9	12	40	3.38	1.44
31 Because of inadequate knowledge of the subject area, it is difficult to identify the appropriate vocabulary for the lessons	3	3	19	5	10	40	3.40	1.17
32 There is no training for teachers to use English as medium of instruction	11	3	10	2	13	40	3.13	1.64
33 There is lack of professional assistance from the supervisors when English is used	4	3	6	11	16	40	3.80	1.32
34 Using English distorts the issue of mathematical concepts	12	2	16	3	7	40	2.78	1.42
35 There is no mathematical vocabulary that I know which could best be explained in English	15	2	11	5	7	40	2.68	1.53
36 There are no reference books for mathematics that could help teachers use English in mathematics teaching	8	7	11	2	12	40	3.08	1.51

Note: The sample sizes were not the same for all the items because some subjects did not give the ratings for that particular item.
Key: 1 = Strongly disagree, 2 = Disagree, 3= Not sure, 4 = Agree, 5 = Strongly agree

7.4.2 Developing categories

In developing the categories of the issues that were rated in the questionnaires, I approximated the ratings to the nearest whole number. For example a rating of 3.68 was approximated to be 4 whereas the mean rating of 3.08 was approximated to be 3. In this way I was able to identify the high (4 and above) and low (2 and below) rated items because by rating them high or low, teachers attached some degree of meaning to them. The ratings for Chichewa medium were separated from those for English medium (see Table 7.5 for Chichewa and Table 7.6 for English). Then I matched them with the categories that were developed in the previous chapters to find out if they increased my understanding of the themes developed so far as shown in Table 7.7.

Table 7.5: The highly and lowly rated teachers' perceptions of mathematics teaching in Chichewa.

Perceptions	Frequency of ratings					Sample size	Mean ratings	Std dev
	1	2	3	4	5			
1 Pupils are motivated and attention is sustained throughout the lesson	3	4	3	15	15	40	3.88	1.24
2 A greater number of pupils are reached equally at the same time	4	4	7	11	13	40	3.68	1.33
6 Pupils' misconceptions about certain concepts are reduced	4	2	7	10	16	40	3.78	1.33
8 Communication problems between the teacher and pupils is reduced	0	4	4	18	14	40	4.05	0.93
10 The content of the lesson by drawing example from everyday life is enriched	3	1	4	14	14	36	3.97	1.18
11 Pupils are able to apply mathematics to solving everyday problems	4	4	4	11	17	40	3.83	1.38
7 The quality of education is lowered	3	6	6	10	14	40	3.63	1.33
14 Teachers will be out of job due to change of medium of instruction to Chichewa	19	6	6	3	5	39	2.21	1.45
16 More time is consumed because pupils tend to dominate the classroom talk	11	11	7	8	2	39	2.46	1.25
17 There is lack of professional assistance from the supervisors when Chichewa is used	7	2	6	4	19	39	3.64	1.58

Note: The sample sizes were not the same for all the items because some subjects did not give the ratings for that particular item.
Key: 1 = Strongly disagree, 2 = Disagree, 3= Not sure, 4 = Agree, 5 = Strongly agree

Table 7.6: The highly and lowly rated teachers' perceptions of mathematics teaching in English.

Perceptions	Frequency of ratings					Sample size	Mean ratings	Std dev
	1	2	3	4	5			
18 Most pupils do not speak English	3	7	5	6	19	40	3.78	1.41
19 It is difficult to understand mathematical concepts because Pupil's Book is written in Chichewa while Teacher's Guide is in English	4	3	4	9	20	40	3.95	1.36
4 The teachers instructional effectiveness are increased	3	4	8	15	11	40	3.68	1.21
19 Pupils sometimes experience difficulties in understanding the message expressed in English because of cultural irrelevance of the content	4	4	4	18	9	40	3.65	1.25
2 A greater number of pupils are reached equally at the same time	7	16	6	6	3	39	2.49	1.21
7 Pupils are helped to relate mathematics to their culture	12	10	8	7	3	40	2.48	1.30
12 Implementing the use of English in mathematics lesson is very costly	13	11	8	5	2	39	2.28	1.21
14 Teachers will be out of job due to change of medium of instruction to English	19	14	3	1	2	39	1.80	1.06
17 The quality of education is lowered	16	13	1	6	4	40	2.22	1.39
18 Pupils do not take seriously the lessons	12	12	3	10	3	40	2.50	1.36
20 Most teachers do not speak more than one local languages	15	3	17	2	3	40	2.38	1.25
21 There is lack of professional assistance from the supervisors when English is used	4	3	6	11	16	40	3.80	1.32

Note: The sample sizes were not the same for all the items because some subjects did not give the ratings for that particular item.
Key: 1 = Strongly disagree, 2 = Disagree, 3= Not sure, 4 = Agree, 5 = Strongly agree

Table 7.7: Categories of issues from questionnaires.

1	**The nature of mathematics**	
	Mathematical relevance and applicability	When Chichewa/English is used: ▪ Pupils are helped to relate mathematics to their culture. ▪ Drawing example from everyday life enriches the content of the lesson.
	Mathematical vocabulary	▪ Mathematical vocabulary in Chichewa/English is usually not available for use during classroom instruction. ▪ There is no mathematical vocabulary that I know which could best be explained in Chichewa/English
	Distorting mathematical issues	▪ Using Chichewa/English distorts the issue of mathematical concepts.
2	**The mystifying language policy in education**	When Chichewa/English is used:
	Implementing language policy in education	▪ Implementing the use of Chichewa/English in mathematics lesson is very costly. ▪ When Chichewa/English is used, teachers will be out of job due to change of medium of instruction.
	Language use across the curriculum	▪ For some subjects the use of Chichewa/English instruction is NOT conducive to effective learning. ▪ Medium of instruction in Chichewa/English is imposed upon the teacher.
3	**The dynamic classroom discourse**	
	Mathematical access and equity in the classroom	When Chichewa/English is used: ▪ Pupils are motivated and attention is sustained throughout the lesson. ▪ A greater number of pupils are reached equally at the same time. ▪ Individual pupils learning needs are supported. ▪ Communication problems between the teacher and pupils are reduced. ▪ An effective way of evaluating pupils learning is provided. ▪ The degree of teacher-pupils' interaction is reduced.
	Improving educational quality	▪ The quality of education lowered.

Table 7.7 (Continues).

4 The divergent source of language for use in mathematics teaching	
Mathematical understanding.	When Chichewa/English is used: ▪ Pupils sometimes experience difficulties in understanding the message expressed in Chichewa/English because of cultural irrelevance of the content. ▪ Most teachers do not speak more than one local language. ▪ Most teachers do not speak Chichewa/English . ▪ Most pupils do not speak Chichewa/English.
Instructional quality.	▪ Misconceptions about certain concepts, which would be difficult for the teacher to explain, are reduced. ▪ Misconceptions about certain concepts, which would be difficult for the pupils to understand, are reduced. ▪ The teacher's instructional effectiveness is increased. ▪ Pupils do not take seriously the lessons . ▪ More time is consumed because pupils tend to dominate the classroom talk.
Teacher training.	▪ There is no money allocated for training teachers to use Chichewa/English as medium of instruction.
Teacher supervision.	▪ There is lack of professional assistance from the supervisors when Chichewa/English is used.
Language in the textbooks.	▪ Textbooks prepared in Chichewa/English provide distorted information about mathematics and in so doing confuse the learners. ▪ There are no reference books for mathematics that could help teachers use Chichewa/English in mathematics teaching. ▪ There is less number of textbooks for mathematics written in Chichewa/English.
Language in the teaching and learning materials.	▪ There are no teaching/learning aids prepared in Chichewa/English.

7.5 Analysing data from the mathematical vocabulary tests

In Sections 7.1, 7.2 and 7.3, I presented the analysis of my data on focus group discussions, clinical interviews and questionnaires with teachers. The analysis of the data was aimed at giving me a feel for how teachers felt when they use Chichewa or English in mathematics teaching. The teachers' perceptions would make them bring into mathematics classes different perspectives and a new set of priorities. For example, the fact that teachers found it difficult to use Chichewa because of inadequate mathematical vocabulary equivalents between English and Chichewa would make them use English more than Chichewa in mathematics lessons which is not in line with the language policy in education in Malawi. Some teachers observed that they would rather use English than Chichewa in mathematics teaching because they could easily find most of mathematical vocabulary in English. Considering that teachers' knowledge of mathematical vocabulary equivalents is essential for them to discuss mathematical concepts in Chichewa, I set out to explore the teacher's knowledge of mathematical vocabulary equivalents in Chichewa and English. The methods of data collection and analysis were described in Section 6.6.

This section presents the analysis of data collected on teacher knowledge of mathematics vocabulary equivalents between Chichewa and English with the aim of answering the following research question: *Does teachers' knowledge of mathematical vocabulary in Chichewa differ from their knowledge of mathematical vocabulary in English? If so, how does it differ?* It was hoped that the findings from this analysis would help me extend my exploratory model to incorporate the potential of mathematics teaching through the use of mathematical language.

The data obtained with regard to the range of mathematical equivalents in Chichewa is presented and analysed to determine the extent to which the equivalents are used in mathematics lessons. This data was collected through focus group discussions on forty mathematics vocabulary equivalents (see Appendices 1 and 2) and observations of mathematics lessons, which focused on teacher use of mathematical vocabulary.

The qualitative data are analysed and presented separately from the quantitative data. Qualitative data analysis focused on determining the range of the mathematical vocabulary equivalents between Chichewa and English that teachers know. Patterns were established in terms of how many different equivalents were provided and how varied were the meanings in those equivalents. Examples of specific equivalents have been used to substantiate the concerns derived from the findings.

The second part of the findings was on data collected through test items involving 40 mathematical items, first in English asking for Chichewa equivalents and second in Chichewa asking for English equivalents. Forty teachers completed the test individually.

Apart from myself two other persons marked the mathematical vocabulary equivalent tests to increase the reliability of the data. The percentage agreement between the two markers for the marking of Chichewa to English mathematical equivalence was 82% and that of English to Chichewa was 95.45%. According to Fanselow (1987:29) any percentage agreement of 80% and above is regarded as acceptable inter-coder reliability.

Statistical procedures of t-test were employed to determine the difference in teacher performance on the mathematics vocabulary equivalent tests. Based on the data collected and analysed, a conceptual structure of teacher knowledge mathematical vocabulary equivalents in Chichewa and English emerged.

The English/Chichewa mathematics vocabulary equivalents that teachers provided through the tests were rich and extensive in helping me understand the linguistic competence of teachers in using language as a resource in mathematics teaching.

My intention in the analysis was to try to identify patterns in the responses, underlying themes and tendencies in teacher use of mathematical vocabulary. From the surface features of the tests, I felt that teachers had enough equivalents for mathematics vocabularies to enable them discuss mathematics in both English and Chichewa because they wrote the tests without consulting each other or anyone or any materials. The mathematical vocabularies represented what they understood to be the equivalents between Chichewa and English.

7.5.1 Coding the responses in the tests

In deconstructing the teacher responses in the tests, I started noticing some striking features to which I gave labels that represented my understanding. Where a teacher did not provide any mathematical vocabulary equivalents, I labelled **lack of mathematical vocabulary equivalents (LMVE).** Those terms that represented misconceptions were labelled **as lack of knowledge of the mathematical concepts (LKMC).** There are terms, which implied that the teacher had a partial knowledge of the mathematical concepts being described but not quite were labelled **mathematical vocabulary equivalent misconception (MVEM)**. Those terms that teachers agreed were the correct description of the mathematical concept were labelled **(CMVE).** Those terms, which had one correct mathematical vocabulary equivalent, were labelled **mono-mathematical vocabulary equivalent (M-MVE)** to contrast with those terms, which had many mathematical vocabulary equivalents, which I labelled **multiple mathematical vocabulary multi equivalents (MMVE)**.

Although the labels used in deconstructing the data from the tests were influenced by the themes already developed in the previous sections of this Chapter, they emerged from the responses in the tests themselves. It was hoped that these codes represented the issues that were derived from the teachers' responses and that the coding system would lead to developing themes to explain further how teachers use mathematical language in mathematics teaching. It was not easy to come up with the appropriate phrases to describe the teachers' responses. However, the focus of my study guided my choice of the words to describe what I understand of the teachers' responses.

Two major categories of concerns emerged from the data analysis: **Inadequate knowledge of mathematics** and **mathematical language mismatch**. Lack of knowledge of mathematical concepts and mathematical misconceptions were classified as *inadequate knowledge of mathematics* whereas *mathematical language mismatch* included lack of mathematical vocabulary equivalent, correct mono-mathematical vocabulary and multiple mathematical vocabulary equivalents.

7.6 Analysing teacher use of mathematical vocabulary during a lesson

Much of the data analysis here draws on the work in Sections 7.1, 7.2, 7.3, and 7.4. However, I set out to explore the teachers' behaviour towards mathematical vocabulary in Chichewa and in English inside and outside the classroom as they reflect on their equivalents between Chichewa and English. I had sensed that teachers had started reacting to the Chichewa terms used in describing mathematics concepts as either difficult or not appropriate. Additionally, teachers were showing a tendency to argue for use of "appropriate" mathematical vocabulary. By this I mean that teachers' use of Chichewa in mathematics teaching is not merely a replacement of refined English vocabulary by crude Chichewa terms that may distort the mathematical issues. The replacement of English terms by the Chichewa terms should be dictated by consideration of the nature of mathematics rather than the need for ordinary language for communication. Teachers' tendency to view mathematical vocabulary as inadequate in describing mathematical concepts permeated many of the themes developed so far. Therefore, I wanted to explore teachers' concerns about use of mathematical vocabulary.

When analysing the data, I began by deconstructing data from the tests then move on to data from lesson transcripts. In analysing data from the tests, I examined the qualitative and quantitative issues that the data provided. The issues were then classified into categories that were then used to develop the themes. The themes were used to extend the model that I develop in Chapter 8.

The qualitative data analysis of the mathematics vocabulary equivalents given by teachers involved not only the frequency of the correct equivalents but also examining the conception and misconceptions which the range of mathematics vocabulary equivalents provided in Chichewa for each mathematics vocabulary in English.

The exploration of teacher use of mathematical vocabulary took me to look at the lesson transcripts. It is my conviction that examining the teachers' knowledge of mathematical vocabulary equivalents is not in itself enough as this may simply give me an understanding of the potentiality of teachers in the use of mathematical language in mathematics teaching. Instead, examining the actual use of the mathematical language offers another important dimension of understanding further the source of concerns in the teachers' use of language in mathematics teaching. However, as I pointed out earlier on, the data on teachers use of mathematical vocabulary is limiting because it was collected on the lessons prepared on the same content and taught by several teachers using Chichewa or English. Consequently, the vocabulary use cannot be generalised to other mathematical topics or other teachers. Nevertheless, the findings highlight important issues regarding the way teachers use mathematical language in mathematics lessons. In my presentation of the findings (see Chapter 8), I have used the excerpts from the actual transcripts in order to be more transparent with data analysis.

7.6.1 Identifying issues from the transcripts and developing categories

In deconstructing the data, I read several times the transcripts, looking for issues about teacher use of mathematical language. I underlined the words, phrases and sentences that to me meant something about the teachers' use of mathematics vocabularies. The codes emerged from the data itself as I attempted to capture what actually happened in the classroom with regard to the use of mathematical vocabularies.

Five categories of issues were identified. In the transcripts, teachers tended to substitute the mathematical terms used in the textbook with theirs. I labelled this **Teacher Substitute Mathematical Vocabulary (TSMV).** Sometimes teachers used an English term with Chichewa spelling and I labelled this **Teacher Use of English terms with Chichewa Spellings (TUECS).** These included terms such as triangle (Thirayango), quadrilateral (kwadililatero) and circle (seko). Sometimes teachers used or avoided using a cumbersome description of a mathematical concept in Chichewa and I labelled this **Cumbersome Mathematical Vocabulary in Chichewa (CMVC).** There was a tendency for teachers to explain the issues of the mathematical terms to pupils. I labelled this tendency **Teaching Mathematics Vocabulary (TMV).**

7.7 Analysing language usage in mathematics classroom

This section presents the analysis of data collected on teacher use of Chichewa and English in mathematics lessons through classroom observation and video tape recording. The methods used to collect the data were described in Section 6.5. The data analysis was guided by the following questions. *Does the teacher use of Chichewa differ from the use of English in mathematics lessons? If so, how does it differ?* The main objective of the data analysis was to explore the patterns and relationships of the teacher language use between Chichewa medium and English medium mathematics lessons so as to further extend my model of teachers' use of language in mathematics teaching developed in Chapter 9.

In my analysis, language usage meant the way language is used during classroom communication. Before the analysis began, I numbered each utterance and then identified each utterance by its source and target. Then propositional statements were prepared based on the issues contained in the words, phrases and sentences. These statements represented my framework derived from the data guided by my theoretical framework described in Chapter 2 and developed further in subsequent chapters.

The analysis of the data from the lesson transcripts involved reading the transcripts more than once, each time underlining the words, phrases and sentences which suggested how teachers used the language during the lessons. This enabled me to identify who used the language that way and for whom. For the sake of transparency, I present excerpts of how transcripts were coded in Chapter 8.

1	Teachers repeated in Chichewa what was said in English.	*Language code switching*
2	Pupils answered more questions in Chichewa than in English.	*Limited range of language use for pupils*
3	Teacher sentence construction was complex for the level of the pupils.	*Inappropriate teacher language use*
4	Pupil talks were characterized by short answers in both Chichewa and English whereas teachers made long utterances.	*Limited range of language for use*
5	Pupils were performing tasks more easily in Chichewa than in English medium.	*Limited range of language for use*
6	Mathematical symbols, words and sentences were read in English.	*Reading mostly in English*
7	Reading mathematical text was mostly by teachers.	*Reading mathematical text limited to teachers*
8	Teachers did not understand some of the Chichewa terms used in the textbooks for mathematics.	*Trilingual code switching*
9	Language in the teaching and learning materials was in Chichewa and English.	*Limited range of language use*
10	Teachers used Chichewa, English and mathematical languages during the classroom discourse.	*Language code switching in instructional materials*

No prior categories were prepared for data analysis. Instead, they emerged as I deconstructed the data. Issues derived from the data were written on a two-column page with all the issues on one side and the other side was used for writing the categories. The categories of issues that emerged from the data were grouped into three categories. These are limited language use, reading in mathematics and tri-lingual code switching.

The choices of this terminology were based on my interpretation of the categories of the discourse analysis in terms of linguistic behaviour in the classroom. My ideological framework that language use in the classroom is a matter of behaviour rather than discrete responses such as grammatical notation also guided my choice of the terminology used. I was inclined to use the terminology that expressed my conviction that classroom language use is dynamic and situational. It is here that teachers' language usage in mathematics teaching was evident. They used language to structure the language behaviour in the classroom using negotiating moves of structuring, soliciting, responding and reacting manifested in strategised language of asking, answering, commanding, acting, which focused on either the substance or the procedures.

The choice of the English words to describe my themes has not been easy as English is not my first language. Nevertheless, these labels were used to guide me in exploring the sources and use of language during the mathematics lessons. However, these themes are not exhaustive but enough to illuminate the dilemmas and tensions in teachers' use of Chichewa and English in mathematics. The excerpts from the sixteen lesson transcripts are used to support my understanding of the dilemmas and tensions from the data.

7.8 Analysing the mathematics classroom discourse

This section examined patterns of classroom talk from the data recorded and transcribed from Chichewa and English medium lessons. The purpose of the data analysis is to compare how teachers use language between Chichewa medium and English medium mathematics lessons. Specifically, the study is intended to answer the following research question: *Is there any difference in the patterns of language use between Chichewa medium and English medium mathematics lessons? If so how?* A discourse analysis was used to analyse the eight lesson transcripts in Chichewa and eight others in English but on the same lesson topic of addition of money. The codes used in analysing the transcripts were discussed and presented in Table 6.8. I present here the actual process of coding the utterances with examples.

7.8.1 Process of coding the transcripts

Usually when a teacher spoke he/she would make a lengthy non-interrupted speech. When coding such lengthy utterances, complete units were identified and coded accordingly. The names of the categories were abbreviated as shown in Figure 6.2

For example:

T: *I have again this paper. What is it? Yes Doreen?*

This was broken into the following:

T: *I have again this paper*
T: *What is it?*
T: *Yes Doreen?*

Then each part was coded accordingly as follows:

T/C	*I have again this paper*	*STR/STA/CON*
T/C	*What is it?*	*SOL/ASK/CON*
T/P	*Yes Doreen?*	*SOL/ASK/PRO*

Similarly, from Chichewa medium lesson transcripts, it was common to get such long utterances as this one:

> *T:* *Good. Timayamba kulemba K kenaka t. Kodi ndi matambala angati amene amapanga K1? Iwe? Tikhalepo timatambala tingati kuti iweyo ukhale ndi K1?*

This was broken into the following units:

T	*Good.*
T	*Timayamba kulemba K kenaka t.*
T	*Kodi ndi matambala angati amene amapanga K1?*
T	*Iwe?*
T	*Tikhalepo timatambala tingati kuti iweyo ukhale ndi K1?*

This was then coded as follows:

T/P	*Good.*	REA/PRA/PRO
T/C	*Timayamba kulemba K kenaka t.*	REA/REP/CON
T/C	*Kodi ndi matambala angati amene amapanga K10?*	SOL/ASK/CON
T/P	*Iwe?*	SOL/COM//PRO
T/P	*Tikhalepo timatambala tingati kuti iweyo ukhale ndi K1?*	SOL/ASK/CON

A fully coded text from the Chichewa medium lesson looked like this:

T/C	Tiyeni tiphatikize ndalama izi	STR/STA/CON
T/C	Kuyambira kuti kodi?	SOL/ASK/CON
C/T	Kumatambala	RES/ANS/CON
T/C	Kumatambala	REA/REP/CON
T/C	Eti?	REA/APP/PRO
T/C	Ya	REA/APP/PRO
T/C	5 kuphatikiza 3?	SOL/ASK/CON
C/T	7	RES/ANS/CON
T/C	5 kuphatikiza 3?	SOL/ASK/CON
C/T	8	RES/ANS/CON
T/C	7 kuphatikiza 2	SOL/ASK/CON
T/P	Yes Ireen?	SOL/ASK/PRO
P/T	9	RES/ANS/CON
T/C	Zoona eti?	REA/APP/PRO
T/C	Muwombereni mmanja	REA/PRA/PRO
T/C	Tiika 8 apa, tisunga 1	REA/EXP/CON
T/C	Tsopano tikupita kumachiyani?	SOL/ASK/CON
T/C	Kumakwacha	RES/ANS/CON
T/C	K3 kuphatikiza K1 ndalama zingati?	SOL/ASK/CON

C/T	K4	RES/ANS/CON
T/C	Pa K4 tiphatikizepo K2 iyi?	SOL/ASK/CON
T/P	Yes Rhoda?	SOL/ASK/PRO
P/T	K6	RES/ANS/CON
T/C	Et zoona eti?	REA/APP/PRO
T/C	Tamuwombereni mmanja	REA/PRA/PRO
T/C	Ndalama zomwe anaononga ana amenewo ndi K6	REA/REP/CON
T/C	Ndalama zingati?	SOL/ASK/CON
C/T	K6 98t	RES/ANS/CON
T/P	Iwe anaononga ndalama zingati?	SOL/ASK/CON
T/P	Stand up!	SOL/COM/PRO
P/T	K6 98t	RES/ANS/CON
T/P	Yes Madalitso?	SOL/ASK/PRO
T/P	Anaononga ndalama zingati?	RES/ANS/CON
T/P	K6 98t	RES/ANS/CON
T/C	Anaononga ndalama zokwana K6 98t.	REA/REP/CON
T/C	Anthu amenewa anaononga ndalama zokwana ..	REA/EXP/CON
T/C	Tikumvana eti?	SOL/ASK/PRO
T/C	K6 98t ndi imene anaononga ana amenewa kuti agwiritse ntchito kuti antilope, batile komanso machesi.	REA/EXP/CON
T/C	Tikumvana pamenepa?	SOL/ASK/PRO

A fully coded text from the English medium lesson looked like this:

T/C	O.K.Today we are looking at addition of money	STR/STA/CON
T/C	Addition of what?	SOL/ASK/CON
C/T	Money	RES/ANS/CON
T/C	Do you know what money is?	SOL/ASK/CON
C/T	Eee!	REA/APP/PRO
T/C	What do you use money for?	SOL/ASK/CON
P/T	To buy	RES/ANS/CON
T/P	You buy what?	SOL/ASK/CON
P/T	T-shirt	RES/ANS/CON
T/C	What else?	SOL/ASK/CON
T/P	You	SOL/ASK/PRO
P/T	Shoes	RES/ANS/CON
T/P	You	SOL/ASK/PRO
T/P	What else ?	SOL/ASK/CON
P/T	Bicycle	RES/ANS/CON
T/C	Bicycle	REA/REP/CON
T/C	Yes if you have got a lot of money	REA/JUT/CON
T/C	What else?	SOL/ASK/CON
T/P	You	SOL/ASK/PRO
P/T	Car	RES/ANS/CON
T/C	What else?	SOL/ASK/CON
T/P	You	SOL/ASK/PRO
P/T	Shirt	RES/ANS/CON
T/C	O.K.	REA/PRA/PRO

T/C	Thank you	REA/PRA/PRO
T/C	We use money to buy things and our money in Malawi is called?	STR/STA/CON
C/T	Kwacha and tambala	RES/ANS/CON

Two other researchers were involved in coding the transcripts. The two people were identified from teachers who had had formal training in discourse analysis during their pre-service courses. I discussed with them my coding system, gave them a sample transcript to code and discussed their coded transcripts to 'standardise' the system of coding the transcripts.

Coding every unit of utterance was not easy because there were some overlaps among some categories. For instance, a structuring move could be a soliciting move at the same time in the sense that a teacher would start an activity by asking a question. For example, "before we start buying and selling, what is this? Adam?" Some structuring moves were a reacting move. However, each unit of utterance was coded as belonging to one category only. Although this was convenient for the analysis purpose, it might have caused the loss of subtle differences in meanings among the utterances.

After coding the transcripts, characteristics of some categories were analysed, I worked out the percent frequencies of each category and compared them between Chichewa medium and English medium lessons. My analysis of classroom discourse was based on a system of categories adapted from the one Bellack, *et al.* (1966) derived to describe the verbal performance of teachers and pupils and developed further by Fanselow (1987). The adaptation process was discussed in Section 6.8.2. It was necessary to adapt the categories rather than use them wholesale because I was not interested in developing new categories of language behaviours but use those already developed to compare the teacher language behavior between Chichewa medium and English medium classes. I wanted to focus on categories of concerns within classroom discourse. Although the categories of issues used in analysing the data were described in Section 6.7.2, a repeat of the description is necessary here because the categories guided my analysis of the data I am about to present. These categories helped me to explore the issues and develop the themes through the questions (See Table 7.8).

Table 7.8: Focus of the issues explored during discourse analysis.

