# TEACHERS' USE OF MATHEMATICAL TERMINOLOGY IN THE CLASSROOM: A CASE OF FOUR SELECTED SECONDARY SCHOOLS IN MUFULIRA DISTRICT

**BY**

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# DECLARATION

This dissertation is my original work and has not been presented for a degree in any other university.

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## CERTIFICATE OF APPROVAL

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# ABSTRACT

Mathematical terminologies are considered to be an important factor in the teaching and learning of mathematics. This study was an exploratory of teachers' use of mathematical terminology in four secondary schools in Mufulira district. It was not clear how mathematics teachers used mathematical terminologies in the classroom.The study used both quantitative and qualitative approaches and adopted a dominant less-dominant design in which qualitative approach was dominant. The research instruments included the questionnaire, structured interview guide, classroom observation field notes and focus group interview guide. The secondary schools were selected using simple random sampling technique. Convenience sampling technique was used to select four heads of mathematics department who were interviewed and 26 mathematics teachers who answered the questionnaire. A purposive sampling technique was used to select eight mathematics teachers who were followed-up to the classroom and 96 pupils who participated in Focus Group Discussions (FGDs) were selected using stratified sampling technique. Descriptive analyses were used to describe the teachers' responses regarding their attitude towards the teaching of mathematical terminology and the discourse analysis technique was used to analyse classroom practices and experiences regarding the teachers' use of mathematical terminology. The findings of the study indicated that to a larger extent, mathematics teachers had a positive attitude towards the teaching of mathematical terminology and they used predominantly oral strategies involving technical and sub-technical terms. The teachers' predominant use of technical terms interfered with the pupils' learning of mathematical concepts and their tendencies to substitute mathematical terminology with easier words deprived pupils of the opportunity to use mathematical terminology. The study recommended that teachers should focus on mathematical terminology when teaching mathematics. Heads of mathematics department should regularly conduct continuous professional development (CPD) meetings where strategies for teaching mathematical terminologies could be discussed.

**Key words**: Teacher, mathematical terminology, classroom, secondary school.

# DEDICATION

This study is tenderly devoted to my beloved wife and three daughters.

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# LIST OF ABBREVIATIONS/ACRONMS

1. CDC: Curriculum Development Centre
2. CPD: Continuing Professional Development
3. DEBS: District Education Board Secretary
4. ECZ: Examinations council of Zambia
5. Focus Group Discussion
6. HOD: Head of Department
7. MESVTEE: Ministry of Education, Science, Vocational Training and Early education
8. MOE: Ministry of Education
9. MRA: Mathematics Register Acquisition
10. NAR: National Assessment Report
11. NRP: National Reading Panel
12. NBT: New Break Through to Literacy
13. NCTM: National Council for Teachers of Mathematics

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Study

Mathematics, just like any other subject, is taught using a language. Pimm (1987) observed that part of learning mathematics is using correct mathematical vocabulary. However, according to Allen (1988) many teachers of mathematics have a tendency to disregard the importance of mathematical vocabulary in the teaching and learning of mathematics. They consider the language aspect of learning to be the preserve of teachers of English. Vacca and Vacca (1996) further pointed out that pupils are not likely to learn mathematical vocabulary in a classroom where the teacher is uncomfortable with mathematical terminologies.

The words that mathematics teachers use in different social activities in the classroom include mathematical terminology. Monroe and Panchyshyn (1995) described mathematical terminologies as words and phrases which have been created to be utilized only in mathematics and convey mathematical concepts which are difficult to express in everyday language and are often used in different social activities by mathematics teachers and their pupils in the classroom. Chapman (1997) pointed out that most statements that involve mathematical terminology have a standard interpretation and pupils have the task of learning how to interpret them. According to Kazima (2008) mathematical terminologies are difficult to translate in most local languages and some of these terminologies may have different meanings in the languages.

In Zambia, recent curriculum reforms have called for efforts to improve literacy skills at all levels of primary and secondary education. To this effect, the Ministry of Education, Science, Vocational Training and Early Education (MESVTEE) (2013) has suggested increase in literacy learning hours. This shift in curriculum has the potential to influence the teaching of mathematics because according to the National Council for Teachers of Mathematics (NCTM) (1991), mathematics and literacy are closely linked and interdependent. Therefore, it is imperative that mathematical vocabulary is taught in the classroom so as to improve literacy skills. In fact several reports have highlighted the need to support pupils' learning of mathematical terminology.

Nkwanga (1980) pointed out that mathematical words which are used at various levels in Zambia's primary schools were not sufficiently understood. The word 'multiple' for example, was one of the words often misunderstood by children in grades six and seven. The 1993 chief examiners' report observed that Grade 12 pupils do not clearly know the difference between such terminologies as 'evaluate' and 'simplify', while the 2005 report advised teachers of mathematics to explain to pupils the difference between 'half a vector' and 'position vector of a midpoint of a given vector'. It was also reported in 2012 that some candidates at school certificate examinations drew actual trees to represent 'tree diagrams' on questions involving probability. Kiwala (2013) observed that some of the challenges which were highlighted in the 2012 examiners' report for mathematics are not new, but have repeatedly appeared in past reports for several years.

These findings were consistent with those of the National Assessment Report (NAR), which is an in-built instrument for monitoring progress made in the provision of

education in Zambian schools. The results of the surveys in mathematics showed that pupils' performance at Grade 5 level continued to increase from 34.3 percent in 1999 to 38.5 percent in 2006. However, it was reported that pupils performed poorly in questions which involved interpreting mathematical words. In more recent reports, the National Assessment results for 2008 and 2012 showed that the proportion of pupils answering correctly questions which involved interpreting mathematical words was only 20 percent.

The challenges on the use of mathematical terminologies in schools as demonstrated by the reports cited above shows the importance of vocabulary in the teaching and learning of academic subjects. The study by Stahl and Fairbanks (1986) suggested that when specific vocabulary from the academic subject area was selected as the focus of instruction, the level of understanding the subject content increased by 33 percent. Therefore, in an effort to understand how teachers in Zambian secondary schools supported pupils' learning of mathematical concepts, this study explored how they used mathematical terminology in the classroom.

### 1.2 Statement of the Problem

Teachers of mathematics give less emphasis on the careful use of language in the teaching and learning of mathematics. They consider the language aspect of learning to be a preserve of teachers of English (Allen, 1988), but several examiners' reports state that pupils at secondary school level have continued to show lack of understanding of commonly used mathematical terminology (ECZ, 1993; 2005; 2012). However, despite these reports, teachers' use of mathematical terminologies has not been widely explored.

How teachers use mathematical terminologies in the classroom remains unclear. Therefore, it was imperative to conduct a research to establish how secondary school teachers used mathematical terminologies in the teaching and learning processes.

### 1.3 Purpose of the study

The purpose of the study was to investigate how secondary school mathematics teachers in Mufulira district used mathematical terminology in the classroom.

### 1.4 Objectives of the study

The specific objectives were:

1.4.1 To assess the teachers' attitude towards the teaching of mathematical terminology.

1.4.2 To determine the different kinds of terminologies teachers of mathematics use in the classroom.

1.4.3 To assess the strategies teachers of mathematics use to support pupils' learning of mathematical terminologies.

1.4.4 To determine how the teacher's use of terminologies affected pupils' learning of mathematical concepts.

### 1.5 Research Questions

The following were the research questions:

1.5.1 What is the teachers' attitude towards the teaching of mathematical terminology?

1.5.2 What different terminologies do teachers of mathematics use in the classroom?

1.5.3 How do teachers of mathematics support pupils' learning of mathematical terminology?

1.5.4 How does the teachers' use of mathematical terminology affect pupils' learning of mathematical concepts?

## 1.6 Theoretical framework

The study was guided by Lave's situated cognition learning theory to understand different classroom practices in the use of mathematical terminologies. This conception of behaviour states that knowledge should be learned in a meaningful context and must be a product of the activity, context and culture in which it is used (Lave, 1988). Basically, this theoretical framework attempts to explain the effective teaching of mathematical terminologies through social interaction and collaborative learning (Brown, Collins and Daguid, 1989).

In this theoretical framework, reference is made to the importance of the activity, context and culture. According to Watson (1989), 'activity' describe the purposeful activities in which pupils are engaged to enable them understand mathematical concepts. The teacher is expected to organize the activities in such a way that mathematical vocabulary with more complex meanings is built upon that which learners are familiar with. On the other hand, Chapman (1997) used the term 'context' to describe the mathematics lessons where conventions and patterns of mathematics are followed and facilitated. In this regard, teachers and pupils communicate with each other and follow conventional routines in the process of using mathematical terminology.

Bishop (1988) also used the term 'culture' to describe the shaping of ideas and meanings through social interaction. Culture provides different types of tools which are useful in

construction of meanings. In the problem statement of this study, reference was made to the use of language in the teaching and learning of mathematics. The term 'language' implies a tool which enables people to construct meanings when they talk to each other in a group through social interaction (Von Glasersfeld, 1995). The use of language in the classroom would therefore influence the teaching of mathematical concepts because the teacher and pupils could share meanings of mathematical terminologies through classroom discussion.

Situated cognition learning theory is also related to Vygotsky's theory of learning through social development. According to Vygotsky (1978), social interaction plays a fundamental role in the construction of knowledge and skills. The theory states that every function in the child's cultural development appears twice: first, on the social level and later, on the individual level. This applies to the formation of concepts in an individual. Vygotsky's theory also explains the potential for cognitive development in terms of the "Zone of proximal development"; a level of development attained when children engage in social behaviour. Full development of the Zone of potential development depends upon full social interaction. The range of skill that can be developed with adult guidance or peer collaboration exceeds what can be attained alone. Thus the teacher's role in cognitive development of the students is important.