Exploring questions	Coding the transcripts
1. How does the teacher use language to structure the classroom activities?	• Identification of words, phrases and sentences that announced the end of an activity – *framing moves.* • Identification of words, phrases and sentences that announced the beginning of an activity – *focusing moves.*
2. Who was speaking and to whom during the lesson?	• Identifying each utterance by its source and target.
3. What was the purpose of the utterance?	• Identifying structuring, soliciting, responding and reacting move types.
4. Why was the utterance made?	• Identifying the issues of the utterances which included substantive meanings.
5. What was the substance in the utterance?	• Identifying the subject matter in the utterance which were the subject content and the procedural move.

7.8.2 Issues and categories of issues

Six categories of issues were explored which included teaching cycle, sources/target of utterances, frequencies of move types, frequency of source/target of move type, frequency of substantive meanings.

Teaching cycles

Two trends were identified as framing moves and focusing moves. The *Framing moves* are the announcement of the end of some activity (Fanselow, 1987). In Chichewa medium lessons, common words used were *Chabwino, Eee, Eya* and *Zikomo*. English words were also used such as *O.K.*, and *Thank you*. In English medium, the framing moves were characterised by the following words: *O.K, Thank you, Very good, Yes.* The analysis of the framing moves suggested that there was no marked difference in the way teachers framed the discourse between Chichewa and English medium lessons. They used equivalent clues to mark the end of an activity.

Focusing moves were also identified in the transcripts. The *Focusing moves* announce the beginning of the next activity (Fanselow, 1987). In Chichewa medium lessons, focusing moves were recognised by such words as *Lero, Takhala, Ndiye, Choncho, Tiyeni, Ndi nthawi ya...,* *Tsono, Titsegule mabuku athu, Tili pa masamu, Mukuona apa, Wina adzalembe..* In English medium lessons, the focusing moves were recognised by such words as *Today ....,* *Take your books...., Now I want to..., Let us add...., You come here...., Yesterday we did...,* *We have been* ... It appears that in both Chichewa and English medium lesson teachers used the focusing moves that were based on time, action, sequence and intent (Table 7.9).

Table 7.9: Types of focusing moves used in Chichewa and English mediums.

Focus move type	**Chichewa medium**	**English medium**
Time	*Lero*... *Ndi nthawi*... *Tili pa* ...	Today, ... Now, ... Yesterday, ...
Action	*Mukuona* ... *Wina adzalembe* ... *Tsegulani*... *Tiyeni* ... *Tipereke chitsanzo,*	Take your ... Look here, Come here, Look at this...
Sequence of activities	*Takhala tiku* ... *Ndiye(no),* ... *Choncho,* ... *Tsono,* ...	We have been ... First thing is ...,
Intent	*Chitsanzo,* *Ndifuna kuti*...	Let us... I want you to

There was very little difference in the way teachers made focusing moves. They used equivalent terms to signal the beginning of the next activity.

Sources/target of utterances

The sources/target of utterances included the teacher to pupil, the pupil to teacher, the teacher to class, the class to teacher, the pupils to class, the class to pupils and the pupil to pupil. Generally, there were marked differences in the roles of language use between teachers and pupils in all the classes observed within the same medium of instruction (Figure 7.2). In the Chichewa medium mathematics lessons, the teacher to class talk dominated the language verbal interaction (61%) while about one third of the talk was either teacher to individual pupils or individual pupils to teachers.

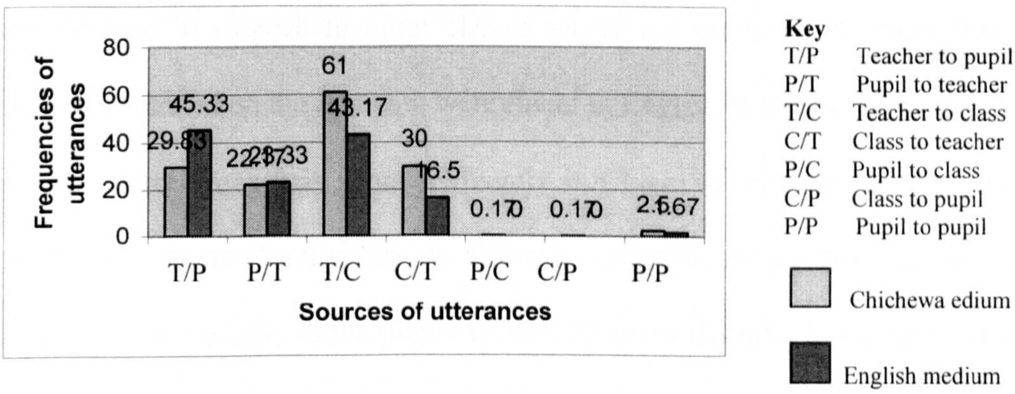


Figure 7.2: Average frequencies of sources of utterances in Chichewa and English medium lessons.

Teachers talked to pupils more frequently in English medium than in Chichewa medium mathematics lessons (Figure 7.2). Unlike in Chichewa medium lessons, in English medium lessons teachers kept on structuring the lesson because pupils could not understand at once what the teacher asked them to do. This resulted in teachers repeating or paraphrasing or indeed changing altogether the teaching cycle in order to save the lesson from collapsing.

There was not much difference in frequency of pupil talking to teachers between English medium and Chichewa medium mathematics lessons (Figure 7.2). It appears that changing the medium of instruction in mathematics teaching would not improve the amount of the pupil talk. Teachers remained dominant speakers in mathematics teaching even if the language of instruction was changed.

Teachers talked to class more frequently in Chichewa than in English (see Figure 7.2). Because many pupils were fluent in Chichewa, it was easy for them to answer in a chorus. This was not the case in English medium classes where not many pupils were fluent in English. Teachers depended on the few who were fluent in English to answer some questions.

The class talked to teachers more frequently in Chichewa medium than in English medium mathematics lessons (Figure 7.2). As I already argued in the preceding paragraph of this section, because the majority of the pupils spoke Chichewa fluently, it was easy for them to answer to the teacher in chorus rather than as individuals.

Pupils talking to class, class talking to pupils and pupils talking to pupils were almost non-existent in both Chichewa and English medium mathematics classes (Figure 7.2). It appears that discussing mathematics among the pupils was not encouraged in either class. A change of the language of instruction did not change the opportunity for pupils to discuss mathematics among themselves.

These findings are related to concerns in teacher use of language for accessing mathematics and also for achieving equity in mathematics. The findings that when Chichewa is used, pupils answered in chorus rather than as individual pupils may indicate that many pupils understood the question and were eager to give an answer. But because knowing that they were too many pupils, who wanted to answer the questions, pupils resorted to shouting the answer together in a chorus.

Frequencies of move types

The move types included structuring, soliciting, responding and reacting. The findings show that there was more of each move type in Chichewa medium than in English medium mathematics lessons (Figure 7.3).

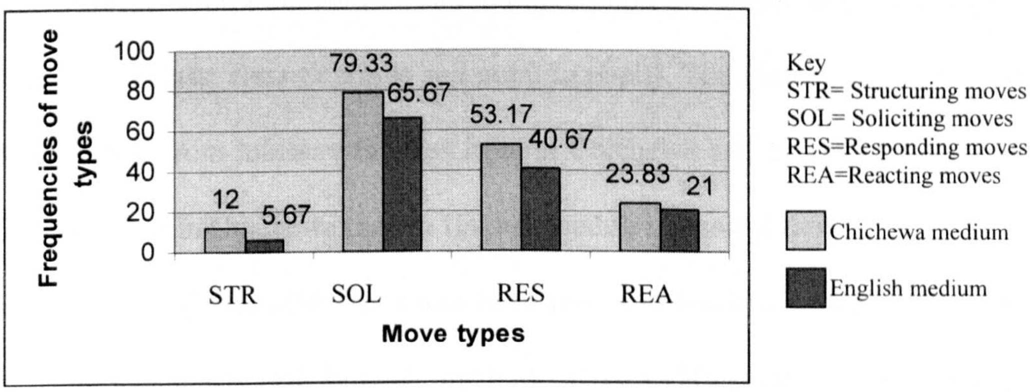


Figure 7.3: Average frequencies of move type in English and Chichewa medium mathematics lessons.

However, soliciting move type constituted the highest percentage in both medium of instruction, about half of the moves were responses and about one-fifth were reactions. This finding shows that there were more verbal interactions in Chichewa medium than in English medium although the pattern of language use did not differ greatly between the two languages of instruction. This finding contributed towards the concerns for teachers use of Chichewa or English in mathematics teaching. The high frequency of move types in Chichewa rather than in English may be in conflict with the teachers' attitude against use of Chichewa in mathematics as well as the limited mathematical vocabulary in Chichewa.

Frequency of source/target of move type

The analysis involved matching the move types (structuring, soliciting, responding and reacting) with the sources/target (teacher to pupil, pupil to teacher, teacher to class, class to teacher, pupils to class, class to pupils and pupil to pupil). The findings show that most of the structuring came from teachers to class in both Chichewa and English medium lessons although it was higher in Chichewa than in English medium lessons (Table 7.10).

Most of the responding moves came from pupils-to-teachers and also from class to teacher in both Chichewa and English medium classes. However, there was a higher frequency of class responding to teacher in Chichewa medium than in English medium mathematics lessons. This may be an indication that many pupils were able to spontaneously speak in Chichewa medium classes, unlike in English medium classes where individual pupils had to be called upon to answer a question.

Another possibility is that teachers made less effort to get pupils to talk in Chichewa medium lessons because teachers felt more comfortable. There was also a higher frequency of individual pupils responding to teacher in English medium than in Chichewa medium mathematics lessons. This may be as a result of teachers wanting to speak to individual pupils who demonstrated high fluency in English or rather when trying to save the lesson from collapsing due to communication problems.

Table 7.10: Percentage of frequency of source of move type in Chichewa and English mediums mathematics lessons.

Source	**Structuring**		**Soliciting**		**Responding**		**Reacting**	
	Chi	**Eng.**	**Chi**	**Eng.**	**Chi**	**Eng.**	**Chi**	**Eng**
Teacher to pupil	0.00	0.15	20.50	32.33	0.30	0.17	7.00	9.67
Pupil to teacher	0.17	0.00	1.83	1.50	16.33	26.00	0.17	0.00
Teacher to class	8.67	5.83	49.5	33.67	1.00	3.33	8.83	8.33
Class to teacher	0.30	0.17	0.17	0.50	29.33	18.83	0.33	0.67
Pupil to class	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00
Class to pupil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pupil to pupil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key: Chi = Chichewa medium lessons
Eng = English medium lessons

Most of the reacting moves in the data came from teacher to either pupils or class. The differences between Chichewa medium and English medium were very small. This implies that pupils do not give their interpretation of the situation during mathematics learning. They do not express their feelings, opinions or judgements of what and how they learn in mathematics.

Frequency of substantive meanings

Substantive issues included subject content and procedural use of language. The findings show that there was more content and procedure in Chichewa medium than in English medium mathematics lessons (Figure 7.4).

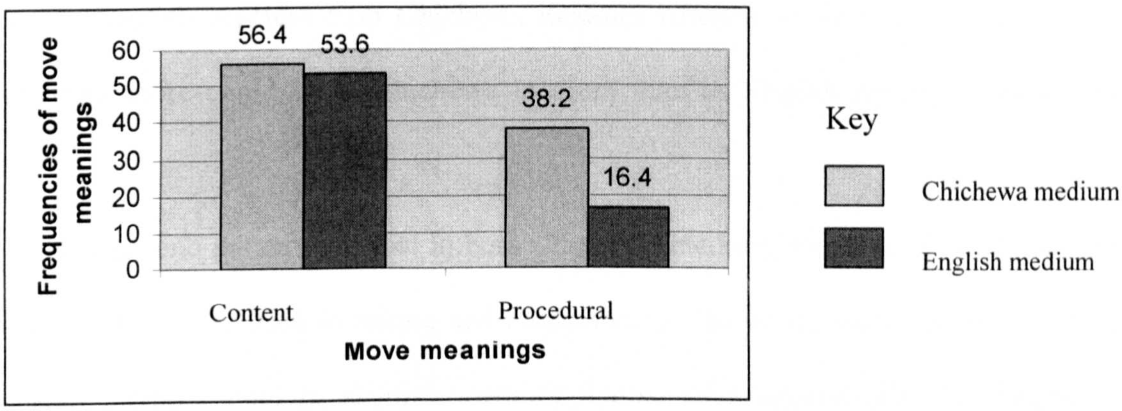


Figure 7.4: Average frequencies of move content in Chichewa medium and English medium mathematics lessons.

Perhaps because of ease of communication in Chichewa medium classes, teachers focused more on content than on procedures. However, there was more content than procedure in both cases.

Meanings in the move types

Some major patterns in meanings in the move types emerged. First, in both Chichewa medium and English medium mathematics classes, structuring was mostly used in action, asking, commanding, explaining and instructing. The finding therefore indicate that, unlike English, the use of Chichewa allows for a discussion of more subject content than classroom. The high frequency of procedural moves in Chichewa medium may imply that teachers were freer to speak to pupils on anything in Chichewa than in English. However, there was more asking in English medium than Chichewa medium whereas explaining, commanding and action were more common in Chichewa medium than in English medium lessons (Table 7.11).

The second pattern was that in both Chichewa medium and English medium classes, soliciting was mostly used in asking and commanding. However, there was more asking in Chichewa medium than in English medium mathematics lessons whereas frequency of commanding was higher in English medium than in Chichewa medium lessons. Third, responding was used in answering, action, accepting and rejecting in both Chichewa and in English medium lessons. However, there was higher frequency of answering and action in English medium than in Chichewa medium whereas the difference in accepting between Chichewa and English medium was very small. Fourth, most of the reacting moves were used in praising, accepting, repeating, rejecting and explaining in both Chichewa and English medium lessons. However, the frequency of explaining, accepting and rejecting were higher in English medium than in Chichewa medium lessons.

Table 7.11: Average percentages of frequencies of meanings in move types in Chichewa and English medium mathematics lessons.

Meanings	Structuring		Soliciting		Responding		Reacting	
	Chi	Eng	Chi	Eng	Chi	Eng	Chi	Eng
Asking	2.65	36.94	83.84	77.56	0.00	0.00	0.00	0.00
Defining	0.00	0.00	0.00	0.00	2.35	0.63	0.51	0.00
Explaining	12.92	9.33	2.70	1.58	3.24	0.63	13.38	18.76
Describing	6.82	5.24	0.85	0.30	0.00	0.00	0.51	0.00
Justifying	0.00	0.00	0.00	0.88	0.89	0.00	0.00	0.27
Commanding	21.75	15.65	9.35	12.72	0.00	1.22	0.00	0.00
Praising	0.00	0.00	0.29	0.30	0.00	1.22	44.08	38.50
Accepting	0.00	0.00	0.00	0.00	8.22	8.03	11.43	15.16
Instructing	3.00	5.19	0.98	0.30	0.00	0.00	0.00	0.00
Action	26.86	25.94	0.85	3.60	5.46	9.89	5.76	6.50
Repeating	0.00	0.00	1.14	2.46	0.46	0.00	4.58	5.40
Answering	0.00	0.00	0.00	0.00	72.97	77.75	4.57	1.40
Interpreting	0.00	0.00	0.00	0.00	0.00	0.00	5.61	0.27
Rejecting	0.00	0.00	0.00	0.30	6.41	0.63	9.57	13.74

Key: Chi = Chichewa medium lessons

Eng = English medium lessons

Using the categories of issues developed so far in this section, I developed five themes about language usage in mathematics classroom. I labelled all the words, phrases and sentences that marked the beginning and the end of a teaching cycle as **structuring the**

classroom linguistic cycles. **Dominating classroom talk** was used to label all the source/target language behaviour. The move types in terms of structuring, soliciting, responding and reacting were labelled as **negotiating**. **Strategising moves** included all the words, sentences that were meant to show how the utterance was emitted. **Substantiating language use** was used to describe all the utterances that contained either the subject matter or procedural language.

7.9 Conclusion

In this chapter, I have deconstructed the data collected through focus group discussion, clinical interviews, classroom observation and mathematical vocabulary equivalents test. In exploring the issues, I was guided by the research questions that I set in Chapter 4 and the theoretical framework presented in Chapters 2 and 3. The research framework developed in Chapter 5 and the research methods described in Chapter 6 guided the data analysis procedures. In deconstructing the data, a number of issues were identified, categories of the issues and themes developed that provide a basis for my understanding of the findings of the teachers' perceptions and use of language in mathematics teaching. The next chapter is a synthesis of the findings.

CHAPTER 8

MAJOR FINDINGS

> If everyday conversation is recorded and transcribed, the participants themselves are often surprised by its apparent confusion (Edwards and Furlong, 1974: 14)

8.0 Introduction

Several themes were identified through the analysis of data from the focus group discussion, interviews, questionnaires, mathematical vocabulary equivalent tests, classroom observations and classroom discourse. They fall under four broad themes – the *linguistic nature of mathematics,* the *mystifying language policy in education*, the *dynamic classroom discourse, and* the *divergent language source for use in mathematics classes.* I chose to use these terminologies because the issues raised in the data represented pressures and concerns in how teachers use Chichewa or English in mathematics teaching. Although I formed groups according to the issues being raised, the discussion of them focused on comparing and contrasting the issues across the categories of issues to explicitly describe the dilemmas and tensions being represented in the data.

The repeated occurrence of the themes is an indication of the reliability of data analysis as well as the validity of the model being developed. However, what are of particular interest are the new issues that teachers brought into the categories. I now discuss each of them in detail. The terms used to describe my understanding of the data were carefully selected. However, it was not easy to find the appropriate English words to describe my understanding of the data because English is not my first language.

8.1 The linguistic nature of mathematics

A number of issues emerged from the data analysis and they focus on:

1. Mathematical language and classroom discourse
2. Mathematical relevant and applicability to everyday life
3. Mathematical vocabulary mismatch between Chichewa and English
4. Correct mathematical vocabulary equivalents between Chichewa and English
5. Teacher knowledge of mathematical vocabulary
6. Teachers' attitudes towards mathematics vocabulary in Chichewa
7. Linguistic difference between Chichewa and English

8.1.1 Mathematical language and classroom discourse

The phrase *mathematical discourse* is used to describe a set of specialised terminology for describing mathematical concepts, principles and relationships (Pimm, 1987). Teachers expressed difficulties in explaining some mathematical concepts in Chichewa. Teachers felt that geometry, measurements and graphs were the topics they found difficult to teach in Chichewa since it is difficult for teachers to explain some concepts in Chichewa. Teachers explained that "To say some terms such as '*graph*' in Chichewa is a problem. There is no equivalent term for graph in Chichewa" (February 9, 1999). Teachers' inability to explain some mathematical concepts in Chichewa is a clear indication that unlike English, the use of Chichewa in mathematics teaching was limited due to the limited mathematical register which teachers distinguished from ordinary language for teaching mathematics.

However, one of the most frequent teachers' responses during the focus group discussions was that some concepts were more enjoyable to teach in Chichewa than in English. The everyday use of the concepts brings about familiarity of the language for discussing them to the teachers and the pupils (February 11, 1999). Relating the compatibility of everyday discourse with mathematical discourse underscores the argument that the use of language in mathematics is a social construct (Adler, 2001; Jaworski, 1994). By socially interacting with mathematical concepts in everyday life, teachers believe that the necessary language is developed to describe and construct the concepts.

There is a relationship between mathematical discourse and classroom discourse in that classroom discourse is a resource for facilitating the learning of mathematics whereas mathematical discourse is the language of the educated discourse - the mathematician. The child usually has a language for learning mathematics but may have limited the mathematical register to enable the child to speak mathematically. As a result the teacher's role is to enable the child to acquire the mathematical register through the use of the ordinary language to access mathematical knowledge. Negotiating access to mathematics knowledge is like peeling the layers of languages to access the mathematical knowledge as shown in Figure 8.1.

From the data analysis it appears that teachers are struggling with classroom discourse to access mathematical knowledge without providing the mathematical register. It also appears that teachers' dilemmas and tensions increase as they try to penetrate through layers of ordinary discourse, classroom discourse, to access mathematical register, which helps pupils construct mathematical knowledge (see Figure 8.1).

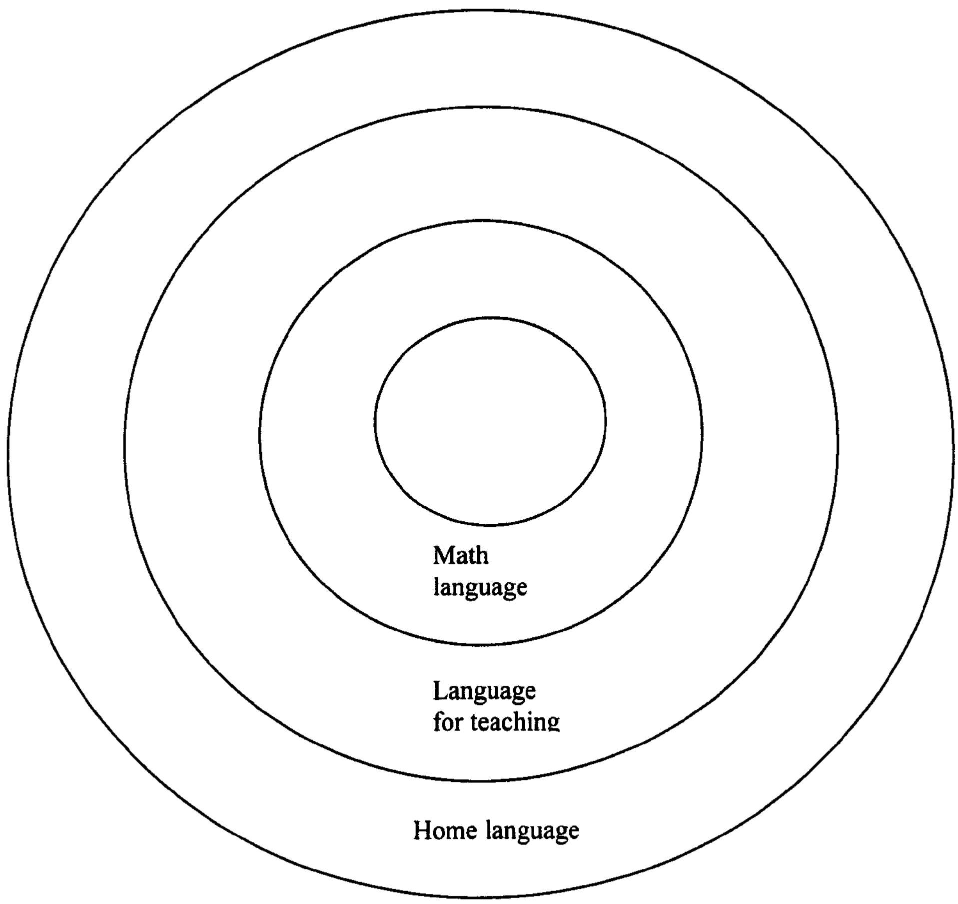


Figure 8.1: The continuum of externalising language from mathematical discourse.

Figure 8.1 illustrates the degree of externalisation of ordinary language from mathematical discourse. The inner circle indicates how teachers perceive mathematics as a body of knowledge that can be accessed through language. Children can learn mathematics through speaking. Similarly, the next inner circle indicates the teachers' perception that there is mathematical language involved in mathematics teaching which is not significantly to do with the nature of mathematics. Teachers and not pupils need this language to explain mathematical concepts. In this way teachers tend to detach the language they use in mathematics from the mathematics itself. Furthermore, there is the ordinary classroom language which has very little to do with mathematics learning. This way of perceiving language use in mathematics has implications on how teachers use language in mathematics.

By the *linguistic nature of mathematics* I also include the mathematics vocabulary equivalents between the Chichewa and English, because it was common among teachers to talk about mathematics vocabulary equivalents between English and Chichewa as one of the conditions contributing to the dilemmas and tensions in the use of the two languages. One teacher pointed out that "There were also some words that I could not express them in Chichewa for example say, 'number'. I would use the same word 'number' instead of saying ---- eee! I can't say it!" (May 18, 2000). Instead, teachers indicated that they were able to find the entire necessary mathematics vocabulary in English, "so it was easy to teach or to mention something in English which I could not express well in Chichewa" (May 18, 2000). This suggests that teachers regard English as rich in mathematics vocabulary. Yet teachers perceived more problems in the use of English than in the use of Chichewa as evidenced by the following responses: "when you speak in English only some children such as in standard 3 don't understand the English; so forcing you to speak in Chichewa" (June 6, 2000). This suggests that teachers regard Chichewa as rich in classroom discourse.

The pressure on the teacher is between mathematical discourse and classroom discourse. On the one hand teachers found mathematics discourse readily available in English whereas it was difficult to speak to children in ordinary English language. On the other hand, teachers found mathematical discourse in Chichewa difficult to find whereas it was easy to speak to pupils in ordinary Chichewa language.

8.1.2 The mathematical relevance and applicability to everyday life

Another theme was teachers' perception of language as influencing the *mathematical relevance and applicability to everyday life*, which was supported on three accounts. First, teachers agreed that when Chichewa is used in mathematics teaching, pupils are helped to relate mathematics to their culture. However, teachers did not agree that when English is used, pupils are helped to relate mathematics to their culture. Second, although teachers agreed that when English is used, drawing examples from everyday life enriches the content of the lesson; the agreement was stronger when Chichewa is used. Third, teachers agreed that when Chichewa or English is used, pupils are able to apply mathematics to solving everyday problems. However, they strongly agreed that pupils are able to apply mathematics to solving everyday problems when Chichewa rather than English is used. This finding suggests that teachers perceive language used in mathematics teaching as influencing the mathematical relevance and applicability in everyday life. This suggests that there is a culture brought in by the language of instruction different from the culture of mathematics and that there is dilemma and tension between the two cultures.

Teachers also felt that availability of mathematical vocabulary influences the use of the language in mathematics teaching as they agreed that when English is used, mathematical vocabulary in English is usually available for use during classroom instruction. However, they strongly agreed that when Chichewa is used, mathematical vocabulary in Chichewa is usually not available for use during classroom instruction. Teachers agreed that when Chichewa is used, there is no mathematical vocabulary that they knew which could best be explained in Chichewa, they strongly disagreed that there is no mathematical vocabulary that they knew which could best be explained in English.

Teachers felt that some languages distort mathematical issues. Teachers strongly agreed that using Chichewa distorts the meanings of mathematical concepts. Nevertheless, they disagreed that using English distorts the meanings of mathematical concepts. The findings show that teachers felt that the problems of language use in mathematics were associated with making mathematics relevant and applicable to everyday life, through the use of appropriate mathematical vocabulary that does not distort the mathematical meanings.

In Figure 8.2, I elaborate the need for mathematics discourse and classroom discourse to operate mutually to help in mathematics learning through construction of knowledge.

However, while this occurs, teachers are constantly reminded of the distortion of meanings and the relevance and applicability of mathematics called by the classroom discourse.

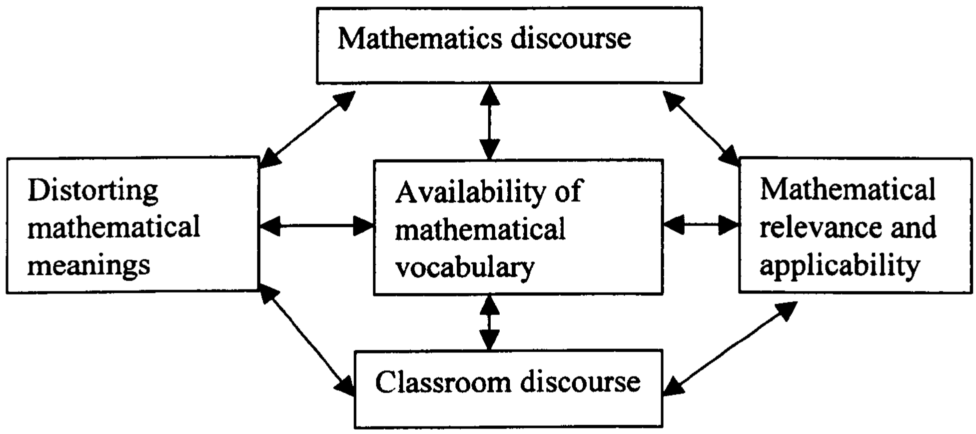


Figure 8.2: The linguistic demands of mathematics teaching on language use.

8.1.3 Mathematical vocabulary mismatch between Chichewa and English.

For most of the mathematical vocabulary in English, teachers gave three equivalents in Chichewa (see Appendix 8). However, the sample of teachers gave as many as twelve different possible equivalents in Chichewa to some mathematical terms in English such as *profit* whereas for other terms such as *factors, sum, graphs*, there were no known equivalents in Chichewa. For example, teachers differed on any Chichewa equivalents for fractions, factors and graphs. This range of mathematics vocabulary in Chichewa may mean two things. First, teachers did not have the vocabulary for the particular mathematical concept, which they might use in mathematics teaching. Second, teachers may not want to use the mathematics vocabulary in Chichewa. Third, that Chichewa is not as precise as English in expressing mathematical meanings.

Figure 8.3 shows that the equivalents of mathematics vocabulariy that teachers in the study schools gave ranged from 1 to 12 different terminologies with the majority of the equivalents being 3 or 4. In order to understand the differences in the range of equivalents to mathematics vocabularies that teachers gave, it is important to keep in mind that teachers did not have to give more than one equivalent. Instead the ranges appeared as a result of listing all the terms that different teachers wrote down for a particular mathematical vocabulary.

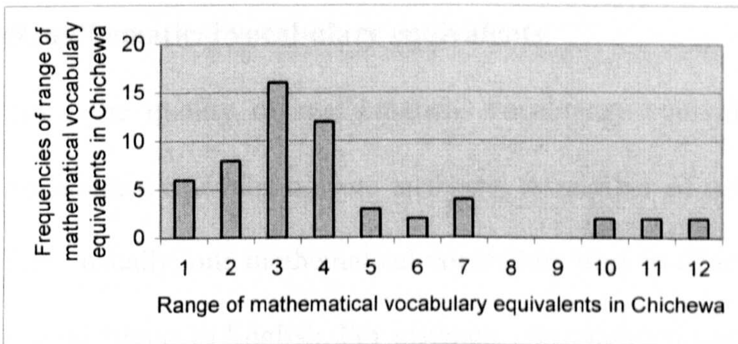


Figure 8.3: The frequency of range of mathematical vocabulary equivalents in Chichewa given by teachers.

Nevertheless, the range of mathematics vocabulary that teachers used during the lessons demonstrates the varied concerns that teachers have about the mathematics vocabulary and also how the mathematics vocabulary equivalents can contribute to mathematical misconceptions. For example, *area* was associated with *bwalo, malo, bungwe,* *dela, maiko, church and court. Bwalo* is perhaps the closest equivalent of area because it means space usually on the ground such as a playground. *Malo* or *dera* or *maiko* may connote area but not precisely, as *malo* is a place, *dera* is area in terms of occupied land, and *maiko* means countries or worlds. My understanding is that by using this range of terminology to describe a single mathematical concept, teachers may bring about mathematical misconceptions that conjure up wrong mathematical images in the pupils. Furthermore if teachers are aware of their deficiency in mathematical vocabulary equivalents, they will experience concerns in the use of the language in mathematics teaching.

8.1.4 Correct mathematical vocabulary equivalents

Apart from the quality of mathematical vocabulary equivalents, the amounts of mathematical vocabulary equivalents were analysed. A number of issues emerged from the data analysis. First, usually, one mathematical vocabulary item in Chichewa was indicated as having different equivalents in English. For instance, *chozungulira* was equivalents to "round or circle or oval shapes".

Second teachers gave more Chichewa to English mathematical vocabulary equivalents (72.60%) than English to Chichewa mathematical vocabulary equivalents (Table 8.1). The difference was significant (alpha = .01). This suggests that the teachers' knowledge of mathematical vocabulary was more limited in Chichewa than in English. This pattern has implications on how teachers use Chichewa or English in mathematics teaching. The difference in teachers' knowledge of equivalents of mathematical vocabularies suggests that teachers are likely to use more English terms than Chichewa when teaching mathematics in Chichewa medium lessons. Considering that pupils are limited in English, this tendency is likely to create pressures and concerns in the teachers who find more mathematics vocabulary terms in English than in Chichewa - the concerns of whether to teach mathematics in English or teach pupils in Chichewa.

Table 8.1: Means, standard deviations and t-values of scores on mathematical vocabulary equivalents between urban and rural schoolteachers.

		N	Mean	Std Dev	t-value
Totals	1. English to Chichewa	40	60.90	11.93	6.6088
	2. Chichewa to English	40	72.68	10.24	
English to Chichewa	1. Urban School Teachers	19	63.68	10.80	1.9978
	2. Rural School Teachers	21	56.38	12.29	
Chichewa to English	1. Urban School Teachers	19	76.19	8.12	3.2156
	2. Rural School Teachers	21	69.00	11.36	

Third, the amount of mathematical vocabulary equivalents from English to Chichewa between urban schoolteachers and rural schoolteachers was not significantly different (alpha = .05). This suggests that regardless of where teachers were teaching, they had similar problems of finding Chichewa equivalents for mathematical vocabulary provided in English.

Fourth, teachers in urban schools translated significantly more mathematical vocabulary from Chichewa to English than teachers in rural schools (alpha = .01). Teachers in the urban schools use more English vocabulary than teachers in rural schools in their everyday life. This may increase their chances of providing more English equivalents to Chichewa.

Fifth, teachers in both rural and urban schools translated significantly more mathematical vocabulary from Chichewa to English than from English to Chichewa (alpha = .01). Teachers in the urban and rural schools found it easy to identify English equivalents of mathematical vocabulary provided to them in Chichewa. However, teachers in urban schools have higher vocabulary equivalent competencies than those in rural schools.

8.1.5 Teacher knowledge of mathematical vocabulary equivalents

By giving completely wrong terms as mathematical vocabulary equivalents between Chichewa and English, teachers might have demonstrated that they either did not have the basic knowledge of mathematical concepts or they might have had misconceptions about the concepts being described. For example, teachers confused the terms for volume and capacity partly because of lack of knowledge of the two mathematical concepts. This state of teacher knowledge of mathematical vocabulary equivalents is fundamentally related to the mathematics education programme and specifically the teacher training.

8.1.6 Teachers' attitudes towards using mathematical vocabulary in Chichewa

Attitudes towards the use of mathematical vocabulary between Chichewa and English created dilemmas and tensions in the use of language because teachers had to base their actions on what they believed would work in the classroom. For example, they considered certain terminology in Chichewa as not appropriate because they believed mathematics could not best be taught in Chichewa even if the terms were precise. It was common to hear from teachers that " I don't like the word *kuwonkhetsa",* meaning 'to add'.

It was common for teachers to substitute terms they don't like during the lesson. Teachers use different terms to describe the same concepts to pupils and sometimes they may not be consistent in using these mathematical equivalents as evident in the following:

T: *42 tambala sitimalemba chonchi chifukwa chakuti tikati 42 tambala ndiye kuti tikuwonkhetsa 40t ndi 2t pansi pakepo. Ndiye ukaika* equals...*0 kuphatikiza 2* equals*?*

The two terms, *kuphatikiza* and *kuwonkhetsa* were used to mean the same concept of addition, and this was common throughout the lessons observed in this study. At the same school, another teacher used *kuphatikiza* and *kuwonkhetsa* with different purposes as indicated in the following:

C: *<u>Kuphatikiza</u>*
T: *Eya. Ndiye masamu a lero akahala otani kodi?*
C: *<u>Ophatikiza</u>*
T: *Eya. Akhala <u>ophatikiza</u>. Kodi pa Chichewa <u>kuphatikiza</u> timati chiyani?*
C: *<u>Kuwonkhetsa</u>*
T: *<u>Kuwonkhetsa</u>, eti? Eya. Ndiye masamu a lero akhala otani?*
C: *<u>Owonkhetsa</u>*

The teacher told the pupils to use *Kuwonkhetsa* because that is the term used in the textbooks to mean addition; otherwise she was likely to use *Kuphatikiza* to mean addition as it was revealed when she explained why she kept on switching between *kuphatikiza* and *kuwonkhetsa*, she said "I don't like the word *kuwonkhetsa*. I don't think that is Chichewa. *Kuphatikiza* is the correct Chichewa equivalent for addition" (School Two, Zomba, 2000).

The same teacher also used a third term, *Tiwonjezera* to mean adding as in the following:

T: *Tiyika pansi pa one? Ati tiyika pansi pa wani, Eee Fatima?*
P: *Tiwonjezera ndi one uja tinasunga uja*
T: *Very good. Tiwonjezera ndi one tinatani uja?*
C: *Tinasunga*

To say that *kuwonkhetsa, kuphatikiza* and *kuwonjezera* are the equivalents of addition, may be misleading as each of these words has different connotations. *Kuwonjezera* literally means putting extra something whereas kuphatikiza describes the physical activity of putting two or more groups of things together. The two terms do not describe the mental processes involved in the process of addition as much as *kuwonkhetsa* probably does.

8.1.7 The linguistic difference between Chichewa and English.

Another concern was that teachers used or avoided using cumbersome descriptions of mathematical concepts in Chichewa. Teachers gave a description of the concept but not one word and these included such terms as *triangle, rectangle, circle, temperature, change, coin and banknote*. For example, triangle was described as *Chinthu cha ngondya zitatu (see Appendix 8)* which literally means three-angled figure. One would argue that this is not different from the root meaning of the English sense of *triangle (tri – angle)*. Perhaps teachers may be worried about the cumbersomeness of naming mathematical vocabulary equivalents such as triangle in Chichewa. Another example is how some numbers are named in Chichewa. 'Seventeen' is named as *khumi, zisanu* and *ziwri* (See Appendix 8), which mathematically means 10 + 5 + 2. By describing the concepts in this way, teachers demonstrated that they understood what the terms stand for but that there were no single name equivalents in Chichewa whereas the same concepts have single term vocabulary in English. Perhaps this linguistic difference of mathematical vocabulary between Chichewa and English makes English vocabulary equivalents more usable than Chichewa vocabulary equivalents.

This relationship can be represented diagrammatically as in Figure 8.4.

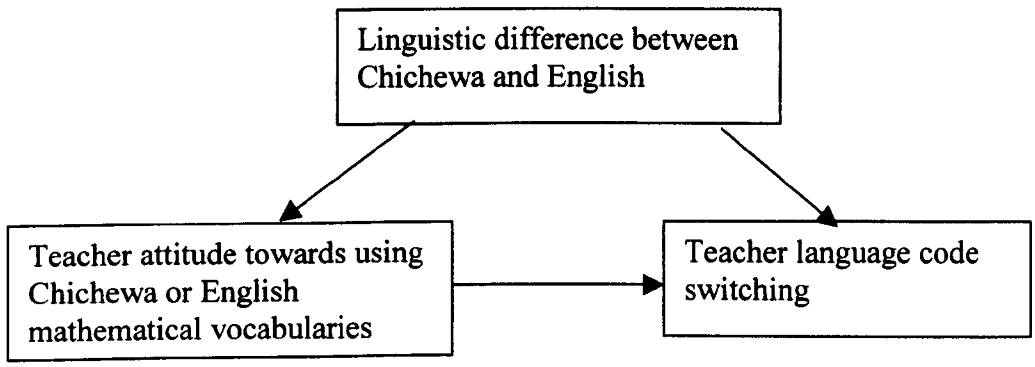


Figure 8.4: Some sources of teachers' concerns in the use of Chichewa or English mathematical vocabulary.

The issues that have emerged from the data in using mathematics vocabulary during the lessons were related. For example, the teachers' attitude towards mathematical vocabulary in Chichewa may influence them into substituting some Chichewa terms with the English terms - language code switching. Similarly, linguistic differences that exist between

Chichewa and English in describing mathematical concepts - such as saying seventeen in English or *Khumi, zisanu ndi ziwiri* in Chichewa - may also tempt teachers into language code switching. However, the influence of teacher attitudes and language code switching on linguistic difference between Chichewa and English seems not to be obvious.

8.2 The mystifying language policy in education

One of the major themes of concerns that emerged from the data analysis is the *mystifying language policy in education.* I have used the term 'mystifying' to emphasise that the language policy in education in Malawi is so ambiguous that it lends itself to different interpretations at school level. Some of the sub-themes derived from the data, which make up this major theme, are:

1. Inconsistency between language of study and language of instruction
2. Uncertainty about the medium of instruction in mathematics
3. Language across the curriculum
4. Late introduction of English as medium of instruction for mathematics
5. Implementation process of the medium of instruction in schools

8.2.1 Inconsistency between the language of study and language of instruction

It appears that the ambiguity that exists in language policy in education with regard to inconsistency among the language of study and the medium of instruction in the instructional materials, coupled with dual functions of medium of instruction, results in concerns and pressures in teachers' use of language in mathematics teaching.

8.2.2 Uncertainty about the medium of instruction in mathematics

The language policy in education created uncertainty about the medium of instruction in mathematics. For example, one teacher articulated a concern that "when Chichewa is used some pupils experience problems when the medium of instruction changes to English in the upper classes" (February 1999).

Teachers were concerned with language policy in education, which states that pupils shall learn in the mother tongue or local languages from standard 1 to 4, and learn in English thereafter (Ministry of Education, Sports and Culture, 1996). The use of Chichewa in teaching mathematics in early classes did not prepare children for further education that was subsequently offered in English in the upper classes. One response was that, "The problem is that when children get to higher classes they face the problem of not understanding lessons in English because they are used to learning in Chichewa" (February 9, 1999).

Teachers' concerns of which language (Chichewa or English) to use in mathematics was also revealed through the analysis of data. Teachers indicated that they were not sure which language, Chichewa or English, should be used in mathematics teaching, as one teacher stated that, "It is difficult to say which language is suitable for mathematics teaching because some teachers cannot speak other languages." (February 9, 1999). Teachers consider the limited number of languages that a teacher can speak fluently as a deciding factor for appropriateness of the language for classroom use.

8.2.3 Language across the curriculum

Another teachers' concern was that the use of Chichewa in many subjects confused the pupils. One teacher's concern was that "Because we use one language for instruction in teaching several subjects, somewhere children lose interest" (February 9, 1999). By using Chichewa in many subjects, teachers might imply that some subjects such as Mathematics could have have been taught in a different language other than Chichewa.

Teachers were concerned with *language policy across the curriculum*. They agreed that for some subjects the use of English or Chichewa instruction is not conducive to effective learning. Therefore, on language policy in education, teachers were concerned with the implementation process as well as the language used across the curriculum, as these were perceived as influencing the use of language in mathematics discourse.

8.2.4 Late introduction of English as medium of instruction for mathematics

Teachers were concerned with late introduction of English as medium of instruction for mathematics. They indicated that English should be used in mathematics teaching early enough to prepare the pupils for further education. The main reason was not for immediate understanding of mathematics, but because pupils would be required to learn mathematics in English in the upper classes. This identifies a dilemma or tension caused by the contradiction between the immediate needs of pupils to learn mathematics in a familiar language and the long-term needs of pupils to develop competence in English. Teachers were also concerned with the time of the introduction of English medium to replace Chichewa as a medium of instruction. The present policy states that English medium is introduced in standard four but teachers felt that that was too late for preparing pupils for learning English.

Delay in the introduction of English medium created concerns and pressures in the teachers' use of language in mathematics because teachers believed that pupils could improve their English by using it in other subjects such as in mathematics. Teachers strongly believed that pupils could not speak English in their classes because most of the lessons were conducted in Chichewa. Teachers felt that it would help such pupils if they were introduced to English medium earlier than standard four to improve their English as was regarded as standard five was far too late for pupils to develop English language competence.

By this, teachers were referring to the preparation of pupils for English as a language rather than mathematical language. The concern here is between the teachers' strong desire to improve pupils' English and the need to make pupils learn mathematics. Teaching mathematics through English at the same time teaching English through mathematics-seemed to be the alternative, though a difficult one.

In their perceptions teachers felt the class level must be considered for the use of Chichewa or English. Although they indicated the levels that were appropriate for the use of Chichewa or English, they did not agree on a particular class level. They indicated that teaching of mathematics in English should begin in standard 1 or 3 or 4. The issue here is an exemplification of teachers' inadequate knowledge of the role of language in mathematics teaching and learning.

8.2.5 Implementation process of the medium of instruction in schools

According to teachers' perceptions, implementation strategies of language policy in education influence the language use in mathematics teaching. While teachers disagreed that the cost of implementing the use of English in mathematics lesson was out of proportion to its value, they were not sure about the cost of implementing the use of Chichewa in mathematics lessons. Teachers strongly disagreed that they will be out of job due to a change of medium of instruction to Chichewa or English. Teachers were not sure whether English or Chichewa medium of instruction is imposed upon the teacher. In this way, teachers seemed not to be concerned with their job risk or the cost of the implementation of the language policy in education or the imposition of the medium of instruction.

The relationship among the language policy and practice in education on the language use in mathematics teaching are represented in Figure 8.5 The uncertainity of language use in mathematics is caused by the dual function of the language of instruction as well as the use of language across the curriculum - in other subjects as well as in other classes. The inconsistency in the use of language as a language of study, a medium of instruction and a language for writing textbooks also exert pressure on how teachers use language in the mathematics classroom. In this way, the major source of concern is the ambiguous language policy in education.

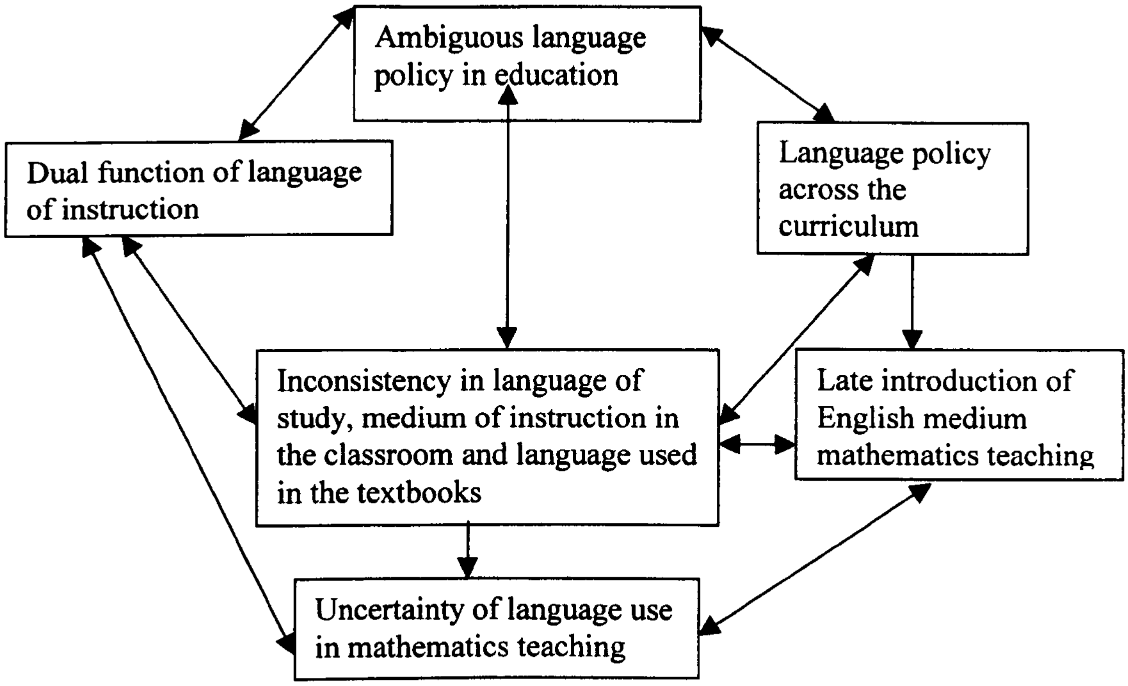


Figure 8.5: The influence of the language policy in education on the use of language in mathematics teaching.

8.3 The dynamic classroom discourse

The concerns and pressures in the use of language came up vividly when teachers discussed the dynamics of the classroom discourse. I use the terminology *dynamics of the classroom discourse* to emphasise that from the data analysis it appears that the teachers' use of language in mathematics classrooms is a function of a number of factors that operate in it at particular time. These appeared from the data analysis to include:

1. Teaching competence

2. Teaching experience
3. Communication problem between the teacher and the pupils
4. Language competence
5. Language code switching and mixing
6. Access mathematics through language
7. Achieving equity in mathematics learning through the use of language
8. Language improves instructional quality

8.3.1 Teaching competence

In the data, the concern for the teaching competence was expressed in two contradictory ways - teacher *dedication* and teacher *confidence*. Here teacher dedication is used to describe a situation where a teacher does not show personal commitment to teaching. From the data, it appears that some problems of using Chichewa in mathematics teaching were perceived to be associated with teacher lack of dedication. One teacher expressed a concern about lack of dedication to duty when Chichewa is used; so teachers do not prepare adequately for using Chichewa in mathematics teaching. This view was expressed by one of the teachers in the sample. "The problem is with the teachers. They are not dedicated to duty because pupils have to know how [for example] *to subtract* from their teacher. So if the pupils do not know it they have to be taught" (February 9, 1999). However, when English is used, teachers feel the challenge to impress upon pupils that they know English.

The second concern was that when Chichewa is used in mathematics teaching, teachers speak with confidence as they indicated that. "The good thing is that you speak with confidence so that the pupil will understand you and that the pupil will pick it up quickly" (February 11, 1999).

Teaching with confidence and without dedication are conflicting reactions to the use of Chichewa as the two behaviours cannot occur together at the same time. This is a clear demonstration of another set of tensions in the use of language in mathematics - that the use of a particular language makes some teachers become confident whereas other become less dedicated to the teaching process.

8.3.2 Teaching experience

During clinical interviews, teachers stated that the success of the use of language in mathematics teaching depends on the teaching experience. Teachers repeatedly related the success and failure of their lessons to the teaching experience. They perceived that language was important for teachers to help pupils understand mathematics. Teachers admittedly recalled that during the lessons, they had to select a language that they thought could help the pupils understand what was being said. For teachers to be able to decide on which language to use, they need teaching experience – exposure to teaching theory and practice.

8.3.3 Communication problem between the teacher and their pupils

What came up frequently during clinical interviews was that pupils needed more help in English medium than in Chichewa medium lessons because of communication problems. Supporting this, I repeatedly saw teachers whispering to pupils in Chichewa during English medium lessons. Those who whispered to the pupils indicated that they whispered in Chichewa because they wanted pupils to understand what was said. They argued that:

> In English medium lessons, I was helping them because they did not understand what to do. They did not know what to do. I should say they did not understand what I instructed them to do. That is why I was helping the pupils to answer the questions. They were able to answer in English but with difficulty (June 12, 2000).

Teachers thus felt that the Chichewa medium mathematics lessons were more successful than the English medium mathematics lessons. Some of the responses were that "The one in Chichewa ...was the most successful lesson because children were more relaxed" (June 7, 2000) and also in Chichewa medium because "in the past they were learning mathematics in Chichewa" (June 7, 2000). The success of a lesson was based on how easy or difficult teachers communicated with pupils.

Teachers also felt that pupils were livelier and more involved in Chichewa medium lessons than in English medium lessons because pupils were contributing to the classroom talk in Chichewa medium more than in the English medium lessons. Teachers felt that pupils were contributing to the classroom talk in the Chichewa medium lmathematics lessons because "Chichewa is their mother tongue". Some teachers felt that "in the Chichewa medium lesson, pupils were able to answer questions". (June 12, 2000).

8.3.4 Language competence

Teachers were concerned with language competence. It was interesting to note that some teachers had problems in speaking English. Teachers indicated that they experienced difficulties teaching mathematics in English for a number of reasons. One of the reasons was that:

> It is true because for us it is also the first time we are teaching mathematics in English in standard 4. So we sometimes forget to speak the appropriate language that a child can understand. What sort words would the child easily understand? What sort of language skills are required?" (May 18, 2000).

This implied two things. First, teachers lacked experience in using English in mathematics teaching especially when I asked them to teach using English during the study. Teachers were not competent enough in English, although this needs further exploration.

In English medium teachers felt that "the lessons were difficult because it is not their language". It is neither my language. Nor it is my second language" (June 7, 2000). Poor choice of vocabulary, irrelevant materials for teaching in English and extensive use of Chichewa in mathematics teaching made it difficult to teach mathematics in English for a number of reasons:

> I haven't found any problems when I teach in Chichewa because I teach in a language that is familiar to the children. But in English, I have had some problems of terms which children don't understand, they are not familiar with the words being used (May 18, 2000).

No teacher indicated that they came across pupils who could not speak Chichewa. This notion suggests that Chichewa medium was suitable as a transitional medium from home to school but once the pupils are settled in school, they should be taught in English.

8.3.5 Language code switching and mixing

The analysis of data revealed that there are concerns about whether teachers use Chichewa or English or mathematical language in mathematics resulting in them using *a mixture of Chichewa and English.* I have chosen to call the mixture of Chichewa and English *tri-lingual code switching* because the terms from ordinary Chichewa, ordinary English and mathematical discourse are used in the same context. However, during focus group discussions, teachers felt that code switching between Chichewa and English was the only way to cope with language use in mathematics teaching for the reason that Chichewa is a common language whereas English is a language more suitable for the technical demands of mathematics teaching. Teachers used English especially when they could not "find some mathematical terms in Chichewa" and "so I try to discuss them in a mixture of Chichewa and English. Words such as circle, triangle and quadrilateral are in English but written with Chichewa spelling as seko, thirayiyango and kwadililatero" (February 9, 1999).

Another cause for code switching was that "it is appropriate to combine English with Chichewa when teaching mathematics in standards 3 and 4 so that when they [pupils] get to standard 5, they will not have any problem learning mathematics in English" (February 9, 1999). This finding suggests that using two different languages as a medium for instruction though at different levels of education tends to create tension in teachers' use of language in mathematics.

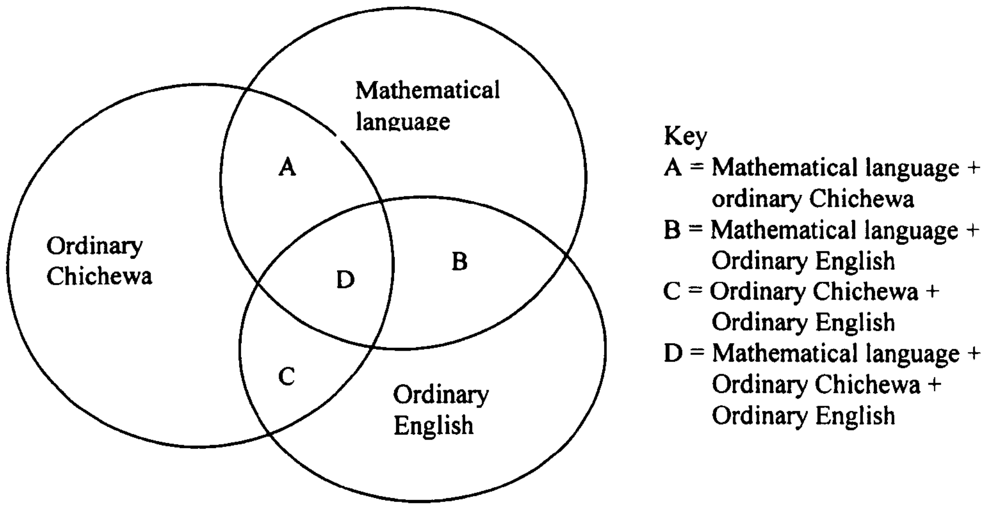


Figure 8.6: Tri-lingual code switching in mathematics classroom.

Language code switching between Chichewa and English was perceived as a panacea to language problems in the classroom. Some teachers felt that mixing the two languages would yield a better lesson delivery than using any single language. *"Nanga nditani? Ndimangophatikiza Chichewa ndi Chizungu basi"* which means that what else can I do? I simply switch between Chichewa and English. By *"nanga nditani"* signifies teacher's helplessness in the use of language in a dynamic classroom discourse. It appears that teachers use language code switching as a coping strategy to deal with the dynamic classroom discourse - an indication of tension.

Teachers felt that they found it easier to communicate with the pupils in Chichewa medium than in the English medium lessons for a number of reasons. First, " because pupils are used to learning in Chichewa. After all I always teach them in Chichewa!" (June 12, 2000). Second, pupils were more fluent in Chichewa than in English. "Most of the pupils speak Chichewa so that they could understand the lesson more quickly than in English" (May 18, 2000). "[I] did not need to repeat. Pupils were able to understand once because they know. I did not need to simplify the words." (June 7, 2000).

There were also pupils, who could not speak English. "Those who have a very poor educational background experience a lot of problems; but those living in town are lucky in that they attended preschool playgroups where they learn English. And it is these children who speak good English unlike those who never went to preschool playgroup" (June 6, 2000).

The results in Figure 8.7 show that although teachers demonstrated lack of experience in the use of language – both Chichewa and English- and that they switched between languages in both Chichewa and English medium classes, there were differences in some elements of the dynamic classroom discourse between them. For example, in Chichewa medium lessons, pupils' contribution to classroom talk was high and also language competence for both the teacher and pupils was high. However, when English was used, pupils needed more help in how to speak in English. Despite all this, teachers feared that the use of Chichewa lowered the teaching of mathematics in English.

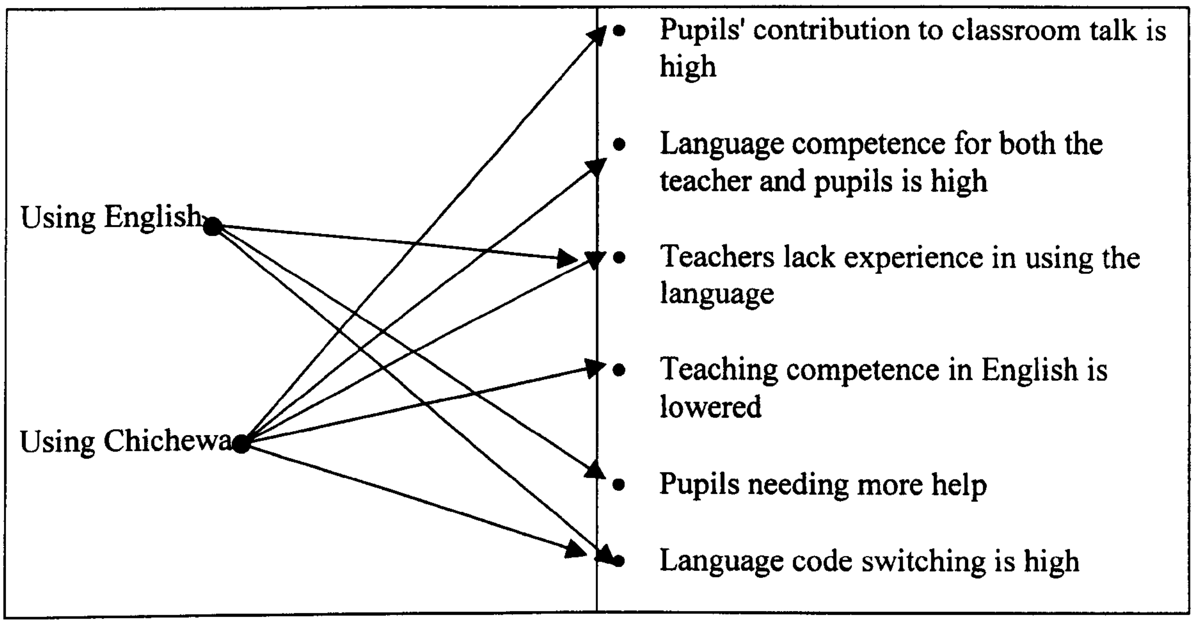


Figure 8.7: A comparison of the elements of dynamic classroom discourse between Chichewa and English mediums mathematics classrooms.

There was a range of occurrences of teachers' responses that reflected the challenges of language use in classroom discourse. The major ones are tri-lingual code switching, using language as a teaching resource, language competence, teaching competencies and dual function of medium of instruction. Teachers felt that in mathematics teaching they code switch between mathematics discourse, classroom discourse and everyday discourse because of the conflict between language as a teaching resource and their teaching competencies with regard to use of language in mathematics teaching. Given the level of teaching competencies, teachers felt that tri-lingual code switching was the only way of using language in mathematics teaching. Their relationships are shown in Figure 8.8.

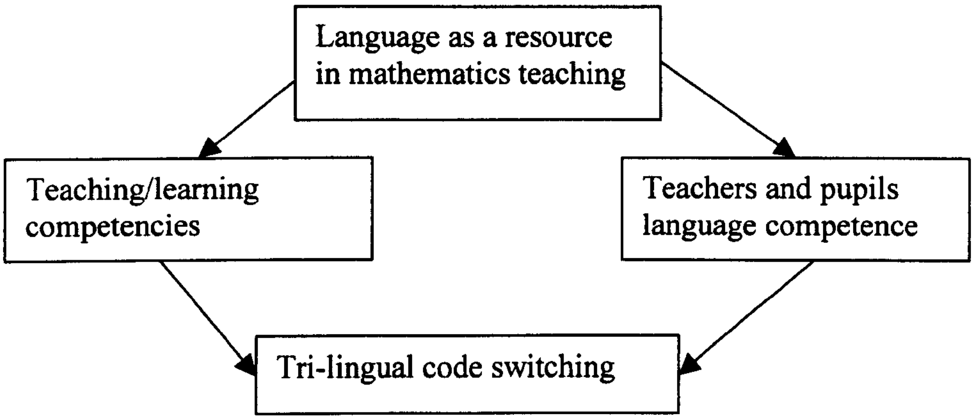


Figure 8.8: The influence of the dynamic classroom discourse on the use of language in mathematics teaching.

8.3.6 Access mathematics through language

Two related concerns were identified under this category: First, teachers were concerned with enabling the pupils access mathematics through language. The concern for accessing mathematics through language was evident because teachers strongly agreed that when Chichewa is used, pupils are motivated and their attention is sustained throughout the lesson whereas on the use of English, teachers are divided. Again, there is a higher degree of agreement among teachers that when Chichewa is used, individual pupils learning needs are supported than when English is used. Although some teachers agreed that when English is used, communication problems between the teacher and pupils are reduced, the majority (80%) strongly agreed that when Chichewa is used, communication problems between the teacher and pupils are reduced. Teachers seemed to agree that when Chichewa or English is used, an effective way of evaluating pupils learning is provided. However, they strongly agreed for the use of Chichewa more than the use of English. Teachers were also not sure whether the degree of teacher-pupils interaction is reduced when Chichewa or English is used in mathematics teaching.

8.3.7 Achieving equity in mathematics learning through the use of language

Teachers were concerned with achieving equity in mathematics learning through the use of language. Teachers strongly agreed that when Chichewa is used, a greater number of pupils are reached equally at the same time. However, they disagreed that when English is used a greater number of pupils are reached equally at the same time. These notions raise the question of how teachers perceive pupils' access and equity in mathematics when they use a particular language.

8.3.7 Improving learning and instructional quality

Teachers were concerned with the use of language that aims at improving educational quality. This feeling was evident when teachers rated those statements that suggest this notion. While teachers strongly agreed that when Chichewa is used, the quality of education is lowered, they strongly disagreed that this is the case when English is used. The findings show that teachers are concerned with mathematical quality when it comes to use of language.

When using language in mathematics teaching, teachers were concerned with two things: mathematical understanding and instructional quality. On mathematical understanding, teachers agreed that when English or Chichewa is used, misconceptions about certain concepts, which would be difficult for the teacher to explain, are reduced, although they agreed more for Chichewa than for English. Teachers strongly agreed that when Chichewa is used, misconceptions about certain concepts, which would be difficult for the pupils to understand, are reduced whereas they were not sure whether the use of English would do the same for pupils.

The concern about the role of language in improving instructional quality was evident when teachers strongly agreed that when Chichewa or English is used, the teachers' instructional effectiveness is increased. Yet during focus group discussions, teachers were concerned with some teachers who may not be dedicated to teaching when Chichewa is used. This may suggest that those teachers who are not fluent in Chichewa may not take lessons in Chichewa as seriously as those teachers who are fluent in Chichewa. Teachers strongly disagreed that when English is used, pupils do not take seriously the mathematics lessons whereas teachers were divided on whether pupils do not take seriously the lessons when Chichewa is used. Teachers strongly disagreed that when Chichewa or English is used, more time is consumed because pupils tend to dominate the classroom talk. This finding shows that when teachers thought of the role of language in mathematics, they felt that language makes a difference in mathematical understanding and instructional quality.

8.4 Divergent sources of language for mathematics teaching

One of the themes of concerns and pressures that emerged from the data analysis is the unreliability of sources of language for use in mathematics teaching. I used the terminology *divergent sources of language for classroom use* to emphasise that the complexity of the language sources is responsible for teachers tensions in language use in mathematics teaching, originating from the language deficiencies of the teacher, the pupils and also the materials being used in the classroom. Here **divergent** defines the **inconsistency** of language use by teachers, pupils, and in instructional materials such as books as perceived by the teachers. This state of **inconsistency** makes it difficult for teachers to source language for use in mathematics teaching. I did not attempt to investigate the levels of inconsistency of language use. However, there are three key categories at this level: pupils' language incompetence, teachers' language incompetence and inconsistency in language use in instructional materials. I decided to discuss the language deficiencies in the mathematics from different sources because of the nature of the source of the deficiencies as perceived by teachers. For example, there are times when the language used was that one which belongs to the teachers or pupils or textbooks. The use of the diagram emphasises my understanding that there are some overlaps among the pupils' language, teachers' language and language in the instructional materials. The overlaps add to my understanding that some of the issues in the use of language in mathematics arise from an attempt to compromise among the three sources of classroom language.

A number of concerns emerged from the data analysis, which I discuss under this theme. They included:

1. Pupils' language competencies
2. Teacher language competencies
3. Inconsistency of instructional languages
4. Limiting the range of languages for instruction
5. Inconsistency in use of languages in the textbooks
6. Inconsistency in the language used in the teaching and learning materials
7. Lack of teacher training and support in the use of language

The relationship of how some of the issues raised influence each other is shown in Figure 8.9. There is interaction between instructional language and the pupils' language (A), the instructional language and the teachers' language (B), and between the pupils' language and the teachers' language (C) which influence how the language in used in the mathematics classroom. The critical point is where the instructional language, the pupils' language and the teachers' language interact (D) because this interaction represents the actual use of language in the mathematics classroom.

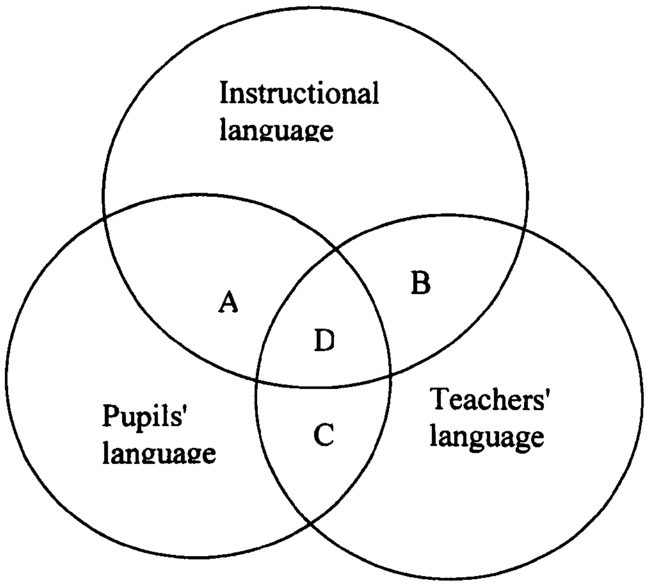


Figure 8.9: Sources of language for use in mathematics teaching.

Considering that in this study the instructional materials are bilingual (Chichewa and English), the pupils are bilingual (Chichewa and home language) and teachers are bilingual (Chichewa and English) and their language competencies differ markedly, the nature of language interaction becomes more complex. Teachers are aware of this bilingualism and that is why they experience concerns as they attempt to explicitly use language in mathematics teaching.

8.4.1 Pupils' language competence

I am using this terminology as shorthand to mean pupils' competence in the language of instruction. Frequently teachers responded by commenting that the pupils' language competence was very important in a number of ways. When Chichewa is used in mathematics teaching, there was a general view that lessons were more successful. One teacher expressed it thus:

> The mathematics lesson seems to be a success in most cases because Chichewa is their home language; so they are attentive and don't miss anything (February 9, 1999).

This raises what appeared to be the major issue for many of the teachers interviewed - that Chichewa is the *lingua franca* for the pupils - the home, native language. When teachers used Chichewa, pupils seemed to them to be somehow more engaged in lessons and more able to be reactive. This suggests that when teachers used Chichewa, there were fewer immediate language barriers. It may be that success here is being measured not necessarily by the learning or attainment of pupils, but by the ease with which teachers felt they communicated with pupils.

A further indication of the importance teachers ascribed to pupils' language competence was that when Chichewa is used in mathematics teaching, pupils seemed to answer questions easily, as one teacher indicated:

> The pupils understand very quickly what they are taught and they answer questions very accurately (February 11, 1999).

This is an indication that teachers perceived pupils' involvement in verbal interaction to be enhanced by the use of Chichewa.

A third issue for teachers arose in the way in which pupils could talk readily about everyday objects, when Chichewa is used in mathematics teaching, typically "most children understand and speak very well and name objects that they know" (February 11, 1999).

Finally, and related to that previous issue, teachers reported preferring to use Chichewa because the pupils were in the transition between home and school. "They speak Chichewa in their homes. So English is a strange language to them. They understand Chichewa better" (February 11, 1999).

In summary, there seem to be several aspects of children' competence in Chichewa that cause teachers to see positive advantages to Chichewa over English for teaching pupils in the early years. This is an interesting finding because it begins to raise some conflicting and contradictory issues that represent dilemmas and tensions in teachers as will become clear as I discuss further aspects of the data in the next section.

8.4.2 Teacher language competence

Another aspect is teacher language competence, which I am using to stand for the teachers' competence in the language of instruction. It was evident from the teachers' responses that the influence of teachers' language competence on the classroom discourse was different from the influence of the pupils' language competence. One teacher responded that it was possible for teachers to "teach in Chichewa because it is the language that we can speak all the time. No child can have a problem to understand whatever we teach since it is our language" (February 9, 1999).

This raises another concern of in many teachers that I interviewed. Chichewa was a *lingua franca* not only for pupils but also for teachers and this aspect made teachers communicate with pupils in Chichewa very easily.

Nevertheless some concerns arose from prolonged use of Chichewa in mathematics teaching which results in lowering teacher competence in English as well as in teachers using Chichewa tha was too difficult for the pupils to understand. Firstly, teachers felt that when Chichewa is used in mathematics teaching, teachers fail to pronounce English terms suggesting that teacher' competence in English is lowered. Here one of the responses was that "I have been seeing some teachers especially in standard one, where, instead of saying one, they say wa-ni; is it because of the Chichewa that they speak?" (February 9, 1999).

Second, when Chichewa is used in mathematics teaching "the kind of Chichewa the teacher is using is not matching with the language of the children" (February 9, 1999). This suggests that when teachers use a dominant language as a medium of instruction, they tend to use language difficult for pupils to understand. It appears that teachers assume too much about pupils' language competence in Chichewa.

Third, the data analysis shows that using Chichewa in mathematics teaching in lower primary made it difficult for the same teachers to teach mathematics in English in the middle and upper classes. The concern was:

> that there are some teachers who teach some subjects in the senior classes and the lessons are conducted in English. So if they come to teach the lessons in standards 3 and 4, they use English because they are used to English. They forget that they are teaching pupils who do not speak English. Sometimes the children do not understand what the teacher is saying. All this is because the teacher is used to teaching in English in the senior classes (February 9, 1999).

This predisposition does not reflect the teachers' language competence, but more the lack of techniques in using the language in enhancing learning.

8.4.3 Inconsistency of instructional languages

I use the terminology inconsistency of instructional languages to refer to the languages used in writing instructional materials including the lesson plans and also the language used for delivering the lesson in the classroom. Teachers were concerned with inconsistency of instructional languages in that when Chichewa is used in mathematics teaching, teachers found that preparing a mathematics lesson in English and presenting it in Chichewa was quite challenging for a mathematics teacher. Specifically the pressure arose as teachers shift from Chichewa to English and back as they prepare and deliver the lesson. The shifting between the languages required that teachers find enough mathematical vocabulary equivalents.

Preparing a mathematics lesson using a Teacher's Guide written in English and the corresponding Pupils' Book in Chichewa exacerbated the pressures. One of the teachers' responses was:

> I think that somehow preparation is a problem because of the textbooks, which are written in Chichewa, and the corresponding teachers' guide is in English. We prepare in Chichewa but write a lesson plan in English and teach it in Chichewa; because of the differences in the two books we have problems to teach in Chichewa (February 9, 1999).

This implies that there is a need for language code switching during teacher preparation for lessons partly because of the instructional materials, and partly the mystifying language policy in education imbued by language incompetence.

8.4.4 Limiting the range of languages for instruction

Limiting the range of languages for use in mathematics teaching refers to the need for lower numbers of languages to be used in mathematics teaching, which formed an essential part of teachers' thinking. This occurred on two fronts - to avoid confusing pupils and because some teachers know one local language only. To this effect it was frequent to hear teachers say that Chichewa should be used in mathematics teaching, as introducing another language would only *confuse pupils*. Furthermore, some teachers do not know other local languages apart from Chichewa. Some of those interviewed stated:

> In this area, many young children are Yao. So for me it is difficult to speak their language that can help them understand mathematics, as I don't speak Chiyao but Chimang'anja only (February 9, 1999).

The two, however, are entwined and a main focus is that teachers are not comfortable when more than one language is used as a medium of instruction in mathematics teaching. Teachers felt that limiting the range of languages would perhaps reduce the pressures and concerns experienced during the use of language in mathematics teaching.

8.4.5 Inconsistency in use of languages between the classroom discourse and the textbooks

What appeared to be another source of concerns was the inconsistency in the use of language in the mathematics textbooks. Teachers felt that the "language used in the textbooks was not appropriate" and that there was a need to "consistently use the correct mathematical terms in Chichewa". Teachers indicated that the terms used in mathematics books were not suitable and that this affected the way mathematics was being taught in Chichewa. Therefore, they indicated that there was a need to use correct words to describe mathematical concepts in the books. One of the teachers called for consistency:

> in the terms used in the books because sometimes when teachers want to use these words, for example, in the book there is kuphatikiza, equals, somewhere you write zitsala, and all this can be confusing especially when children get to higher classes (February 9, 1999).

Teachers are suggesting that there is language code switching in the textbooks and these create pressures in teachers' use of the language in mathematics.

8.4.6 Inconsistency in the language used in the teaching and learning materials

The findings from the data analysis showed that materials used in mathematics teaching provided a source of language for use during the lesson. Teachers and pupils engaged themselves in mathematical discussion through the use of the language to describe the materials or the mathematical aspects in the materials. Teachers indicated that teachers do not have the appropriate materials for teaching mathematics in Chichewa. It was important that appropriate materials be produced and made available to the teachers for use in mathematics teaching. "The teacher should be resourceful to find materials that are familiar to the children; the material children play with in their homes. Do not use [materials with] strange names. Children can sometimes bring some of the materials from their homes" (February 11, 1999). This is evident enough to suggest that the language used in the instructional materials causes considerable pressures in teachers as they use language in mathematics teaching.

Teachers indicated that pupils did not have the materials for teaching and learning mathematics in Chichewa. It was important that appropriate materials be produced and made available to the pupils for use in mathematics teaching. "Use attractive teaching and learning materials whether they are in Chichewa or not they should be attractive so that everyone can understand" (February 9, 1999).

8.4.7 Lack of teacher training and support in the use of language

Another concern was about teacher training and supervision because I see them as related to effective use of language in mathematics teaching (See Figure 8.10). While initial teacher training course provide the basic knowledge and skills in the use of language in mathematics teaching, much remains with how teachers actual think through and plan for the use of language in terms of what to say and how to say it so that it provide pupils with an opportunity to learn mathematics easily. The professional support and the availability of intructional materials help teachers in the thinking and planning for the use of language in mathematics.

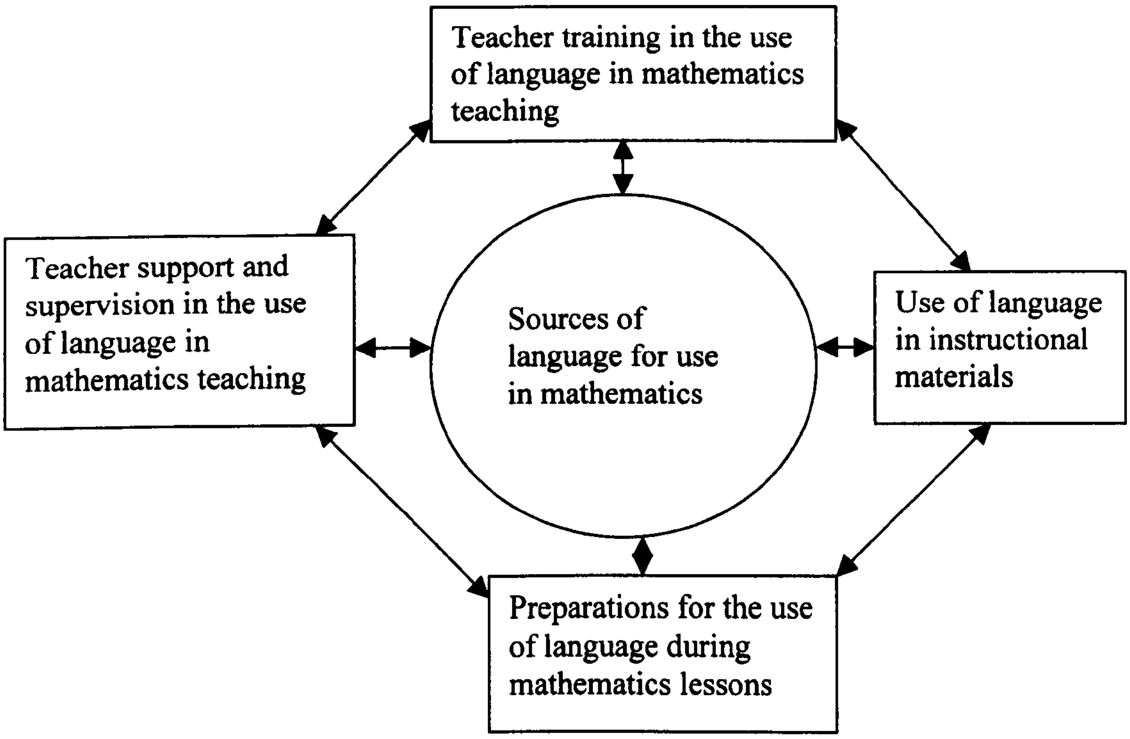


Figure 8.10: The influence of teacher support and training on the language use in mathematics teaching.

Teachers felt that they were not trained in the use of language in mathematics teaching during preservice or inservice programmes. Supervisors do not pay attention to the use of language in mathematics classroom.

8.5 Conclusion

The analysis of the data has identified for me that there are several concerns and pressure in the use of Chichewa or English in mathematics teaching. The group of issues became themes not only because they occurred frequently in the data but also they were critical in their nature as representing the teachers' tendencies in the use of language in mathematics teaching. I was not interested in how many teachers demonstrated that tendency but the meaning implied in what the teachers told me. Thus an issue became critical when it showed some contradictory tendency. In identifying the concerns, I am not saying that they are important and discrete teachers' perceptions of use of language in mathematics teaching. They are my constructions, both in terms of data collection, analysis and organisation of the issues. They served as a categorising mechanism as I delve into the data from teachers to reach a deeper organisation of their perceptions. In conclusion, it appears that teachers experience a number of concerns and pressures as they use language in mathematics teaching. The concerns and pressures seem to be caused by different factors, which I expand upon as I continue exploring them in the next Chapter.

CHAPTER 9

LINGUISTIC DILEMMAS AND TENSIONS OF THE MATHEMATICS TEACHERS.

> We assume that the primary function of language is the communication of meanings and that describing linguistic events in the classroom in terms of the meanings expressed by teachers and students was a potentially fruitful direction of research (Bellack, *et al.*,1966: 2).

9.0 Introduction

This chapter presents a synthesis of the issues identified through the data analysis. In particular, it considers the pressures faced by the mathematics teachers in the use of language in mathematics classroom. The language policy that mathematics is taught in Chichewa in standards 1 to 4 and in English from Standard 5 seem to have created some concerns and pressure in the classroom communication. Teachers are now facing increasing pressure to implement the language policy on medium of instruction to raise the standards of mathematics teaching. This is set within the context of managing the problems of the classroom communication caused by the use of language. As a result, the role of language in mathematics teaching remains both challenging and complex, requiring high level of skill in a range of diverse and often competing areas. The concerns that emerged from the analysis of the data reveal that there are dilemmas and tensions in the mathematics teachers when it comes to the use of language in mathematics classes. In deconstructing the data, I identified teachers' concerns, which represented the contradictory demands on the medium of instruction, which required that teachers constantly make a choice regarding what to do with the language. These concerns were labelled *dilemmas*. On the other hand, I identified some teachers concerns, which represented pressure exerted on the teachers, the pupils, and the curriculum because of the type of the medium of instruction used in mathematics teaching. I labelled these concerns *tensions*. The tensions and dilemmas facing mathematics teachers tend to reflect the multi-faceted demands of the roles of language in mathematics teaching. Teachers are constantly juggling demands upon the pupils, the subject, and themselves. They reflect the concerns of teachers who would like to use language to achieve educational goals.

The constructs of tensions and dilemmas were selected to describe the teachers' concerns because they offer lenses through which to consider the accounts of mathematics teaching through language in bilingual classroom. Using these two constructs, the immediacy of the everyday conflicts faced by many of the mathematics teachers in this study can be captured. The notion of dilemmas and tensions underscores the continuing dynamics between their personal values, language function and mathematical demands and captures their pressures, challenges, concerns and aspirations.

The main distinction between a tension and a dilemma concerns the possibilities of choice and influence. The tensions identified in this study tended to be those over which mathematics teachers had little choice or influence. The dilemmas did exist but the degree to which the teachers exercised the possibilities and choice varied considerably. A dilemma in this sense is a situation, which presents at least two contradictory propositions. Whichever is chosen, however, will not be entirely satisfactory. However, in practice the distinction between dilemmas and tensions is subtle because in most cases dilemmas result into some kind of tension in an individual.

Again it was becoming clear to me that the teachers' dilemmas and tensions had their origin and I labelled these the *sources of dilemmas and tensions*. The impact of the dilemmas and tensions of the teachers' perceptions of the use of language in mathematics was also evident from the data and I labelled these *Teachers' mental images*. I now discuss the teachers' dilemmas and tensions in the use of language in mathematics teaching together with their possible sources and the teachers' mental images. Finally, I present what I call a sociolinguistic model of the mathematics teachers.

9.1 Linguistic dilemmas of mathematics teachers

In deconstructing the data, I identified five pairs of conflicting demands from which a teacher had to make a choice. I do not want to claim that the list is exhaustive but that they have been selected to illustrate the kind of dilemmas which teachers experience as they use language in mathematics teaching as captured by my data. The dilemmas include:

- To meet a child's immediate learning needs or to prepare the child for future life.
- To teach language through mathematics or to teach mathematics through language.
- To reach many pupils or to access mathematics knowledge.
- To be monolinguistic or to code switch between Chichewa and English.

- To teach mathematics in Chichewa or in English.

I now present each dilemma, giving evidence from the data wherever possible.

9.1.1 To meet immediate child's learning needs or to prepare the child for future life

There is a dilemma that is created in the teachers due to the attempt to meet the child's immediate learning needs while at the same time trying to prepare children for future life. For example the children's immediate learning needs require that they understand mathematics by learning in a language that provides the least communication barrier whereas the same pupils require that they get ready for the future linguistic challenges of education by learning a new language.

9.1.2 To teach language through mathematics or to teach mathematics through language

The second dilemma concerns teachers' choice between teaching mathematics through a language and teaching language through mathematics. Teachers were aware that one of their roles was to make pupils understand mathematics. To achieve this role teachers are expected to pay more attention to the mathematical discourse than perhaps the classroom discourse (language of instruction). However, mathematical content exists in a highly specialised language - the language for communicating mathematical concepts. Teachers experience a dilemma when it comes to deciding whether to teach mathematical content to pupils who have no language for communicating the content. This dilemma is a question of chicken and egg. Balancing between mathematical knowledge and language for instruction is a concern for teachers.

9.1.3 To reach many pupils or to access mathematical knowledge

Teachers were concerned with equity as well as access of mathematical knowledge in classroom discourse. On the one hand, they said that when they used Chichewa, many pupils were able to answer questions, implying that teachers were able to reach as many pupils as possible. This is not the case when English is used. On the other hand teachers find most of the mathematical vocabulary in English; thus they discuss most of the mathematical concepts in English. The dilemma arises when teachers have to decide whether to achieve equity through using Chichewa or to access mathematics through using English.

9.1.4 To be monolinguistic or to code switch between Chichewa and English

Language code switching is another manifestation of dilemma in classroom discourse in two ways. First, the teachers' tendency that mathematical concepts can best be described in English and not in Chichewa, they are at pains to use the appropriate English terms. Second, teachers had to choose between using English terms with English spelling or Chichewa spellings although they were pronounced in English. What was interesting is how teachers gave English spelt Chichewa equivalents to number names in English such as 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 as zilo, *wani, thu, fili, folo, faifi, sikisi, seveni, eight*, and *naini* and also such terms as *nambala* (number), *thirayiyango* (triangle), etc. Yet these numbers have names in

Chichewa and they are widely used today (Kaphesi, 1997). Such terms were used even where plausible Chichewa equivalents were available to the teachers. In most cases when teachers were asked to give a Chichewa equivalent to English term they would spontaneously give a contrived word and only when they were asked again would they give a Chichewa equivalent. It is possible that teachers are gradually losing the Chichewa mathematical terms because of not using them or because of the feeling that the Chichewa terms do not describe the mathematical terms with sufficient precision. However, most of them were able to remember enough terms to be able to discuss mathematics in Chichewa. This may signify gradual replacement of the use of local language in mathematics teaching by the English terms-representing a language shift.

9.1.5 To teach mathematics in Chichewa or in English

The findings show that teachers gave more Chichewa to English mathematical vocabulary equivalents (72.60%) than English to Chichewa mathematical vocabulary. This suggests that the teachers' knowledge of mathematical vocabulary was more limited in Chichewa than in English. This pattern has implications on how teachers use Chichewa or English in mathematics teaching. The difference in teachers' knowledge of equivalents of mathematical vocabularies suggests that teachers are likely to use more English terms than Chichewa when teaching mathematics in Chichewa medium lessons. Considering that pupils do not speak English, this tendency is likely to create dilemmas in the teachers who find more mathematics vocabulary terms in English than in Chichewa - the dilemma of whether to teach mathematics in English or teach pupils in Chichewa.

9.2 Linguistic tensions in the mathematics teachers

In deconstructing the data, a number of tensions were identified from the data analysis. However, just like the dilemmas, these are not exhaustive but enough to illustrate the pressure which operate on the teachers as they use language in mathematics teaching. The tensions include the following:

- The difference between teacher and pupil competences in the language of instruction and the mathematical language;
- The clash between the culture in mathematics and the culture in the language of instruction;
- The disparity between the language in instructional materials and the pupils/teachers competencies in the instructional language;
- Limited range of use of language in the classroom and the linguistic demands of mathematics teaching;
- The mismatch of mathematical vocabulary between Chichewa and English;
- Inadequate teacher knowledge of mathematical vocabulary;
- Teachers' attitudes towards using mathematical vocabulary in Chichewa;
- The linguistic difference between Chichewa and English.

I now present these linguistic tensions in mathematics teaching in turn.

9.2.1 The difference between teachers and pupils competencies in the language of instruction and the mathematical language

A tension arises between teacher competence and pupils competence in instructional languages. It appears that in most cases, where English is a medium of instruction, teachers seem to be more competent in English than pupils are whereas teachers may be less competent in Chichewa than are the pupils. This imbalance in language competence creates a tension when it comes to teachers using either Chichewa or English for instruction.

9.2.2 The crash between the culture in mathematics and the culture in the language of instruction

Another tension arises due to difference in culture between mathematics and language of instruction. It appears from the data analysis that the culture brought into classroom through mathematics teaching is different from a culture in the medium of instruction and usually teachers have a problem to integrate the two cultures. This tension is manifested in the desire for relevance and applicability of mathematics knowledge to everyday life.

9.2.3 The disparity between the language in instructional materials and the pupils/teachers competencies in the instructional language

The disparity between the language in instructional materials and teacher/pupils' language competence in the medium of instruction creates another tension in teachers' use of language in mathematics teaching. On instructional materials, teachers were concerned with language use in the textbooks for mathematics. Teachers were not sure whether textbooks prepared in English or in Chichewa provide distorted information about mathematics and in so doing confused the learners. Yet they strongly agree that using Chichewa, and not English distorts the meaning of mathematical concepts. This is because with the use of one set of textbooks for mathematics, teachers were not able to assess the language influence of the books on mathematics. However, it was possible to assess the language influence from the everyday use of language and mathematical language in mathematics discourse.

Although teachers agreed that, in most cases, it is difficult to understand mathematical concepts because the Pupil's Book is written in Chichewa while the Teacher's Guide is in English, they strongly agreed that both Pupils' Book and the corresponding teacher's guide should be written in English and not in Chichewa. However, teachers were divided on whether there are no reference books for mathematics that could help teachers use Chichewa or English in mathematics teaching. Although teachers were not sure that there are fewer numbers of textbooks for mathematics written in both Chichewa and English, they tended to agree more for English medium than for Chichewa medium. Therefore, the books that are available for use in schools tend to exert pressure on which language to use in mathematics teaching.

9.2.4 The limited range of use of language in the classroom and the linguistic demands of mathematics teaching

Limited range of use of language was evident in instructional materials, pupils' language use, teachers' language use and classroom discourse as source of tensions in teachers' use of language in mathematics teaching. Firstly, language in the instructional materials was both in Chichewa and in English. The instructional materials used during both the Chichewa and English medium lessons included charts of the drawings, which were usually drawn on the chalkboard. A shop scene was also used for teaching addition of money. In both cases, names of items such as onions, beans, cassava, cooking oil, soap, skin oil, oranges, biscuits and sweets with their prices were indicated in local currency of *kwacha* and *tambala*. The items on the charts had their names written in either Chichewa or English or English with Chichewa spellings. This state of bilingualism in the instructional materials brought about pressure on teachers' use of Chichewa in mathematics teaching. Nevertheless data from the questionnaires indicated that teachers strongly disagreed that there were no teaching/learning aids prepared in Chichewa. However, they were not sure whether there were no teaching/learning materials prepared in English. This scarcity of instructional materials in Chichewa or in English limited the range of use of language in mathematics teaching.

In both Chichewa and English medium lessons, non-indigenous materials with English names were used. This had an effect on how Chichewa was used during the lessons as it made both teachers and pupils' use English to name some of the items during the Chichewa medium lessons. However, similar materials were used in English medium lessons, but teachers did not use any Chichewa names of items. This tendency suggests that teachers used teaching and learning materials that were suited to English medium rather than Chichewa medium mathematics lessons and this created pressure on how to teach mathematics in Chichewa.

Another striking tendency that emerged from the data analysis was that textbooks were not used for language development in mathematics. First, although seven of the 16 lessons used the Pupil's Book,I noticed that books were rarely used for reading mathematical texts both in Chichewa and in English medium lessons. In one case, a teacher used a book during an English medium lesson and yet she did not use it during the Chichewa medium lesson. Second, where they were used, either the teacher was using them to copy a problem onto the chalkboard or they were used for doing written exercises. The textbooks were seen not to provide an opportunity for the teaching of mathematics through language. For example, lists of key words for mathematical concepts that must be taught are missing in the textbooks. This observation raises a question of whether children in Malawi Primary schools learn mathematical language from the mathematics textbooks or from teachers only.

Third, limited range of use of language was also shown in the length of pupils' utterance as evident from the findings from discourse analysis. Pupils spoke very little;

instead teachers dominated the talk. However, where pupils talked, their utterances were short and brief and mostly one word. They did not give long descriptions or explanations or reactions.

9.2.5 The mismatch of mathematical vocabulary between Chichewa and English

The findings shows that the equivalents of mathematics vocabularies that teachers in the study schools gave ranged from 1 to 12 different terminology with the majority of the equivalents being 3 or 4. In order to understand the differences in the range of equivalents to mathematics vocabularies that teachers gave, it is important to keep in mind that teachers did not have to give more than one equivalent. Instead the ranges appeared as a result of listing all the terms that different teachers wrote down for a particular mathematical vocabulary. This range of mathematics vocabulary in Chichewa may mean two things. Firstly, that teachers did not have the vocabulary for the particular mathematical concepts, which they may use in mathematics teaching. Secondly, teachers may not want to use the mathematics vocabulary in Chichewa. Yet effective use of language in mathematics teaching requires knowledge of mathematical vocabulary. The matching of the mathematical vocabulary between Chichewa and English is crucial, as it is a means of ensuring the smooth transition of pupils from home language to classroom language. Therefore, the mismatch of the vocabulary created pressure on teachers in the use of language in mathematics teaching.

9.2.6 Inadequate teacher knowledge of mathematical vocabulary

By gaving completely wrong terms as mathematical vocabulary equivalents, teachers might have demonstrated that they either did not have the basic knowledge of mathematical concepts or teachers had the mathematical misconceptions. For example, teachers confused the terms for *volume* and *capacity* partly because of lack of knowledge of the two mathematical concepts. This state of teacher knowledge of mathematical vocabulary equivalents is fundamentally related to the mathematics education programme and specifically the teacher training programmes.

The ability of teachers to identify mathematical vocabulary equivalents between Chichewa and English was another concern. Teachers were asked to identify the mathematical vocabulary equivalents between Chichewa and English. They gave more Chichewa equivalents in English terms than English equivalents to Chichewa. Nevertheless, the range of mathematics vocabulary that teachers used during the lessons demonstrates the varied meanings that teachers have about the mathematics vocabulary and also how the mathematics vocabulary equivalent can contribute to mathematical misconceptions. My understanding is that, by using this range of terminology to describe a single mathematical concept, teachers may bring about mathematical misconceptions that conjure up wrong and conflicting mathematical images in the pupils. Furthermore, if teachers are aware of their deficiency in mathematical vocabulary equivalents, they will experience dilemmas and tensions in the use of the language in mathematics teaching.

The fact that all teachers demonstrated this problem is evidence enough that the problem was about understanding *the linguistic nature of the mathematics.* I want to contrast it with another situation where teachers from different school settings – urban and rural - gave different amount of mathematical vocabulary equivalents between Chichewa and English. Teachers in the urban schools gave more English vocabulary than teachers in rural schools. I prefer to term this *the social setting of mathematical language* because of its association with the social setting of the schools. This revelation may suggest that this type of tension depends on the school locality; though there is need for further study.

9.2.7 Teachers' attitudes towards using mathematical vocabulary in Chichewa

The tension was identified from the classroom observation in that teachers substitute terms they don't like. Teachers use different terms to describe the same concepts to pupils and sometimes they may not be consistent in using these mathematical equivalents. For example, the two terms, *kuphatikiza* and *kuwonkhetsa* were used to mean the same concept of addition, and this was common throughout the lessons observed in this study. At the same school, another teacher used *kuphatikiza* and *kuwonkhetsa* with different purposes. The teacher told the pupils to use *Kuwonkhetsa* because that is the term used in the textbooks to mean addition; otherwise she was likely to use *Kuphatikiza* to mean addition as it was revealed when she explained why she kept on switching between *kuphatikiza* and *kuwonkhetsa*, she said "I don't like the word *kuwonkhetsa.* I don't think that is Chichewa. *Kuphatikiza* is the correct Chichewa equivalent for addition" (School Two, Zomba, 2000). Considering certain terminology in Chichewa as not appropriate because teachers believed mathematics could not best be taught in Chichewa even if the terms were precise is evident enough of the teachers' attitude towards a language of instruction. Attitudes created tensions in the use of language because teachers had to base their actions on what they believed would work in the classroom. This clearly indicates some *teachers' negative attitude towards use of Chichewa in mathematics.*

9.2.8 The linguistic difference between Chichewa and English.

Teachers used or avoided using cumbersome descriptions of mathematical concepts in Chichewa. For example, triangle was described as *Chinthu cha ngondya zitatu (see Appendix 8)* which literally means three-angled figure. One would argue that this is not different from the root meaning of the English sense of *triangle (tri – angle).* Perhaps teachers may be worried about the cumbersomeness of naming mathematical vocabulary equivalents such as triangle in Chichewa. Another example is how some numbers are named in Chichewa. 'Seventeen' is named as *khumi, zisanu* and *ziwri* (See Appendix 8), which mathematically means 10 + 5 + 2. By describing the concepts in this way, teachers demonstrated that they understood what the terms stood for but that there were no single name equivalents in Chichewa whereas the same concepts have single term vocabulary in English. Perhaps this state of vocabulary makes English vocabulary equivalents more usable than Chichewa vocabulary equivalents.

The dilemmas and tensions that have emerged from the data in using mathematics vocabulary during the lessons were related. For example, the teachers' attitude towards mathematical vocabulary in Chichewa may influence them into substituting some Chichewa terms with the English terms - language code switching. Similarly, linguistic differences that exist between Chichewa and English in describing mathematical concepts - such as saying seventeen in English or *Khumi, zisanu ndi ziwiri* in Chichewa - may also tempt teachers into language code switching. However, the influence of teacher attitudes and language code switching on linguistic difference between Chichewa and English seems not to be obvious.

9.3 Exploring the sources of the dilemmas and tensions

Four sources of dilemmas and tensions were identified from the data analysis. These include:

1. The linguistic nature of mathematics
2. The language policy in education
3. The dynamic classroom discourse
4. The source of language for use in the mathematics teaching

I now discuss each source, giving evidence wherever possible.

9.3.1 The linguistic nature of mathematics

From the analysis of the data, some dilemmas and tensions have emerged that highlight some considerable detail on the theoretical framework, which incorporates the forces, operating on teachers' perceptions of classroom discourse. Some of these appear to be subject based. For example, the linguistic nature of mathematics makes teachers feel that the use of English is more suitable than the use of Chichewa in mathematics teaching. Indeed teachers felt that language has a role of making mathematics relevant and applicable to everyday life. Yet teachers have limited mathematical vocabulary in Chichewa and this makes difficult to stick to Chichewa when teaching mathematics in Chichewa. Teachers perceived mathematics as a language full of technical terms that are mostly in English. When teachers said that they found it easier to teach mathematics in Chichewa than in English, they meant that they could use Chichewa for classroom discourse but not necessarily mathematics discourse. Teachers were aware of the linguistic demands of mathematics teaching and felt that the demands could not be met by using Chichewa. That is why they felt that they could not explain some terms in Chichewa. Therefore, from the analysis of the data, it can be concluded that teachers use Chichewa for classroom discourse and use English for mathematical discourse.

Teachers' perceptions are also based of the relevance and applicability of mathematics in everyday life. Teachers see the use of Chichewa or English in mathematics teaching as a function of relevance and applicability. In this case they felt that Chichewa was more appropriate than English in achieving this goal of relevance and applicability.

9.3.2 The mystifying language policy in education

The mystifying language policy in education also has emerged as one of the major sources of dilemmas and tensions, as it guides what teachers are required to do with the language. For instance, teachers felt that the use of Chichewa did not prepare the pupils for English medium classes in the upper levels. This implies that teachers did not see any sense in teaching the pupils in Chichewa for only four years and allow them to spend their education life learning in English. Teachers felt that the language policy in education does not cater for preparing pupils for life not merely a medium of communication and consequently part of their role to prepare children for a wider social needs in learning; ability to speak English and learn in English. To do this, teachers felt they needed to code switch between Chichewa and English in the early classes to prepare pupils for take off into English medium classes. It is this perception that makes teachers underplay the pupils' incompetence in the English language.

9.3.3 The dynamic classroom discourse

The findings also showed that the dynamic classroom discourse had influence on teachers' perception and use of language in mathematics teaching. Some of the elements of the dynamic classroom discourse included the teaching competence, teacher competence in the medium of instruction, pupils' competence in the language of instruction and the dual function of the language of instruction. The functions of the classroom seem to create dilemmas and tensions in the teachers with regard to how to use the language. For example, it was common for teachers to code switch between Chichewa and English because of the dilemma about whether to access the mathematical knowledge or to achieve equity among the pupils during the lesson. Silence among the pupils during the English medium mathematics lesson may not be an indicator of understanding of mathematics, obedience or linguistic incompetence. Teachers worked to break this silence by either doing most the work to themselves or code switching between Chichewa and English.

9.3.4 The limited source of language for use in mathematics classroom

Another source of dilemmas and tensions that emerged from the data analysis was the perception that language is a teaching resource. For instance, teachers felt that there was a limited range of languages they could use and these were mostly Chichewa and English. This perception was based on the fact that teachers were aware that pupils were fluent in Chichewa and not in English whereas teachers were fluent in both English and Chichewa. Sufficient mathematical vocabulary in English and not in Chichewa made teachers feel that the former was a more reliable teaching resource to use than the latter.

A related perception on language as a resource for teaching was the teachers' concerns about lack of support in terms of instructional materials and teaching and learning materials. Teachers were aware of the importance of the language used in the instructional materials and wished they were much better than they were. Teachers felt that the support they needed should include supervision and training in the use of language in mathematics teaching. This implies that the language policy in education was not well implemented.

What I have attempted to do in this section is to bring together the issues and themes that highlight teachers' perceptions in the use of language in mathematics teaching by drawing directly the evidence from the teachers' words and actions. I have tried to give the possible explanations of the sources of the perceptions and their implications on mathematics teaching. However, as I argued in Chapters 2, 3, 4 and 5, such perceptions are crucial because they a blueprint of what teachers do with language when teaching mathematics.

9.4 Sociolinguistic mental images of the mathematics teachers

In deconstructing teachers' perceptions of the use of language in mathematics teaching, I look at each theme in turn, and also attend to an underlying structure of the relationships among the dilemmas, tensions including their sources to develop the sociolinguistic mental images of the mathematics teachers. The mental images fall into four groups according to the degree of their relationships to the teachers' perceptions along the elements of the theoretical framework that I had developed in Chapters 2 and 3. I use the term 'mental images' to link the dilemmas and tensions with the sources together. I do not, however, use the mental images in a hierarchical sense of giving more importance to higher levels. I use "mental images" to illustrate how the dilemmas and tensions are organised, moving between sources to the actual dilemmas and tensions. I want to emphasise here that the dilemmas and tension are a result of the interaction between the various sources and the teachers' knowledge, attitudes, beliefs and practices in the use of language in the classrooms. This then is a symbolic representation resting on spatial references and drawing on teachers' linguistic behaviour within a mathematics classroom discourse. That is to say teachers understand the use of language in mathematics teaching from different perspectives which I interpret as

- externalising the mathematics discourse from the classroom discourse;
- setting conditions for use of language;
- using language in a classroom discourse; and
- sourcing language for use in mathematics discourse.

9.4.1 Externalising mathematics discourse from classroom discourse

One of the links between dilemmas and tensions and their sources is the teachers' understanding of the relationship between language and mathematics. Teachers tend to put language relative to mathematics. On the one hand, teachers perceive mathematics as a language with its own register. On the other hand teachers perceive mathematics as a body of knowledge and that language is used to describe it. I use the terminology externalising mathematics from language on two accounts. First, I want to emphasise my understanding that the degree of the dilemmas and tensions in the teachers' use of language in mathematics is a function of the way they perceive the relationship between language and mathematics. Second, I signify that process of perception, which emanates from the linguistic nature of mathematics, relates to external/internal linguistic demands of mathematics teaching. The linguistic nature of mathematics distinguishes the teachers' perceptions of mathematics teaching as constituting teaching mathematics through language as opposed to teaching language through mathematics.

In this process, teachers' main perceptions consist of the linguistic nature of mathematics. This seems to be very related to how teachers perceive mathematics, which consequently influences the classroom discourse. Teachers perceive mathematics as full of technical terms that are not readily available in some subjects such as Chichewa but are abundant in English and this perception affects and interacts with other aspects of language use in mathematics teaching. I refer to this as internal mathematical discourse because it involves teachers in orienting themselves to perceiving mathematics as a language, which should be approached like any other language. By perceiving that using Chichewa makes it easier to teach mathematics, perhaps teachers imply the external mathematical discourse whereby they refer to the common usage of language for communication rather than for specialised messages such as mathematical knowledge. They placed the language of instruction outside mathematics. These are the structural elements, which form the basis of the teacher perceptions of the use of language in mathematics. Teachers' perceptions are split between internal and external mathematical discourse.

9.4.2 Setting the conditions for classroom and mathematics discourses

I use the terminology *setting the conditions for classroom and mathematical discourses* because the language policy spells out what language to use, how and when to use it. It defines the expectations and aspirations in the use of language and teachers are expected to work towards achieving such goals. The conditions are set in many ways. However, in this study teachers perceived the conditions for using the language as set in the implementation strategies, curriculum design and the dual functions of the language in the classroom.

The fact that teachers perceive the change of medium of instruction from Chichewa to English as influencing their code switching underscores the conditions which the present mystifying language policy in education has created in mathematics teaching. I refer to this as teachers' **working conditions**, because it defines the conditions under which Chichewa and English are perceived and used in mathematics teaching. The analysis of teachers' perceptions showed that teachers felt that the conditions for the use of language are not favourable. The language policy in education provides the context in which teachers perceive the use of language in mathematics teaching. As described in Chapter 3, there are a number of inconsistencies in the guidelines for the use of language in education. I use the terminology of **mystifying language policy in education** to emphasise that the policy is *ambiguous*, prone to *different* interpretations and practices. Consequently, the language policy in education causes dilemmas and tensions.

Teachers perceive language use as having a **dual function** in mathematics teaching. Firstly, language is used for communication during the lesson. There was a concern with making pupils understand mathematics. To do this, the use of Chichewa seems to be the option. Secondly, language is used for preparing children for further education. Teachers were also concerned with poor preparation of pupils towards the change of medium of instruction to English in upper classes when Chichewa was used in mathematics teaching.

This was a direct response to the language policy in education, which requires that pupils learn in their mother tongue in the first four classes and change to English in the upper classes. It appears that some teachers felt that there was no need to delay using English during the lessons because when teachers use the language, they are also teaching the language. They see that either Chichewa or English alone does not help in achieving the dual function of language use in mathematics.

According to teachers' perceptions, implementation strategies of language policy in education influence the language use in mathematics teaching. While teachers disagreed that the cost of implementing the use of English in mathematics lesson was out of proportion to its value, they were not sure about the cost of implementing the use of Chichewa in mathematics lessons. Teachers strongly disagreed that they will be out of job due to a change of medium of instruction to Chichewa or English. Teachers were not sure whether English or Chichewa medium of instruction is imposed upon the teacher.

Teachers were concerned with *language policy across the curriculum*. They agreed that for some subjects the use of English or Chichewa instruction is not conducive to effective learning. Therefore, on language policy in education, teachers were concerned with the implementation process as well as the language used across the curriculum, as these were perceived as influencing the use of language in mathematics discourse.

9.4.3 Using language in the dynamic classroom discourse

Teachers were concerned with achieving the goal of not only constructing the mathematical knowledge but also preparing pupils for further education. The teachers' perceptions seem to suggest that the achievement of the goal depends on how they manage and control of the dynamics of the classroom discourse. The effective use of language in mathematics teaching is related to the classroom discourse and those teachers try to achieve the goal through classroom discourse. I refer to this as a **means of achieving the task** where there is dual task: the use of language in mathematics to construct mathematical knowledge as well as preparing the pupils for further education. Having taught the same lesson in Chichewa and then in English, teachers felt that pupils needed more help on what to say and how to say it in English medium lessons than in Chichewa medium lessons. The fact that the help is not necessarily in mathematical language but in ordinary language, has several implications. First, in English there are communication problems between the teacher and pupils. Second, the teaching task increases when teachers use English. This notion also was echoed when teachers lamented that teachers become complacent with the lesson when Chichewa is used.

9.4.4 Sourcing language for use in mathematical discourse

The findings show that teachers are preoccupied with where to get the appropriate language for use in mathematics teaching. They consider the teachers, the pupils and the materials as well as the professional support as the major sources of the language for use in teaching mathematics. However, they find such sources very unreliable, contradictory and sometimes confusing. It is against this notion that I use the terminology sourcing the language for use in mathematics teaching to emphasise the influence of various sources of classroom language on teachers use of language in mathematics teaching.

Teachers are concerned with the resources they use in the process of using language in mathematics teaching. Teachers' perceptions consist of the limited range of language resources for use, poor quality of resources in terms of inappropriate teaching and learning resources and instructional materials and teaching and learning incompetence. These seem to be related to and form a category of use of language as a resource in mathematics teaching. These are elements of language as a resource in mathematics teaching. Here a resource defines what can be said within the teachers' perceptions of use of language in mathematics and may be in opposition to use of language as a resource. In some respects, they represent the use of language not as a means for teaching mathematics but as an end in itself – using language for teaching the language.

Teachers were concerned about their inability to use language in mathematics teaching because of lack of support in terms of supervision and also lack of training in the use of language for mathematics teaching. These two constitute the major perceptions of what makes teachers unable to use language in mathematics teaching and they are related to how teachers evaluate themselves and see the teachers as a hindering factor in the use of language in mathematics teaching. I refer to this as effective use of language as a resource in mathematics teaching.

9.5 Representing the model

The findings from data analysis raise issues related to teachers' use of language are based on a number of inconsistencies in the educational system culminating in dilemmas and tensions in the teachers (see Sections 9.1 and 9.2). The common sources of dilemmas and tensions included the linguistic nature of mathematics, the mystifying language policy in education, the dynamic classroom discourse and the divergent sources of language for use in mathematics teaching (see Section 9.3). The terminology used to describe the dilemmas, tensions, the sociolinguistic images and the sources of the dilemmas ad tensions can be evasive because they are likely to reflect my value judgement of the data and consequently affect the validity of the analysis. What I did was to draw the teachers' own terminology and inclinations in attributing a label to the key dilemmas, tensions, sources of dilemmas and tensions and the sociolinguistic images as I interpret the data. The labels of the dilemmas, tensions, sources of dilemmas and tensions and the sociolinguistic images are therefore not objective or neutral, but are an indication of teachers' perceptions within each theme. I have tried to increase the validity by developing and expanding on the nature of the data I have allocated to each theme in my subsequent data analysis.

The major categories of issues became themes not only because they occurred frequently in the data but also they were critical in their nature as representing the teachers' tendencies in the use of language in mathematics teaching. I was not interested in how many teachers demonstrated that tendency but the meaning implied in what the teachers told me. An issue became a dilemma or tension when it showed some contradictory tendency to the most frequently held views. Dilemmas were deduced from where two or more contradictory tendencies were located in the teachers and tensions were identified from where teachers demonstrated some pressure resulting from the use of language in mathematics teaching.

For example, there were two instances in the focus group discussions where teachers appeared to contradict themselves with regard to what happens when Chichewa is used in mathematics teaching. They said that mathematics teaching was made easier when Chichewa was used as the medium of instruction and yet they felt that the use of Chichewa was not suitable for mathematics because mathematics was full of technical terms that were difficult to translate into Chichewa. These instances represent how complex and dynamic the classroom discourse is in mathematics teaching. Such contradictions are helpful in exposing and deconstructing different teachers' perceptions of the use of language in mathematics as will be evidenced in my subsequent data analysis.

In identifying these dilemmas and tensions, I am not saying that they are important and discrete teachers' perceptions of use of language in mathematics teaching. They are my constructions, both in terms of data collection, analysis and organisation of the issues. They served as a categorising mechanism as I delve into the data from teachers to reach a deeper organisation of their perceptions.

As I worked with the data analysis, there appeared to be a number of overlapping dilemmas and tensions their sources and linguistic mental images. The dielmmas and tensions emerging from linguistic nature of mathematics overlapped with the category of mystifying language policy in education. The dilemmas and tensions emerging from dynamic classroom discourse overlapped with the category of mystifying language policy in education and also the divergent sources of language for use in mathematics teaching. These overlaps emphasise the commonalties and consistency of dilemmas and tensions and cohesion of the model. However, the overlaps also show that some of the dilemmas and tensions may be linked to each other as a cause-effect relationship. For example, mystifying language policy in education might have caused teachers to experience teaching incompetence when using languages in mathematics teaching. In some cases, the themes themselves may not be the perceptions but the sources of perceptions. The images of cause-effect relationships among the dilemmas and tensions seem to be the way to explain the model for the teachers' understanding of use of language in mathematics teaching. It is with this notion that I would present my exploratory model as consisting of sources of dilemmas and tensions in the use of language in mathematics teaching.

Several possible relationships among the dilemmas and tensions were considered. It was considered not appropriate to describe the relationship as hierarchical as their occurrence does not show any marked difference in levels of complexity. Diagrams were used at some stages of model development but it was difficult to represent the general model in a Venn Diagram because some dilemmas and tensions did not show signs of overlapping. What appeared a feasible structural organisation of my model was to consider all the four sources of dilemmas and tensions as representing a sphere of influence on dilemmas and tensions in teachers' use of language in mathematics as shown in Figure 9.1.

Figure 9.2 maps out my understanding of the structure of teachers' tensions in the use of language in mathematics teaching. In constructing the diagrammatic structure of the model, I am reducing the conceptual complexity for the sake of visual simplicity. The intersecting circles in some diagrams of the themes indicate my understanding that there is interaction among the various elements of teachers' tensions in the use of language in mathematics. The descriptions on the left-hand side represent the sources of the tension, the

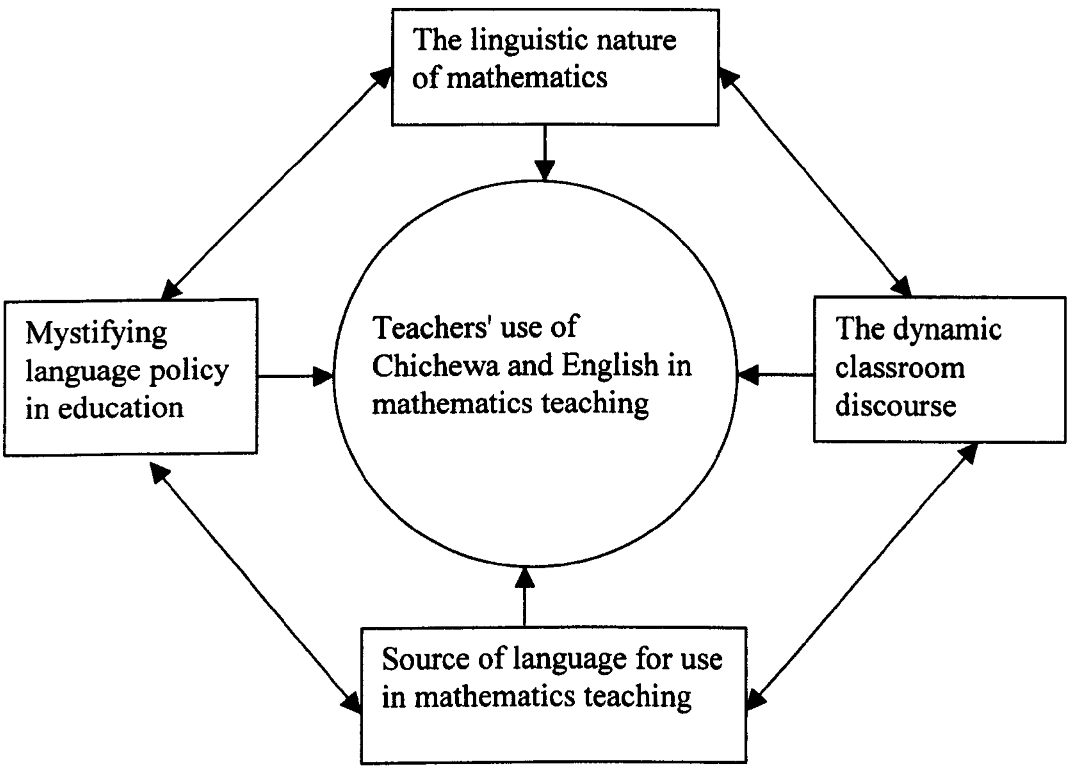


Figure 9.1: Some factors influencing the use of Chichewa or English in mathematics classrooms.

descriptions in the middle represent my interpretations of the process in which the tensions are understood and on the right are some of the elements of tensions. The influences are more theoretical than empirically based here because the data I collected on teachers' perceptions do not allow such effects and changes to be mapped or even identified particularly well. One hypothetical effect of the influence might be apparent in teachers' assumptions and expectations of classroom discourse. External conditions set by the language policy in education (both in the classroom and in the curriculum) force teachers to use copying strategies of language code switching between Chichewa and English. The fact that teachers acknowledged that they code switch between English and Chichewa terms in mathematics lessons underscores the tensions in which teachers are using the language.

The conditions both inside and outside the classroom are so mystifying that teachers are failing to use one language at a time. The sources of language for use in mathematics teaching are also not helping the teachers to make the best use of language in mathematics teaching as they distinctly contradict the language policy in education. Analysis of teachers' data on perceptions of the use of language in mathematics teaching has helped me construct this empirical structural model of organisation of the major themes in the teachers' conceptual and perceptual framework of dilemmas and tension in teaching.

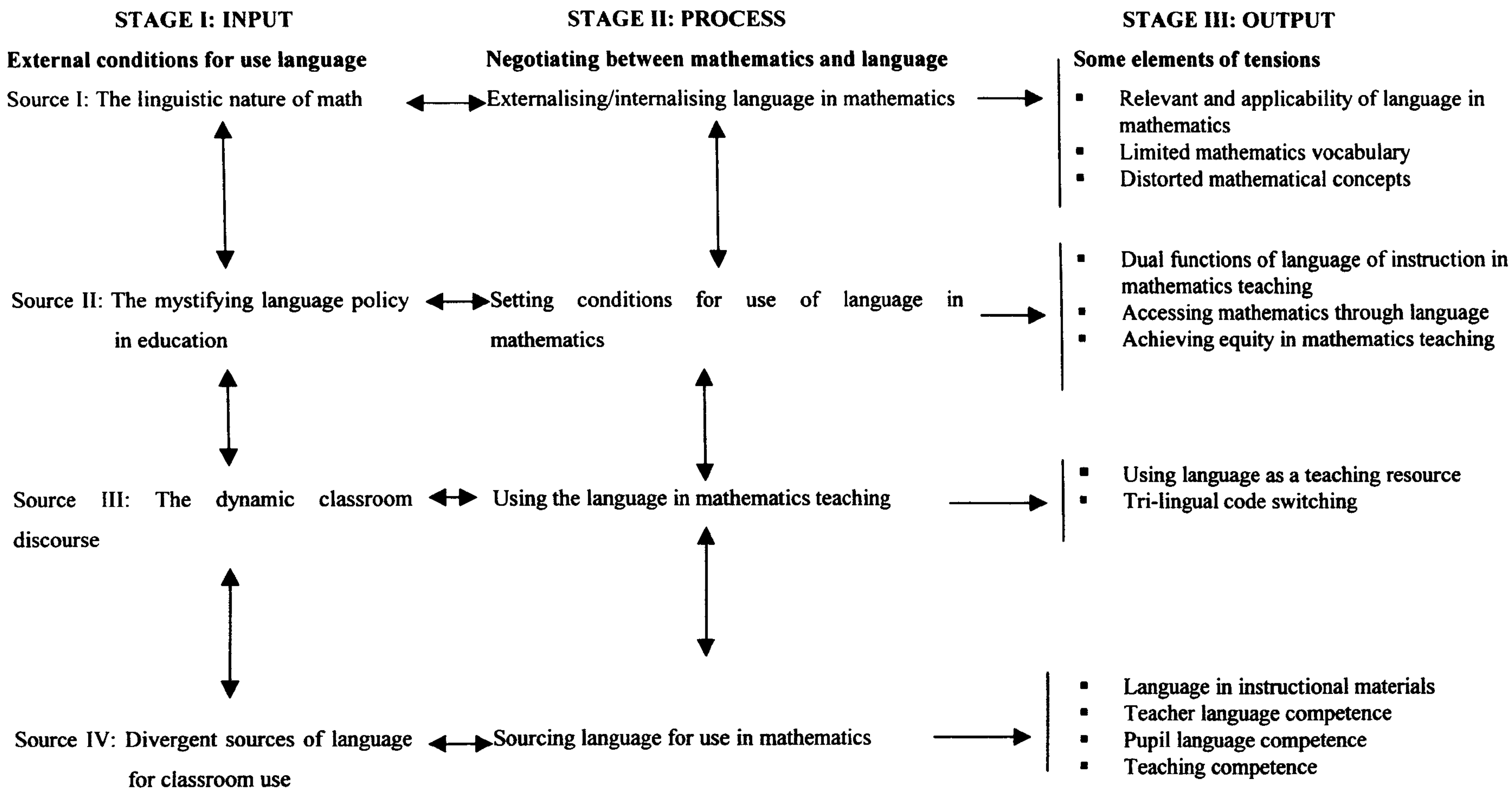


Figure 9.2: The model of the sociolinguistic orientation of the primary mathematics teachers.

I use the term *sources* to signify the possible causes of teachers' tensions. There are four basic possible causes of teacher tensions, which have emerged from the data analysis (see Figure 9.2). These are the linguistic nature of mathematics, the mystifying language policy in education, the dynamic classroom discourse and the inconsistency in sources of language for use in mathematics teaching.

In Source I, teachers experience the nature of mathematics which makes them perceive the relationship between language and mathematics as either external (there is a special language for mathematics) or internal (mathematics as a language). This may result in perceiving the relevance and applicability of language in mathematics based on the limited mathematics vocabulary and the distorted mathematical issues.

In Source II teachers go through the emotions of the mystifying language policy in education which set the conditions for using the language in mathematics. This may result into dual functions of language of instruction in mathematics teaching that may affect accessing mathematics through language and achieving equity in mathematics teaching.

Source III is where a teacher perceives the use of language in mathematics teaching in terms of the dynamics of the classroom discourse. This is how the language should be used given the dynamic context of the classroom manifested through using language as a teaching resource, tri-lingual code switching, language in instructional materials, teacher language competence and pupil language competence.

Source IV is where teachers perceive the sources of language for use in mathematics teaching as limited. Both teachers and pupils have language competence problems in both

English and Chichewa. The instructional materials do not provide the necessary help in identifying mathematical vocabulary that can be used in mathematics teaching. Teachers are not trained or supervised in using language in mathematics teaching.

My understanding is that a teacher progresses in stages, which are input, process and the output (see Figure 9.2). In stage I, a teacher experiences the external influences consisting of the linguistic nature of mathematics, the mystifying language policy in education, the dynamic classroom discourse and limited sources of language for use in mathematics teaching which make up the conditions under which language should be used in mathematics teaching. In stage II, a teacher arbitrates the conflicts between language and mathematics through interpretation of the conditions set by the external influences. At this stage, a teacher is preoccupied with externalising/internalising language in mathematics, interpreting the conditions for use of language in mathematics and using the language in mathematics teaching and sourcing the language for use in mathematics teaching. In stage III teachers actually describe what they perceive given the input and the process. For example the nature of mathematics, which makes teachers externalise language from mathematics, teachers perceive the use of language in mathematics in terms of relevance and applicability of language in mathematics limited mathematics vocabulary and distorted mathematical issues. Given the mystifying language policy in education which sets the conditions for use of language in mathematics, teachers perceive the use of language in mathematics teaching in terms of the dual functions of language of instruction in mathematics teaching, accessing mathematics through language and achieving equity in mathematics teaching. The dynamic classroom discourse which provides the opportunity for using language in mathematics makes teachers perceive using language as a teaching resource, tri-lingual code switching, language in instructional materials, teacher language competence and pupil language competence.

The arrows used in the diagram indicate that the model is interactive in the sense that every component between and within stages influence each other resulting into the elements listed at the end of the diagram.

9.6 Conclusion

In this way, I have presented my understanding of the findings from the analysis of data from teachers' focus group discussion, clinical interviews, questionnaires, classroom observation and discourse analysis. In the analysis procedures, I have explored the theory, which explains the teachers understanding of use of Chichewa and English in mathematics discourse. During the analysis, I have identified four sources, processes and types of dilemmas and tensions. In discussing these findings, I have been progressive and iterative at the same time relied on using direct quotations of what teachers said to enrich and validate my findings. I now turn to discuss the implications of the findings on theory and practice in the next chapter.

CHAPTER 10

DISCUSSION AND CONCLUSION

> If there is always the likelihood of saying what is obvious, there is also the possibility of saying some things, which are not normally seen because they are so obvious (Edwards and Furlong, 1978: 3)

10.1 Overview of the study

The aim of this chapter is to present reflections on the analysis and the findings of the data. Limitations of the study are also discussed to provide the scope within which the study findings are valid. A brief description of the successes of the study is given and the areas for future research are outlined. Finally, the recommendations are stated.

The main purpose of this study was to investigate how teachers understand and use language in mathematics teaching. In order to attain the goals of the study, the following guiding objectives were formulated:

1 Identify the teacher perceptions of the use of Chichewa and English in mathematics teaching.

2 Determine the extent to which teachers can translate mathematical vocabulary equivalents between Chichewa and English.

3 Explore the extent to which teachers use language in mathematics teaching.

4 Analyse the patterns of teacher language use in mathematics lessons using discourse analysis.

To collect the relevant data, the study involved 40 primary school mathematics teachers drawn from 10 primary schools selected in the Zomba district of Malawi. The teachers were teaching mathematics in standards 1- 4 during the study. Two groups of five teachers each were involved in focus group discussions on the use of English or Chichewa in mathematics teaching. Tests were administered to the 40 teachers on giving Chichewa equivalents in February 1999 and English equivalents of the same terms in February 2000. The same teachers completed two parallel questionnaires, one on perceptions of the use of Chichewa was administered in February 1999, and one on the perception of the use of English in mathematics teaching was administered to the same teachers in February 2000. Clinical interviews were conducted with the eight teachers who volunteered to have their lessons observed. A total of sixteen lessons on addition of money using a shop scene were video-recorded and discourse analysed to determine how teachers use language in mathematics teaching .

Using the five data collection strategies – focus group discussion, questionnaire, tests, clinical interviews, and classroom observation– brought an element of triangulation into the study. This was done to improve the accuracy of the conclusion made from the findings of the study. It also provides richness and depth to the data collected, thereby creating a strong base for credibility.

In reviewing the data analysis of the study, some insights into teachers' knowledge, perceptions and practices of the use of Chichewa and English in mathematics teaching can be stated. However, it may not be appropriate whatever methodological persuasion to present my findings as the best account of how teachers use language in mathematics teaching. Nevertheless, the inseparability of the theoretical framework and empirical evidence on which this study is developed makes it possible for me to offer a final account of the teachers' use of Chichewa and English in mathematics teaching in Malawi Primary schools.

10.2 Reflections on the methodologies of the study

The findings of the study have answered the research questions using the described methods of data collection. The findings show that triangulation has been applied throughout the data collection, analysis and interpretation procedures; thus providing an in depth understanding of how teachers use Chichewa and English in mathematics. The study has clearly demonstrated the importance of triangulation in that it was established that because of the conditions prevalent in the classroom, teachers say one thing and do quite the opposite about use of language in mathematics teaching. The use of the interview, or questionnaire alone without observing lessons would not yield valid findings of this nature. The study has also demonstrated how complex the nature of language use in the classroom is and that further study is urgently required if the teachers are to be assisted in the use of language in mathematics teaching.

The use of triangulation has also revealed how the innovation of use of medium of instruction in mathematics was introduced in Malawi Primary Schools. It appears that very little consideration, if any, was made to recognise the important role language plays in mathematics learning. No efforts were made to critically analyse how best language can enhance mathematics learning. There is no provision for learning mathematics vocabulary.

This study is fundamentally sociolinguistic in approach, as I claimed in Chapter 4,with focus on use of language rather than language skills- pragmatics rather than semantics, utterances rather than sentences, purposes rather than grammar. In this way the dilemmas and tensions that are created as a result of personal understanding of the linguistic nature of mathematics, role of language in mathematics education, the realities of dynamic classroom discourse and the sources of language for use in mathematics classroom are revealed.

However, the study used a sample of teachers from ten primary schools in one of the 28 educational districts in Malawi. The results cannot be automatically generalised to teachers who do not share similar characteristics or who are not in a similar setting.

A video camera was used to collect some data in the classroom during the lesson. Although there was a time when the piloting of video-taping was done on the same teachers, the video-taping might have brought about unnecessary anxiety during the lesson.

Teachers were used to teaching mathematics in Chichewa in standards 1 to 4 as required by the policy. I only asked them to teach mathematics in English for the purpose of this study. This might have brought about artificiality in the way teachers taught the English lessons. However, because I allowed the teachers to teach in English for five months before the recording was done, I believe the anxiety was reduced.

Researchers of language and mathematics education have tended to examine more student learning than teacher competencies in the use of language in mathematics teaching.

Consequently there seemed to be very little done to come up with established methodologies in terms of instruments and procedures. For this reason I had to construct my own instruments and procedures. It was difficult for me to create instruments as well as procedures that were rigorously validated within the period of the study.

It is clear that the model presented in this thesis has been elicited from a wide range of teachers, in a variety of settings and using different methods. The diversity is in itself something to be remarked upon and even celebrated at a time when there is a widespread expressed need for the use of local languages in mathematics teaching in place of foreign languages. It is refreshing to be reminded of the richness and complexity of the use of language in mathematics teaching demonstrated by mathematics teachers of young children. At the same time, it is possible to identify a number of common issues or concerns which can be seen to emerge from the different methods and sources.

The first common concern is essentially methodological: how do we gain access to a person's understandings, and what value do we attach to what we have obtained? As Munn in Hughes (1994: 8) pointed out, "perceptions are essentially individual mental phenomena," and yet the main method used to access these perceptions is through language.

All the methods used in this study were targeted on sampling teacher language in groups or individually or in the classroom together with pupils. And yet it is widely recognised that linguistic behaviour can be extremely sensitive to context (Edwards and Furlong, 1978; Cocking and Mestre, 1988; Jaworski, 1994; Adler, 2001). That is to say that what we say to one person in one situation may be very different to what we say to another person in a different situation. This example comes from the findings from focus groups which did not entirely correlate to the findings from clinical interviews or questionnaires. Such observations point to the need to obtaining additional evidence from as many different sources as possible, and for caution in interpreting findings based purely on one source of evidence. Both these points are acknowledged either implicitly or explicitly by the findings of this study.

A second and related concern, which emerged from the findings of this study, lies in the relationship between perception and actions. As a result of this study we have a much greater insight into the perceptions and practices of the use of the language in mathematics teaching. But what is the relationship between the perceptions and practices in language use in mathematics teaching? While such questions are in theory open to empirical investigation, in practice the methodology required to answer them is by no means straightforward.

A third issue raised in this thesis is that of the commonality of perceptions among teachers with different characteristics towards local and foreign language use in mathematics. The first concern is the extent to which different teachers have similar or different perceptions concerning the use of language in mathematics. This question is addressed mostly directly by comparing the teachers' perceptions with their characteristics on the findings from the questionnaires. The findings suggest that there is substantial difference among teachers with different characteristics such as training, home language, sex, and school settings. Second, there is also a concern about teachers' perceptions of different languages used in mathematics teaching. The study considered the teachers' perceptions between local language and foreign language. The findings suggest that there is substantial difference in perceptions between use of local language and foreign language in mathematics teaching. Such differences in perceptions are perhaps to be expected although they still need to be explained. The second question concerning commonality is rather different, and concerns the extent to which different teachers use different languages in mathematics teaching, particularly when they differ in perceptions. Thus it seems from the findings on discourse analysis that there is a remarkable difference in the way teachers use local languages and foreign languages. For example, it appears from the analysis that teachers tended to talk to the class more than to individual pupils in Chichewa medium classes whereas in English medium classes, teachers tended to talk to individual pupils more than to the whole class. Thus one of the major implications that emerged from the study findings is the difference in knowledge of mathematics vocabulary equivalents, in perceptions of language used in mathematics teaching and practical language use in mathematics classes.

Third, there is also a methodological concern regarding how dilemmas and tensions in teaching have been studied. In this study, dilemmas and tensions are emergent issues arising from the data analysis of what teachers understood to be the use of language in mathematics teaching. Thus much of my discussion on dilemmas and tensions of language use are inferential on the teachers' words and actions which are essentially elements of emotional conflicts between beliefs and actions, theory and practice and perhaps also understanding and ignorance of the use of language in mathematics teaching.

10.3 Reflections on the data analysis and reporting procedures

This section is about my reflections on the data analysis I undertook in this study. My intention is to offer the reader some explanation of the nature of the data analysis and the analytical model by comparing and contrasting between the conceptual frameworks and empirical analysis. I bring to the surface my interpretations on the uniqueness of the teachers' perceptions and the use of Chichewa and English in mathematics teaching and discuss some of the implications for my understanding of how this might be accounted for. My reasons for pursuing this are to uncover some of the implicit dilemmas and tensions in the teachers' use of language in mathematics in primary schools in Malawi. I also want to justify the analysis procedures used and consequent model developed by relating back to the theoretical perspectives as represented in the positions of Edwards and Furlong (1978), Hills (1969), Jaworski (1994); Adler (2001, 1995, 1998a, 1998b, 1998c). This last discussion is important not because I want to re-discuss or strengthen the theoretical underpinnings, but to contextualise the study and to evaluate its utility. Therefore, my discussion focuses on reflecting on the modeling, the practice, classroom discourse and the nature of the model.

10.3.1 Modeling teacher dilemmas and tensions in the use of language in mathematics

What I have achieved in this analysis has been to present a model for understanding the sphere of influence of teachers' dilemmas and tensions in the use of language in mathematics teaching. This analysis offers a sociolinguistic approach to understanding the foundations for teacher perceptions and uses of language in mathematics, which compare and complement existing approaches based upon the communication models (the dimensions of feedback and noise in communication). What I have presented is both an exemplification and manifestation of some key sociolinguistic concepts (situational use of language). The existing literature does not always present the concepts of classroom communication as susceptible to influence from factors external and internal to the classroom as well as the teacher. They are often presented as theoretical issues unexamined in an empirical context and inherent in the language, subject matter and the learner (Jaworski, 1994).

There are likely to be overlaps among the elements of the model. However, this is not a weakness in the approach I used or in the linkage of diverse and incoherent elements, but a recognition that while the teachers' perceptions and uses of language in the classroom occupy differential positions in the literature, they do not necessarily represent exclusive or antagonistic approaches in empirical sociolinguistics analysis. I have elaborated these elements and have shown how they might be manifested in classroom communication practices in Chapters 2, 3, 4 and 5.

Some of the findings presented in Chapter 8 resembled those found by Mooneyan (1998) in Mauritius except that his study focused on pupils rather than teachers and also focused on the use of language assessment rather than classroom communication. Studies reported by Adler (2001) resemble mine in that she reported on findings about teachers' dilemmas and tensions in mathematics teaching arising from language use. Nevertheless what is unique about my model is that it explains not only the nature of teacher perceptions but also how they are formed in the teachers including the dilemmas and tensions created in the process of using the language. The model also explains how teachers understand and use the languages under the prevailing linguistic conditions in the educational system in Malawi.

Many studies similar to mine have tended to focus on attitudes rather than perception of use of language (Yeung, 1991). The distinction between attitudes and perceptions must be made clear here because attitude is concerned with teacher disposition about language use whereas perception is concerned with teachers' understanding of the use of language in mathematics. My analysis identifies the understandings rather than dispositions as they relate to practices in classroom communication.

It is perhaps not surprising that the model here represents somewhat typically a sociolinguistic set of constructs in the teachers. This can be crudely expressed as dilemmas and tensions in language use manifested in negotiating (purpose of language use), explicit use of language (nature of language use) and language code switching (strategy of language use) (see Pimm, 1987; Jaworski, 1994; 2000; and Adler, 1998 for an elaboration of this argument). The model also further supports Postman and Weingartner's (1969) view that every teacher is a language teacher, which implies that a mathematics teacher is also a language teacher whose work can be described using sociolinguistic theories. Teachers' tendencies of wanting to help pupils speak good English supported this theory. Rather it is encouraging that some of my findings are comparable with those of other researchers. Had it been otherwise there might have been justifiable questions over the validity or extendibility of the analysis. If such sociolinguistic roles were reflected in teachers' perceptions of the use of language in mathematics, then it would seem consistent for a model that based itself on the belief and deep-seated ideological foundations to reflect those distinctions, dilemmas and tensions.

In my analysis I have identified the stages and sources of the teachers' dilemmas and tensions in the use of the language in mathematics; demonstrated how teachers use language in mathematics lessons; offered some examples of empirical evidence of theoretical sociolinguistic influence; and identified how we might view an ideological basis of teacher use of language in mathematics. Dilemmas and tensions in teachers' use of language characterised my findings. The use of examples from Chichewa and English medium mathematics lessons enriched the findings of the study.

Generally, I would claim to have developed an account which illustrates the relationship between the sources and stages of teachers' perceptions of the use of the language and on the other hand the sociolinguistic influence and origins of teacher linguistic behaviour in mathematics lessons. The striking part of my account is that it is influenced by my incorporation of elements of the philosophy of constructivism (Lerman, 1996), as applied in teaching especially the use of language in classroom communication theory (Hills, 1969; Edwards and Furlong, 1978) and also the discourse analysis by Bellack *et el.* (1966) and Fanselow (1987) among others rather than pure linguistics or psychology of mathematics.

In looking at teachers' understanding of the use of language in mathematics, I consider how I can describe and account for the sociolinguistic nature of the teacher, the pupils, the subject and the instructional materials which constantly interact during the lesson. By drawing on a critical sociolinguistic framework, this approach can shed light on the theoretical issues behind the classroom communication and also the professional issues behind the development of mathematics teachers. My analysis does not therefore conflict or call into question work on sociology of mathematics teaching or psychology of mathematics teaching. Instead it can offer a further dimension to our understanding of the complexity of the interplay between teacher understanding of the use of language and the actual use of language in mathematics teaching given the conditions prevalent in educational systems. I have focused on how teachers understand and use language to enhance mathematics learning in a bilingual classroom in terms of sociolinguistic and constructivistic theory rather than looking at what language does to mathematics in terms of learning theories.

10.3.2 The nature of the model

The model of teachers' perceptions and use of language in mathematics I have developed in Chapters 9 is interactive and progressive. It is interactive in that each theme is influenced by and dependent on another, forming a network of interrelatedness. It is also progressive because the themes of the dilemmas and tensions can be perceived as a chain of reaction such that the occurrence of one thing leads to the occurrence of another resulting in creating dilemmas and tensions. Thus the model is too complex for any diagrammatic representation other than providing it descriptively. For example, the external conditions of language use are powerful in influencing the teachers' understanding of the role of language in classroom communication and consequently the actual use of language in the classroom to the extent that they create dilemmas and tensions. While the conditions directly influence the teachers at all stages of use of language in the classroom, they also influences the teachers at the source of externalising language from mathematics in terms of preparing for teaching, selecting and using the instructional materials, selecting and using the languages; the instructional materials influence the teacher commitment to using language in mathematics as indicated below.

1. Teachers' understanding of the use of language in mathematics teaching is manifested in explicit and implicit perceptual components in the classroom discourse arising from the teachers' effort to negotiate between mathematics and language influenced by the external conditions for use of language.
2. In a bilingual mathematics classroom, teachers' experience is either multiple or mono or lack of mathematical vocabulary equivalents which determine whether the mathematical language being used precisely describe the concepts or leads to mathematical misconceptions.
3. Linguistic difference between Chichewa and English coupled with teachers' attitudes towards using Chichewa or English leads to teachers' language code switching during mathematics teaching.
4. Teachers use language in mathematics teaching explicitly or implicitly for negotiating access and equity in mathematics learning through language code switching.
5. When using language, teachers are concerned with structuring the classroom activities using negotiating moves that are aimed at accessing pupils, accessing mathematical

knowledge and accessing language as well as achieving equity among pupils by substantiating the language being used.

10.3.3 Practical implications of the model

In the opening chapter of this thesis, it was stated that the general concern was to explore how teachers use Chichewa and English in mathematics teaching. The two languages have different statuses in the language policy in Malawi in that Chichewa is both a local and a national language thus it is regarded as a first language (L1). On the other hand, English is both a foreign and official language, thus it is regarded as a second language (L2). It was hoped that an examination of the teachers' use of the two languages in mathematics teaching would shed light on what happens when teachers are asked to use L1 as compared to L2 in mathematics teaching. The literature reviews and discussions and the studies reported in Chapters 2,3,4 and 5 of this thesis were intended to yield a theoretical framework that might assist in the interpretations of the patterns of teachers use of language in mathematics teaching when L1 and L2 are used. It was hoped that findings would be of interest to at least professionals in the field of sociolinguistics, concerned with how the use of L1 and L2 accounts for classroom communication; mathematics educators concerned with the role of language in mathematics education; teacher trainers concerned with how to improve the teacher effectiveness in the use of language in teaching; the policy makers concerned with language policy in education; curriculum designers concerned with providing a curriculum and curriculum materials that would facilitate teaching and learning and teachers concerned with using the language to communicate content in the classroom. It was argued in Chapter 2 that teaching mathematics would benefit from the philosophy of constructivism by using language to help pupils construct mathematical knowledge. Thus any effective communication in mathematics teaching would need to create a two-way communication where teachers and pupils talk to each other as well as talk mathematically.

The evidence arising from this study might be interpreted against my assumptions that the dilemmas and tensions of teachers in the use of language would be the same in Chichewa and English medium lessons because of the linguistic nature of mathematics, the mystifying language policy in education, the dynamic classroom discourse and the limited language resource for use in the classroom. It was also assumed that teachers perceived the two languages equally and that they would not mind which language they use, it is their confidence and disposition towards mathematics teaching which are most likely to lead to successful use of language in mathematics teaching. However, some of the findings confirmed whereas others disconfirmed my assumptions as I discuss in the next section.

10.4 Reflections on the findings

In this section, the findings of each investigation are considered in relation to the earlier literature reviews and to the generation of the themes and patterns; the implications for further research are explored and the educational implications are examined with particular reference to the situation in Malawi. Elements constituting the differences and similarities in the use of Chichewa and English are discussed as each focus of the study is considered, and these are drawn together into a single structure.

The findings of the study presented in Chapter 8 show that there was a difference in the degree of dilemmas and tensions of teachers with regard to the use of Chichewa and English in mathematics teaching. Teachers perceived more positively the use of Chichewa than English in mathematics teaching. However, teachers perceived more constraints with the use of Chichewa than the use of English in mathematics teaching. The findings are slightly different from Yeung (1991) who found out that people perceived the use of English to be more appropriate than the use of local languages, perhaps because my study was conducted on the teachers who are the practitioners whereas Yeung's study was conducted on non practitioners. Unlike Yeung's study, the findings of my study have shown that teachers have responses for perceiving the use of each of the language in the way they do. This aspect of the findings makes the study more teachers' action oriented than those previously conducted.

The findings presented in Chapter 8 on the knowledge of mathematics vocabulary in Chichewa and English show that teachers were able to give equivalents of mathematics from Chichewa to English more than from English to Chichewa. This might have an effect on how teachers communicate the mathematical concepts to children when one of the two languages is used. It appears that teachers have problems in describing most of the mathematical concepts in Chichewa due to limited amount of vocabulary caused by scientific and technological advancement that influences mathematical vocabulary.

The results also show that there was no significant difference in the amount of mathematical vocabulary equivalents from English to Chichewa between teachers in the urban schools and those in the rural schools. This may imply that all teachers experience the similar problem of mathematics vocabulary in Chichewa regardless of the school location. However, teachers in the urban schools gave more mathematical vocabulary equivalents from Chichewa to English than those in the rural schools. They also gave more equivalents from Chichewa to English than from English to Chichewa. Perhaps this has to do with the exposure of the teachers in the urban schools to modern socio-economic, scientific and technological activities that may contribute to new and more use of mathematical vocabulary in English than in Chichewa.

Teachers in the rural schools gave more equivalents of the mathematical vocabulary from Chichewa to English than from English to Chichewa. Teachers in the rural schools could understand better mathematical concepts in Chichewa such that they could associate the terms with those in English easier than those terms presented to them in English. The differences in teacher mathematics vocabulary in English and in Chichewa suggest that teachers have limited mathematical language. Since an essential precursor to the ability to communicate mathematical concepts is the ability to know and use appropriate vocabulary (Shuard and Rothery, 1984; Pimm, 1987 and Orton, 1987), it is suggested that this ability correlates to the use of Chichewa and English in mathematics teaching. Orton (1987) asserts that vocabularies play a central role in concept formation. So little was to be gained by using Chichewa in terms of vocabulary and concepts. The quotation from Shuard and Rothery

(1984) at the beginning of Chapter 7 suggests that teachers as well as books have a role in making sure that pupils learn mathematical vocabulary. There is evidence that teachers found vocabulary difficult not only because they are in Chichewa or English but that they have a special meaning in mathematics. For example most words such as triangle used in mathematics are not English words; they are Greek works. Shuard and Rothery (1984) report of an attempt made in the United Kingdom to create mathematical words in English but their use was unpopular and they died a natural death. A lesson may be learnt here that although many researchers have recommended the creation of special mathematical terms in particular languages, such as Chichewa, this may not work considering the current teacher perceptions of use of Chichewa in mathematics. Its prolonged use may be short lived as already demonstrated by the findings in this study. Teachers are likely to maintain using English words.

The fact that teachers gave a number of optional Chichewa equivalents to single mathematical vocabulary in English suggests that there is a problem of meaning when Chichewa is used. Orton (1987) observes that the problems of meaning of terms used in mathematics could affect the learning of mathematics. In the English sense, some words have mathematical meanings that are unrelated to their everyday usage. The findings of this study show that the problem of vocabulary meaning also exists in Chichewa where the problem of vocabulary meaning has not been established and teachers simply use any word they know to describe mathematical concepts. The problem is compounded when one vocabulary in English is matched to several equally plausible vocabularies in Chichewa. The evidence suggests that although lessons in Chichewa were successful, the vocabulary used did not provide the precise concept and in the long run this may affect concept development in the children. However, since the vocabularies are there in Chichewa, standardisation perhaps is the panacea to the problem. Thus, although the Chichewa medium lessons seemed more successful than the English medium lessons, many teachers said they were unable to find and use the appropriate vocabulary in Chichewa medium, unlike in English medium. That is why they used some English in Chichewa medium lessons and almost no Chichewa terms in English medium except when giving instructions. At the same time, they said that they could not use the vocabulary in English they knew because pupils could not understand. Lack of teacher preparation for the use of mathematical vocabulary equivalents might actually have exacerbated the difficulty of the use of the vocabulary in both Chichewa and in English as the findings showed that teachers paid very little attention to language use during preparations for mathematics lessons.

The findings presented in Chapters 8 show that lack of systematic training in the process of identifying and using mathematical vocabulary in Chichewa and in English is also responsible for the failure of teachers to use appropriate mathematics vocabulary in the two languages. Teachers in the rural schools where the majority of them were untrained showed more problems with mathematical vocabulary equivalents than teachers in the urban schools where the majority of them were trained.

The findings indicated that teachers were sensitive to vocabulary problems when Chichewa was used in mathematics lessons. The problem as they saw it was that any successful use of Chichewa in mathematics was limited by having to look for vocabulary to describe the mathematical concepts. It is unlikely that this phenomenon may apply to English. The present study suggests that if teachers have the entire necessary vocabulary in Chichewa then this will facilitate the use of Chichewa in mathematics teaching. This is not surprising given that when people are talking, they rely on vocabulary for the subject under discussion (Shuard and Rothery, 1984). The discussion in Chapter 8 would suggest that the imbalance in mathematics vocabulary equivalents between Chichewa and English might have an impact on how teachers use Chichewa and English in mathematics teaching so that it was possible for teachers to use a mixture of Chichewa and English instead of any one of the two languages.

The findings on mathematics vocabulary have implications on classroom communication in mathematics lessons. Observing teachers on how they used vocabulary indicated that in Chichewa medium where vocabulary was a problem teachers were not consistent in the use of vocabulary in Chichewa. As Pimm (1987) argues, mathematics is a language in its own right and that lack of concepts and inaccuracy in the use of mathematical terms retards the use of correct expression in problem solving. The inability to verbalise mathematical thought is one of the results of insufficiency of mathematical vocabulary. Teachers may not be able to facilitate the construction of mathematical knowledge in pupils if the language skills are deficient. To this effect Ndaba (1997) found that pupils did have some vocabulary, but did not master them. Vocabulary was scattered. The findings of this study suggest that this problem would originate from the teachers who might have problems with the use of mathematical vocabulary.

The findings have also demonstrated that vocabulary is central and focal in mathematical teaching. It is vital for the teachers' aspirations and success as teachers kept on mentioning lack of mathematical vocabulary for some equivalents as a constraint to the use of Chichewa in mathematics (see Chapter 8). It affects their communication strategies and actions and generates their classroom experiences, dilemmas and tensions. A lack of vocabulary impedes communication. It does hinder listening and speaking, thus creating some dilemma and tension in the teachers regarding the use of language in mathematics.

The findings on teacher use of Chichewa and English in mathematics teaching show that there was a marked difference in the use of language by teachers between Chichewa medium and English medium mathematics lessons. For example, generally, there were higher frequencies of use of language in Chichewa medium than English medium mathematics lessons although not in all aspects. The findings also show that there were more teachers to individual pupils talk in English medium than in Chichewa medium lessons. From the classroom observation it was evident that teachers tended to talk more to individual pupils rather than a class because, in most cases, the class would not answer any question asked in English. Instead, it was easier for the individual pupils to answer the question. The teachers tended to talk more in English than in Chichewa medium lessons to save the lesson from collapsing. There was more focus on content rather than procedures in Chichewa medium lessons than in English medium lessons. In English medium lessons teachers tended to spend a considerable amount of verbal interaction in instructing the pupils on what to do and how to do it in a repeated manner. It appears that teachers spent less time on content when they use English rather than when they used Chichewa in mathematics teaching.

However, the role of the teachers and pupils in terms of verbal interaction did not change with change in the medium of instruction. Teachers tended to dominate the classroom talk in both mediums of instruction. So changing the language of instruction may not affect the teacher dominance in the classroom talk. It would hardly be an exaggeration to say that the thinking skills in mathematics are not being developed if the language skills are deficient. As previously discussed in Chapter 2 it appears that the classroom talk was not flowing very well and this has a negative effect of efficiency on communication (Hills, 1969).

As reported in Chapter 8, it is fascinating to note that teachers did not engage pupils in reading mathematics text in both Chichewa and English medium mathematics lessons. Where reading occurred, it was the teachers reading from either the book or from the chalkboard or the chart. Shuard and Rothery (1984) argue that pupils have to learn mathematical concepts from either the teachers or from the books. Mathematical text refers to written mathematical messages. In Chapter 3, I have made a claim that mathematics learning is not complete unless pupils learn the appropriate vocabulary by which they can speak and discuss mathematics. If this is true, then the findings that teachers do not engage pupils in reading mathematics text is an interesting finding to those who would like to see mathematics learning improved. By asking teachers to use Chichewa in mathematics teaching and also write Pupil's Books in Chichewa was partly to encourage teachers to engage pupils in reading mathematics text at least in Chichewa. It was assumed that reading mathematics text in

English would be more challenging considering that pupils were not fluent in English, suggesting that the source of vocabulary for pupils is the teacher through classroom talk.

It appears that there is more to it than simply replacing English by Chichewa in mathematics text if teachers are to engage pupils in reading mathematics text. Studies done in Primary Schools in Malawi (Improving Educational Quality (IEQ) Malawi Project 2000) showed that most pupils are able to read and write in Chichewa by standard 3 and in English after standard 4. As discussed in Chapter 3, mathematical words are unlikely to be used at home or in the pupil's everyday speech. They are rare in the child's experience and thus make reading difficult. A further difficulty associated with mathematical vocabulary is that no single language has enough vocabulary to describe all the concepts. Chichewa is more limited than English so much so that when teachers try to describe a mathematical concept in Chichewa it becomes a long and cumbersome group of words such as '*chinthu cha ngondya zitatu*' meaning 'triangle'. However, it was not within the scope of this study to critically examine the readability of mathematics books, which were written in Chichewa.

As reported in Chapter 8, one of the major differences was on the frequencies of sources of utterances between the teachers and the pupils in Chichewa and in English medium lessons. It is interesting to note that teachers dominated the talk more in English medium classes than in Chichewa medium classes suggesting that teachers talk more when they use L2 than L1. Edwards and Furlong (1978) argue that teacher dominance in classroom talk is justifiable; a teacher needs it to manage and control classroom communication and that any attempt to change the teachers' dominance will result in change of the functions of classroom communication. In this case, it means that teachers exercise more authority and control when they teach in L2 than in L1 implying that teachers have more problems with L2 medium classes than L1 medium classes. However, although there were more of each of the pedagogical moves in Chichewa medium lessons than in English medium lessons, there was no marked difference in the percentage in all types of moves. This finding suggests that teachers talk more in L2 than in L1 but essentially the purposes of the talks are the same. This finding is significant considering that very few if any such studies of comparing the discourse in L1 and L2 are conducted.

The use to which classroom talk was put is also a concern of this study and the findings show that although the percentages of frequency of content was higher in procedural content in both cases, the percentage of subject content was higher in English medium than in Chichewa medium. This implies that when L2 is used, teachers talk more about the subject than procedure. They talk about the subject without communicating with the children – talking at the pupils, as Edwards and Furlong (1978) put it. In the Chichewa medium lessons, the difference between subject content and procedure content is very insignificant suggesting that teachers talk about the subject as well as with pupils. This finding is unique because it highlights the reasons why children do not do as well when they learn in L2 as in L1 (Kachaso, 1988).

The findings show that teachers talked more in English medium than in Chichewa medium perhaps because of rephrasing and *paraphrasing of questions* and answers which in most cases were not understood by pupils in English medium lessons. Edwards and Furlong

(1978) claim that teachers use language to exercise power and authority necessary for classroom management. Teachers use language to make demands on the pupils who have to obey if learning is to take place. It would be argued here that perhaps the more the demands made by the teacher, the more power and authority the teachers exercise. This would occur especially where the teacher's power and authority is threatened by lack of confidence in something which in this study can be the language being used. When teachers used English, they made more demands perhaps because they felt threatened by the use of English. It may therefore be suggestive that teachers feel insecure when they use English unlike when they use Chichewa. This was supported by the perception teachers gave that they felt confident when they used Chichewa in mathematics teaching.

When teachers make demands, pupils are supposed to obediently respond. One would expect therefore that where teachers exercise more power and authority, pupils make the most responding moves. However, it was not the case in this study in as far as teacher-to-pupils ratio of responding moves was concerned. For every responding move that a teacher made, there were 35 responding moves in Chichewa and about 13 responding moves in English medium lessons. This finding suggests that although teachers ask more questions in English medium lessons, a good number of them are either unanswered or answered by the teacher himself or herself. A similar pattern was observed with reacting moves. For every reacting move made by a pupil, teacher made 32 in Chichewa and 27 in English medium lessons. Chichewa allowed for teachers to accept or reject or comment on most of what the pupils said.

Considering that the same group of teachers used more of some aspects of language use in Chichewa medium than in English medium and visa versa may suggest that teachers were using language as what Edwards and Furlong calls 'coping strategy'- a way of working developed to reconcile the difficult problems of maintaining order, communicating information and providing at least some degree of pupils autonomy.

Considering that different countries – including Malawi - are trying to adopt the use of mother tongue as the language of instruction in the first four years of primary school, the findings of this study have demonstrated that there is need for considering teachers in the implementation of such policy. Teachers have their own perceptions of how things should work in as far as the use of Chichewa and English in mathematics teaching in concerned.

10.5 Some assumptions about the study

There were some assumptions under which the findings of this study were interpreted. First, this study was specially designed and conducted to examine aspects of language use that highlight the teachers' use of L1 and L2 in mathematics teaching. In the study, tasks were given to indigenous mathematics teachers speaking Chichewa fluently and English as L2. Working fundamentally around the models of classroom communication (discourse) advanced by Hills (1969), Edwards and Furlong (1978); Bellack, *et al.* (1966) and Fanselow (1987), the first part of the study was concerned with teachers' perceptions of use of Chichewa and English in mathematics teaching. The second part of the study was concerned with mathematics vocabulary equivalents in L1 and L2. The third was concerned with the language use in mathematics lessons- the way teachers use L1 and L2 in mathematics teaching. It was considered that the analysis of the data on these aspects of language use in the classroom might help uncover and identify those elements which constitute the use of L1 and L2 in mathematics teaching. It was also hoped that it would help in specifying salient aspects of the teacher use of languages that make L1 different from L2 in mathematics teaching. The way teachers use L1 and L2 in the classroom is potentially useful for revealing the strengths of the use of L1 highlighting the importance of salient communication processes in the normal user and the deficiencies of the teacher use of L2 highlighting what can go wrong when these salient elements and processes are inefficient or below language mastery. It is argued in this study that the teachers' perceptions of use of language when L1 and L2 are involved are probably of great importance for the success of not only classroom communication to mathematics teachers in Malawi, but also understanding how the philosophy of constructivism can be applied in mathematics teaching through use of language.

Second, although rigorous study of this latter contention must await further research, the general strategy I employed in this respect was to compare and contrast the teachers' use of L1 and L2 in mathematics teaching and therefore assumed that the teachers' use of Chichewa was the similar as the use of English in mathematics teaching. In order to tap into the teachers whose L2 proficiency is at a level permitting the exploration of evidence of sufficient quality and quantity to allow for a productive analysis, it was decided to work with primary school teachers in selected schools in Zomba, Malawi who were using Chichewa and

English in teaching. In order to obtain evidence, which enabled me to generalise to particular school settings, it was decided to work with teachers in urban and rural schools in Zomba, Malawi faced with the task of using Chichewa and English in mathematics teaching in their classes.

10.6 Implications of the findings on practice

Because the findings of the study revealed differences in the teachers' knowledge of mathematics vocabulary in Chichewa and in English, and in their perception of the use of Chichewa and English in mathematics teaching and the use of the language in mathematics teaching, it is necessary to define these differences operationally to incorporate them easily in any policy on language in education, teacher training programmes, textbooks and ultimately in the classroom.

The fact that it was possible to investigate how teachers use language in mathematics teaching and establish the differences between Chichewa and English media means that the procedure can be standardised to be universally applied in analysing uses of language in mathematics teaching. The procedure can also be adapted into guidelines in implementing the use of language in mathematics teaching in the education system.

This study revealed how much there is to be done to improve the use of language in mathematics teaching in Malawi Primary Schools. Educational planners, curriculum developers, textbook authors, and teachers need to be aware of the uses of language skills in mathematics teaching so that they deliberately and consciously incorporate them into the curriculum policy, syllabuses, textbooks and lessons. In order to make a breakthrough in this area, pre-service teachers must become aware of the differences in the way Chichewa and English can be used in mathematics teaching. They should also be helped to understand how language use could be incorporated into lessons. Another step that needs to be taken is to evaluate textbooks with respect to the use of languages in mathematics. The more the appropriate language is used, the more effective the textbooks may be to help teachers teach mathematics to enable them to use the languages effectively.

The teachers were not able to give equivalents to some mathematical vocabulary and the two languages they used did not have the equivalents of mathematical vocabulary for some concepts. This finding may suggest the need to make these vocabularies available to teachers.

Many teachers indicated that they do not receive systematic training in the use of language in mathematics teaching. Therefore, because mathematics educators have an obligation to improving mathematics education, they will have to change their perception of the use of languages in mathematics teaching. That requires an enormous amount of training in the use of language in mathematics teaching.

The results of this study have also some implications for the textbook writers and publishers. If the procedures for determining the various uses of language in mathematics teaching are refined, it could be used to measure language uses in mathematics books. It could also serve as guidelines for publishers.

The results of this study have an implication for mathematics education. The teachers who participated in this study are products of the Malawi school system, which suggests that perhaps the experiences that they had in school did not adequately prepare them to be alert to uses of language in mathematics teaching. I think it would be helpful for mathematics educators to check the school curriculum for its richness in uses of language.

The results, which show that teachers know, perceive and use Chichewa differently from English in mathematics teaching, may not be surprising to many educators. The results indicated how teachers teach mathematics. When teaching mathematics teachers may make an effort to make use of language skills in mathematics teaching by using a 'coping strategy' (Edwards and Furlong, 1978) amidst dilemmas and tensions in how to use language - whether to attend to personal gains or educational goals. Sometimes teachers may need to make a conscious effort to use language in mathematics teaching in the manner that serves their interest rather than those of educational values.

10.7 Recommendations

Based on the findings of the study, it is recommended that the Ministry of Education, Science and Technology, the Malawi Institute of Education and teacher training colleges produce an agenda to identify the problems faced in schools in the use of language in mathematics teaching, and create a strategy for addressing the problems. When these three parties are involved, there is a possibility that the number of dilemmas and tensions (including the sources and impact) in the mathematics teachers prevailing in schools concerning the use of the language in mathematics teaching will be reduced.

This study is the first of its kind in Malawi and possibly in Central Africa (Malawi, Zambia and Zimbabwe). Although it is relatively in-depth, there is yet more research to be done on the topic. I view this study as a launching pad for more research to be conducted in Malawi and other countries. The possible areas of the study could include the following:

1 The use of language in two or more local languages could be examined.

2 Compare the use of language among different subjects.

3 Develop the system of discourse analysis specifically for mathematics classes as the present systems were developed for language classes.

4 Investigate the effects of the use of language on student learning to determine the optimum value of the use of language in mathematics teaching and learning.

5 Investigate the effects of dilemmas and tensions on pupils learning to determine the impact of teacher dilemma of the use of language in mathematics teaching.

This study was unique in a number of ways. I have used the principle of methodological triangulation to come up with rich data that led to valid conclusion. The study has tackled a national problem of improving quality mathematics education, which is a contemporary issue not only in Malawi but also in Africa and most of the developing countries. Those countries entangled in multilingual education may benefit from the findings of the study.

It is hoped that this study has provided a useful overview of the teacher use of language in mathematics teaching with regard to use of Chichewa (local language) and

English (foreign language) as instructional languages. The issues raised in this study, it is hoped, may enable the Ministry of Education Science and Technology to examine the policy on the use of Chichewa and English in mathematics teaching in primary schools. The teacher training colleges should examine their courses to accommodate the issues of language in mathematics teaching. The Malawi Institute of Education should emphasise the proper use of language in mathematics teaching through provision of in-service courses as well as during curriculum development processes. With the increasing campaign for use of local languages medium of instruction in the early years of primary education, the Ministry of Education Science and Technology should seriously assess ways in which the local languages may be utilised fully to improve mathematics education in Malawi.

To be more specific, the following could be done to promote the effective use of language in mathematics teaching in Malawi Primary Schools.

1. The Ministry of Education Science and Technology must spell out the desired language of instruction and language uses in terms of performance terms rather than in broad terms. Instructional materials should make references to specific language uses if possible. Such detailed information would guide teachers as to what type of language they are expected to use.
2. The Ministry of Education Science and Technology should provide information about other sources of mathematics vocabularies and establish the equivalents link with other languages. The ministry should produce a mathematics dictionary that would assist teachers with mathematics vocabulary for use in the classroom.

3. The Ministry should provide technical and financial support to all stakeholders to conduct further studies into the language use in mathematics teaching. This would be similar to what was done in Tanzania and more recently in South Africa and Ghana.
4. The Ministry should allocate funds for workshops and seminars for teachers, teacher trainers, book writers, curriculum developers, and primary school supervisors. The Malawi Institute of Education should be responsible for organising these activities at the Institute as well as at school levels. In so doing they will share knowledge of the use of language in mathematics teaching.
5. The Ministry should organise a sensitisation campaign for all managers of primary education on the appreciation of the role of language in mathematics teaching.
6. Schools should encourage their teachers on the use of language in mathematics teaching by including on their agenda meetings an item on the use of language in mathematics teaching. Teachers would express their concerns and suggestions on how those concerns could best be addressed. These meetings should provide for incentives for teachers to encourage them to use language in mathematics teaching as well as reduce their dilemmas and tensions.
7. At each school, all the barriers affecting the use of language should be reduced. Teachers and pupils should be provided with appropriate books and materials for use.
8. Short and long-term plans for training teachers in the use of language in mathematics teaching should be put in place. If language skills are to be used in mathematics teaching, teachers have to be trained in the use of the language in mathematics

teaching. Teachers should not be sent to schools to teach mathematics with the expectations that teachers would learn to use language in mathematics teaching on their own as this may result in dilemmas and tensions as shown by the findings of this study.

10.8 Summary

The main purpose of this study was to investigate how teachers use language in mathematics teaching. Comparison was made among teachers and between Chichewa medium and English medium mathematics lessons in lower primary schools in Malawi. Issues explored in the study included teacher mathematics vocabulary, teacher perceived prospects and constraints in the use of Chichewa and English in mathematics teaching and teacher use of language in mathematics lessons. The results of the study showed that mathematics teachers experience different dilemmas and tensions in the use Chichewa or English and the degree of dilemmas and tensions are different between Chichewa and English. There are distinct sources of dilemmas and tensions, which include the linguistic nature of mathematics, the mystifying language policy in education, the dynamics of classroom discourse and inconsistency in the sources of language for use in mathematics. The dilemmas and tensions result in teachers emphasising some uses of language more than others.

Based on the research findings it has been recommended that a plan be developed to identify the dilemmas and tensions in teachers in the use of language in mathematics teaching and find solutions to the problems. Further research should be conducted not only in Malawi but also in the Africa region.

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Appendix 1: Teachers mathematics vocabulary equivalents test

TEST 1: English to Chichewa

INSTRUCTIONS

You are provided with 40 mathematical terms which are most used when teaching mathematics in standards one to four. The terms are in English. Can you write down the best Chichewa equivalence for each term in the space provided?

The English Math Vocabulary	Chichewa Math Vocabulary
1. Zero	
2. Four	
3. Five	
4. One	
5. Eight	
6. Nine	
7. Ten	
8. Seventeen	
9. Twenty	
10. Thirty four	
11. One hundred	
12. One thousand	
13. Number	
14. Counting	
15. Addition	
16. Subtraction	
17. Multiplication	
18. Division	
19. Money	
20. Coins	
21. Bank notes	
22. Buying	
23. Selling	
24. Profit	
25. Change	
26. Line	
27. Angle	
28. Circle	
29. Side	
30. Centre	
31. Measuring	
32. Volume	
33. Length	
34. Weight	
35. Area	
36. Capacity	
37. Time	
38. Distance	
39. Height	
40. Price	

Appendix 2: Teachers mathematics vocabulary equivalents test

TEST 2: Chichewa to English

INSTRUCTIONS
You are presented with mathematics vocabulary in Chichewa. We would like to find out if you know them in English. You asked to provide the English equivalents by writing them against each term in the space provided. The information you provide will be confidential

Chichewa terms	English equivalents
1. Kulemera	
2. Chimodzi	
3. Ngondya	
4. Zisanu	
5. Zisanu ndi zinai	
6. Khumi	
7. Ndalama	
8. Kuchotsa	
9. Kutalika	
10. Makumi awiri	
11. Pakati	
12. Kuchulukitsa	
13. Nthawi	
14. Makumi atatu ndi zinai	
15. Kugula	
16. Kuphatikiza	
17. Chikwi chimodzi	
18. M'mbali	
19. Ndalama zapepala	
20. Vunkha	
21. Zisanu ndi zitatu	
22. Mtunda	
23. Kugulitsa	
24. Ndalama zazitsulo	
25. Kuyesa	
26. Chiwerengero	
27. Zinai	
28. Mzele	
29. Kugawa	
30. Thunthu	
31. Phindu	
32. Zana limodzi	
33. Msinkhu	
34. Ndalama zotsala/zosintha	
35. Kuwerenga	
36. Khumi ndi zisanu ndi ziwiri	
37. Chozungulira	
38. Bwalo	
39. Palibe	
40. Mtengo	

Appendix 3: Questionnaire for teachers' perceptions of use of Chichewa in mathematics teaching

PART I: PERSONAL INFORMATION

Would you please provide the following information by marking an 'x' against the correct option in numbers 1, 2, and 5 and also questions 3,4 and 6 by filling in. You do not need to write your name on the questionnaire. All information provided will be held in confidence.

1 Your gender

_________ male _________ female

2 Your current qualification

Grade Source

_________ PT1

_________ PT2

_________ PT3

_________ PT4

_________ Temporary teacher

Academic

_________ MSCE

_________ JCE

_________ Others

3 Your mother tongue

____

4 Previous schools where you taught before coming here

School	District
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

5 Number of years teaching in primary schools

_________ 1 to 5 years _________ 6 to 10years _________ 11 or more years

6 List subjects you are teaching currently and the standard

____

____

____

____

____

PART II: FREQUENCY OF USING CHICHEWA IN DIFFERENT SUBJECTS

Will you please indicate by circling a correct number to indicate the extent to which you use Chichewa in each of the following subjects.

		NONE	SELDOM	NOT SURE	SOMETIMES	VERY OFTEN
1	Creative Arts	1	2	3	4	4
2	General studies	1	2	3	4	4
3	Mathematics	1	2	3	4	4
4	Music	1	2	3	4	4
5	Physical Education	1	2	3	4	4
6	Religious Education	1	2	3	4	4

PART III: PERCEPTIONS ABOUT USING CHICHEWA AS MEDIUM OF INSTRUCTION IN MATHEMATICS

The following statements represent various perceptions about the use of Chichewa as medium of instruction. Indicate by circling the number to show the degree to which you agree or disagree with each of the statements. SA = Strongly Agree; A = Agree; DA = Disagree; SDA = Strongly Disagree; NS = Not Sure

	Perception When Chichewa is used in mathematics teaching,	**SDA**	**DA**	**NS**	**A**	**SA**
1	pupils are motivated throughout the lesson	1	2	3	4	5
2	a greater number of pupils are reached equally at the same time	1	2	3	4	5
3	individual pupils learning needs are supported	1	2	3	4	5
4	the teachers instructional effectiveness is increased	1	2	3	4	5
6	misconceptions about certain concepts which would be difficult for a teacher to explain is reduced	1	2	3	4	5
7	misconceptions about certain concepts which would be difficult for the pupils to understand is reduced	1	2	3	4	5
7	pupils are helped relate mathematics to their culture	1	2	3	4	5
8	communication problems between the teacher and pupils is eased	1	2	3	4	5
9	an effective way of evaluating pupils learning is provided	1	2	3	4	5

10	the content of the lesson is enriched by drawing example from every day life	1	2	3	4	5
11	pupils are able to apply mathematics to solving everyday problems	1	2	3	4	5
12	The cost of implementing the use of Chichewa in mathematics lesson is out of proportion to its value	1	2	3	4	5
13	the degree of teacher-pupils interaction is reduced	1	2	3	4	5
14	teachers will be out of job	1	2	3	4	5
15	For some subjects the use of Chichewa instruction is NOT conducive to effective learning	1	2	3	4	5
16	time is wasted because pupils tend to dominate the classroom talk	1	2	3	4	5
17	the quality of education is lowered	1	2	3	4	5
18	Pupils do not take seriously the lessons taught in Chichewa.	1	2	3	4	5
18	Pupils sometimes experience difficulties in understanding the message expressed in Chichewa because of cultural irrelevance of the content	1	2	3	4	5
20	Textbooks prepared in Chichewa provide distorted information about mathematics and in so doing confuses the learners	1	2	3	4	5

21 Other (specify briefly)

____

____

____

PART IV: PERCEIVED BARRIERS TO THE USE OF CHICHEWA AS MEDIUM OF INSTRUCTION IN MATHEMATICS

The following statements represent some of the general constraints or barriers to the use of Chichewa as medium of instruction in mathematics. Indicate with a circle around the number indicating the degree to which you perceive each of the constraints.

	Perceived barriers	Degree of barriers None	Min	Not sure	Moderate	Major
1	Mathematical vocabulary in Chichewa are usually not available for use during classroom instruction	1	2	3	4	5
2	Medium of instruction is imposed upon the teacher	1	2	3	4	5
3	There are not teaching/learning aids prepared in Chichewa	1	2	3	4	5
4	There are fewer number of textbooks for mathematics written in Chichewa	1	2	3	4	5
5	Most teachers do not speak more than one local languages	1	2	3	4	5
6	Most teachers do not speak Chichewa	1	2	3	4	5
7	Most pupils do not speak Chichewa	1	2	3	4	5
8	Teaching several subjects makes it difficult to prepare for use of Chichewa as medium of instruction	1	2	3	4	5
9	In most cases it is difficult to understand mathematical concepts because Pupil's Book is written in Chichewa while Teacher's Guide is in English	1	2	3	4	5
10	The long syllabuses and short time makes it difficult to teach mathematics in Chichewa	1	2	3	4	5
11	Because of inadequate knowledge of the subject area, it is difficult to identify the appropriate vocabulary for the lessons	1	2	3	4	5
12	There is no money allocated for training teachers in using Chichewa as medium of instruction	1	2	3	4	5
13	There is lack of professional assistance from the supervisors when Chichewa is used	1	2	3	4	5

14	Using Chichewa distorts the meaning of mathematical concepts	1	2	3	4	5
15	There is no mathematical vocabulary that I know which could best be explained in Chichewa	1	2	3	4	5
16	There are no reference books for mathematics that could help teachers to mathematics using Chichewa	1	2	3	4	5
17	Other (Specify) ______________________________					

Appendix 4: Questionnaire for teachers' perceptions of use of English in mathematics teaching

PART I: PERSONAL INFORMATION

Would you please provide the following information by marking an 'x' against the correct option in numbers 1, 2, and 5 and also questions 3,4 and 6 by filling in. You do not need to write your name on the questionnaire. All information provided will be held in confidence.

1 Your gender

_________ male _________ female

2 Your current qualification

Grade Source

_________ PT1

_________ PT2

_________ PT3

_________ PT4

_________ Temporary teacher

Academic

_________ MSCE

_________ JCE

_________ Others

3 Your mother tongue

____

4 School currently teaching ____

5 Class Source currently teaching: _________________

6 Previous schools where you taught before coming here

School	District
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

7 Number of years teaching in primary schools

_________ 1 to 5 years _________ 6 to 10years _________ 11 or more years

8 List subjects you are teaching currently and the standard

____

____

____

____

PART II: FREQUENCY OF USING ENGLISH IN DIFFERENT SUBJECTS

Will you please indicate by circling a correct number to indicate the extent to which you use English in each of the following subjects.

		NONE	SELDOM	NOT SURE	SOMETIMES	VERY OFTEN
1	Creative Arts	1	2	3	4	5
2	General studies	1	2	3	4	5
3	Mathematics	1	2	3	4	5
4	Music	1	2	3	4	5
5	Physical Education	1	2	3	4	5
6	Religious Education	1	2	3	4	5

PART III: PERCEPTIONS ABOUT USING ENGLISH AS MEDIUM OF INSTRUCTION IN MATHEMATICS

The following statements represent various perceptions about the use of English as medium of instruction. Indicate by circling the number to show the degree to which you agree or disagree with each of the statements. SA = Strongly Agree; A = Agree; DA = Disagree; SDA = Strongly Disagree; NS = Not Sure

Perception When English is used in mathematics teaching,	**SDA**	**DA**	**NS**	**A**	**SA**
1 pupils are motivated throughout the lesson	1	2	3	4	5
2 a greater number of pupils are reached equally at the same time	1	2	3	4	5
3 individual pupils learning needs are supported	1	2	3	4	5
the teachers instructional effectiveness is increased	1	2	3	4	5
5 5misconceptions about certain concepts which would be difficult for a teacher to explain is reduced	1	2	3	4	5
6 misconceptions about certain concepts which would be difficult for the pupils to understand is reduced	1	2	3	4	5
7 pupils are helped relate mathematics to their culture	1	2	3	4	5
8 communication problems between the teacher and pupils is eased	1	2	3	4	5
9 an effective way of evaluating pupils learning is provided	1	2	3	4	5
10 the content of the lesson is enriched by drawing example from every day life	1	2	3	4	5

11 pupils are able to apply mathematics to solving everyday problems	1	2	3	4	5
12 The cost of implementing the use of English in mathematics lesson is out of proportion to its value	1	2	3	4	5
13 the degree of teacher-pupils interaction is reduced	1	2	3	4	5
14 teachers will be out of job	1	2	3	4	5
15 For some subjects the use of English instruction is NOT conducive to effective learning	1	2	3	4	5
16 time is wasted because pupils tend to dominate the classroom talk	1	2	3	4	5
17 the quality of education is lowered	1	2	3	4	5
18 Pupils do not take seriously the lessons taught in Chichewa.	1	2	3	4	5
19 Pupils sometimes experience difficulties in understanding the message expressed in English because of cultural irrelevance of the content	1	2	3	4	5
20 Textbooks prepared in English provide distorted information about mathematics and in so doing confuses the learners	1	2	3	4	5

21 Other (specify briefly)

___

PART IV: PERCEIVED BARRIERS TO THE USE OF ENGLISH AS MEDIUM OF INSTRUCTION IN MATHEMATICS

The following statements represent some of the general constraints or barriers to the use of English as medium of instruction in mathematics. Indicate with a circle around the number indicating the degree to which you perceive each of the constraints.

	Perceived barriers	**Degree of barriers**				
		None	**Min**	**Not sure**	**Moderate**	**Major**
1	Mathematical vocabulary in English are usually not available for use during classroom instruction	1	2	3	4	5
2	English as Medium of instruction is imposed upon the teacher	1	2	3	4	5
3	There are not teaching/learning aids prepared in English	1	2	3	4	5
4	There are fewer number of textbooks for mathematics written in English	1	2	3	4	5
11	Most teachers do not speak more than one local languages	1	2	3	4	5
6	Most teachers do not speak English	1	2	3	4	5
7	Most pupils do not speak English	1	2	3	4	5
8	Teaching several subjects makes it difficult to prepare for use of English as medium of instruction	1	2	3	4	5
9	In most cases it is difficult to understand mathematical concepts because Pupil's Book is written in Chichewa while Teacher's Guide is in English	1	2	3	4	5
10	The long syllabuses and short time makes it difficult to teach mathematics in English	1	2	3	4	5
11	Because of inadequate knowledge of the subject area, it is difficult to identify the appropriate vocabulary for the lessons	1	2	3	4	5
12	There is no money allocated for training teachers in using English as medium of instruction	1	2	3	4	5
13	There is lack of professional assistance from the supervisors when English is used	1	2	3	4	5
14	Using English distorts the meaning of mathematical concepts	1	2	3	4	5

15	There is no mathematical vocabulary that I know which could best be explained in English	1	2	3	4	5
16	There are no reference books for mathematics that could help teachers to mathematics using English	1	2	3	4	5
17	Other(Specify)					

Appendix 5: Guiding questions for teacher focus group discussions

University of Nottingham

Guiding questions for teacher focus group discussions

1 (a) In what language do you teach mathematics in your class?

(b) What are your views about the teaching of mathematics in the language you use?

(c) What other languages do you think could be used in the teaching of mathematics in your class?

(d) What do you think is the appropriate language for teaching mathematics in your class?

(e) What are your views about the language used in the teaching of mathematics in relation to the language in the teaching of other subjects:

2 Which mathematical concepts/topics do you

(a) enjoy teaching in Chichewa?

(b) find difficult to teach in Chichewa?

17 What do you think are the advantages of teaching mathematics in Chichewa to the:

(a) teacher?

(b) pupils?

18 What should be done to make mathematics teaching in Chichewa effective for the:

(a) teacher?

(b) pupils?

Appendix 6: Classroom observation schedule

University of Nottingham

CLASSROOM OBSERVATION SCHEDULE

1. Date: ....
2. Name of School: ....
3. Mixed or Single Sex School ....
4. Standard: ....
5. Teacher's Mother tongue: ....
6. Teacher Qualification: (Circle)

T2	T3
T4	TT

8. Subject: ....
9. Topic: ....
10. Time: Started: ....

    Finished: ....

LESSON ASPECT	KEY ISSUES	OBSERVATIONS
Introduction	• In what language does the teacher introduce the lesson? • Are objectives stated in Chichewa?	
Lesson Development 1. Teaching and learning materials 2. Teacher exposition 3. Reading 4. Mathematical vocabulary 5. Written language 6. Use of textbooks 7. Discussing 8. Fluency in speaking 9. Pupil participation 10. Code switching	• Are the T/L aids prepared in Chichewa/English? • Are the T/L aids discussed in Chichewa/English? • Is the lesson topic explained in Chichewa/English? • Are the concepts explained in Chichewa/English? • Is there any deliberate effort to teach pupils Mathematical terms in Chichewa/English? • Are the questions asked in Chichewa/English? • Are pupils given a chance to express their Mathematical ideas in Chichewa/English? • Are the pupils fluent in Chichewa/English? • Is the teacher fluent in Chichewa/English? • Is there any consideration for the use of Chichewa/English in Mathematics? • Are Mathematical terms written on C/B in Chichewa/English? • Is the textbook used written in Chichewa/English? • Is reading of the Mathematics symbols, terms, sentences in Chichewa/English? • Are pupils able to read the Mathematical text in Chichewa/English? • Are the exercises presented in Chichewa/English? • Does the teacher draw examples from everyday life? • How are the pupils performing in the task?	
Conclusion	• Does the teacher summarise the lesson in Chichewa/English? • Is pupils' assessment in Chichewa?	

OBSERVER'S COMMENTS

Appendix 7: School survey questionnaire

University of Nottingham
SCHOOL SURVEY

School: ______________________ **Date:** ________________

Instructions
Answer all the questions in this questionnaire

1. Who is the proprietor of this school ___________________ 2 When was it established? ____
1 How many classes are there at this school?

Standard	Number of classes
1	
2	
3	
4	
5	
6	
7	
8	

4 What is the total enrollment for this year?

Standard	Enrollment	
	Boys	Girls
1		
2		
3		
4		
5		
6		
7		
8		

5 Does this school have the following:

School facilities	Quantity
Headteacher's office	
Classrooms	
Library	
Mathematics club	
Store room	
Staff room	
Playground	

6 What is the main source of water for the school? (Please tick)
1 Piped water 2 bore hole 3 open well 4 river water 5 lake

7 How far away is the school from the following:

Facility	Distance
the nearest hospital	
The nearest school	
The nearest main road	
The nearest market	
The nearest town	

8 How many pupils textbooks are there in the school for the following classes?

Standard	Mathematics	Chichewa	English
1			
2			
3			
4			

9 What is the home language for the majority of the pupils at this school?

____

10 What are the major economic activities in the community surrounding the school?

____

11 Fill in the necessary information in the table below:

Teacher's name	sex	class teaching	teaching qualification	Academic qualification	Teaching experience	Home language

Appendix 8: Mathematical vocabulary equivalents in Chichewa and English

English Math Vocabulary	Chichewa Math Vocabulary
1 Zero	Zilo, Palibe kanthu, Kupanda kanthu, Palibe, Zunguliru, Dzira
2 Three	Fili, Zitatu
3 Five	Faifi, Zisanu
4 Eight	Eyiti, Zisanu ndi zitatu
5 Ten	Teni, Khumi
6 Seventeen	Seventini, Khumi ndi zisanu and ziwiri, Khumi limodzi, Zisanu ndi ziwiri
7 Twenty	Tuwente, Makumi awiri
8 Thirty four	Sete folo, Makuni atatu ndi zinai
9One hundred	Handiredi, Makumi khumi, Khumi makuni, Mazira awiri ndi chimodzi, [Zana]
10 One thousand	Sauzande, Wani sauzande, Makumi handiredi, Mazira atatu ndi chimodzi [Chikwi]
11 Place value	Mateni ndi mawani
12 Number	Nambala, Zinthu, malembo [chiwerengero]
13 Counting	Kuwerenga
14 Factors	
15 Fractions	Fulakishoni, Masamu odetsa
16 Addition	Times, Kuphatikiza
17 Subtraction	Kuchotsa, Kuchotsera
18 Multiplication	Times, Kuphatikiza, Kuchulukitsa
19 Division	Kugawa, Kuphatikiza
20 Sum	
21 Money	Ndalama, Makobiri
22 Coins	Ndalama zachitsulo, Ndalama zasiliva, Ndalama zamangwinjiri, Ndalama zazikoloni
23 Bank notes	Ndalama zapepala
24 Buying	Kugula
25 Selling	Kugulitsa
26 Profit	Ndalama zopitirira pa ndalama zomwe uli nazo, Ndalama zambiri, Phindu, Mawini, Kupeza ndalama zambiri, Ndalama zambiri, Pindula, Kupeza, Kulemera, Chithandizo, Kuchlukitsa ndalama, Kuwonjezera
27 Loss	Kuchitaya, walephera, Kulephera, Kusapeza, Kukanika kanthu, Ulibe kanthu, Kuluza, Kuduka, Siunapateko
28 Change	Kusintha ndalama, Ndalama za siliva, makobiri omwe atsala, Ndalama yotsala, Ndalama zobwerera
29 Line	Mzere, Kandodo
30 Angle	Pakona, Rekitango, Ngodya
31 Triangle	Chamakona atatu, Chinthu cha ngodya zitatu, Thirayango
32 Quadrilateral	Chamakona anai, Bokosi, Chinathu cha ngodya zinai, Kwadirilatero, Sikweya, house
33 Circle	Chozungulira, Seiko, Watch
34 Shape	Maonekedwe
35 Side	Mbali, Kunja, Mphepete
36 Centre	Pakati
37 Measuring	Kuyeza, Kuyeza, Kulinga, Kutchula nzere
38 Volume	Mkati, Zenje, Mbowi, Kulira kwa wailesi, Speaker, Kukweza mau pa wailesi
39 length	Mwamutali, Mlitali, Kutalika
40 Weight	Kulemera, Sikelo
41 Area	Bwalo, Malo, Anthu a misonkhano, Bungwe, Chairman, Anthu a chipani, Nthambo, Dela, Maiko,
42 capacity	Vunkha
43 Time	Nthawi
44 Distance	Ulendo, Mtunda, Kutalika
45 Height	Msinkhu, Kutalika
46 Temperature	juu! Kutentha, Kuwotcha, Kuzizira
47 Graph	
48 Physical graph	
49 Picture graph	
50 Bar graph	

Appendix 9: Research clearence letter from Ministry of Education

In reply please quote No. ....

legrams: MINED LILONGWE
lephone: Lilongwe 784 800
x No.: 782 873

mmunications should be addressed to:
e Secretary for Education

UNITY AND FREEDOM

MINISTRY OF EDUCATION
PRIVATE BAG 328
CAPITAL CITY
LILONGWE 3
MALAWI

Ref. No. IN/2/8B

30th December, 1998

Mr E.S. Kaphesi

Forwarded
12/1/99

Through : The Director
Malawi Institute of Education
P.O. Box 50
DOMASI

MALAWI INSTITUTE OF EDUCATION REGISTRY 1999 -01-

Dear Sir,

RE : THESIS RESEARCH IN THE PRIMARY SCHOOLS IN MALAWI

Your letter of 18th November, 1998 on the above subject refers. Permission has been given for you to carry out the research in the selected schools in Zomba, Mangochi and Dedza from 25th January 1999 to 30th September, 2000.

B.T. Khonje
DIRECTOR OF EDUCATION (BE)
for : **SECRETARY FOR EDUCATION, SPORTS AND CULTURE**

Director's Office
Malawi Institute of Education
12 JAN 1999
P.O. Box 50
Domasi, Zomba

Appendix 10: Sample letter from the School

LETTER OF CONSENT

1 HEADTEACHER

I agree that my school takes part in this project and that you will work with Mrs L.R. Dzama a mathematics teacher in standard One (1) whose consent is shown below.

PSKaphesi 06/01/99

Signature Date

2 MATHEMATICS TEACHERS

I agree to take part in this project. I know what I will have to do and that I can stop at any time

L. R. Dzama 6th January, 1999

Signature Date

I agree to audio/ video tape my interview/ lesson. I have been told that I have the right to listen to the audio tape or view video tape before they are used. I have decided that I:

✓ want to listen to the audio tapes
___ do not want to listen to the audio tapes
✓ want to view the video tapes
___ do not want to view the video tapes

Elias S. Kaphesi and other researchers approved by University of Nottingham may/ may not use the tapes made of me. The original tapes or copies may be used for

✓ the research project
___ education
___ presentation at professional meetings

Dzama 6th January, 1999

Signature Date