Therefore, the concept 'use of mathematical terminology' in teaching and learning of mathematics would be more beneficial to the pupils if mathematical terminologies could be used in meaningful context. Since situated cognition learning theory regards learning communities as dynamic (Lave and Wenger, 1991), the teachers' use of mathematical

terminology would enhance pupils' understanding of mathematical concepts depending on the purposeful activities in which learners are engaged and the social interaction taking place in the classroom. It is anticipated that teachers would engage pupils in practicing how to use mathematical terminology in the right pattern of discourse.

### 1.7 Definitions of terms

Direct vocabulary teaching: This is when pupils are taught specific mathematical words and the strategies to learn the words (Marzona, 2004).

Discourse analysis: This implies analysing selected texts of a wide range of possible data sources such as transcripts of recorded interviews (Willing, 2008).

Everyday language: Language used in day to day life.

Indirect vocabulary teaching: This is when pupils are provided with opportunity to encounter mathematical words through discussions and participating in reading extensively on their own (Marzona, 2004).

Mathematical terminology: Refers to words and phrases that convey mathematical concepts. Miller (1993) gave examples of mathematical terminologies and stated that, "many mathematical words represent concepts and not objects, such words as quotient, fraction and factor which have no unique representation in the real world but describe concepts" (1993: 312).

Sub-technical terms: Refers to words which have more than one meaning and these meanings vary from one subject to another or from one subject to everyday experience. Pupils may know and be able to use one or more meanings for a sub-technical term, but may not necessarily know its specific mathematical meaning (Monroe and Panchyshyn, 1995).

Technical terms: Refers to words and phrases which have only one meaning specific to mathematics and are encountered only in mathematical context (Monroe and Panchyshyn, 1995).

Mathematical vocabulary: Refers to words and phrases teachers and pupils need to know to communicate effectively in mathematics.

### 1.8 Significance of the Study

A limited amount of research has been done about the teachers' use of mathematical terminology in Zambian schools. This study would contribute to the body of knowledge in mathematics education in three ways. Firstly, the findings of this study could be useful to teachers of mathematics. The teachers of mathematics would be helped to become more aware of the challenges that mathematical terminology poses to the pupils in the learning process of mathematics. The theoretical perspective that guided this study emphasised learning in diverse situations and settings (Collins, 1988). Knowledge about this perspective would enable teachers plan appropriate instruction that may help pupils to acquire appropriate mathematical vocabulary which is crucial to pupils' development of thinking and understanding of mathematical concepts.

Secondly, an exploration of teachers' use of mathematical terminology in the Zambian secondary school classroom would yield necessary information that would enable policy makers and curriculum developers in the Ministry of Education, Science, Vocational Training and Early Education (MESVTEE) understand challenges teachers and pupils face when dealing with mathematical terminology. Such information could be used in the planning of continuing professional development (CPD) programmes for teachers of

mathematics. Thirdly, educators of other content subjects areas where terminologies pose similar challenges as those in mathematics would also use this information to enhance pupils' learning of such subjects. Colleges of Education would also use the findings of this study in teacher training programmes. Researchers who are considering language issues in mathematics are also likely to use the findings from this study to extend knowledge on this topic.

### 1.9 Organisation of the study

In this study, the first chapter is aimed at showing that the teaching of mathematical terminology has not received much attention in Zambian schools despite the evidence that pupils have been failing to understand commonly used mathematical terminologies and have performed poorly in mathematical problems involving mathematical words. However, literature suggests that when mathematical vocabulary is used as a focus of instruction pupils' understanding of mathematical concepts is improved (Stahl and Fairbanks, 1986).

In chapter two, the literature on a brief history of mathematical words is outlined and the aspect of the mathematics register, its categories and the difficulties encountered by pupils in acquiring the register is discussed. The emphasis is on the teachers' role in teaching mathematical terminologies and the strategies suggested in the literature which can help pupils to acquire the register as well as the relationship between different findings which arose from the studies done both within and outside Zambia. This chapter justifies why it was necessary to conduct this study

The research design and the methods for data collection and analysis are discussed in chapter three. In the quest to have a valid set of data, a combination of both qualitative and quantitative methods was used where a dominant-less dominant design was adopted and the dominant approach was the qualitative. The teachers' questionnaire was used as an initial data collection instrument and Classroom observation was used as the main data collection instrument. The structured interviews with heads of mathematics and focus group interviews with pupils were used to determine also used in data collection.

The findings of this study are discussed in Chapter four. It brings out the findings on mathematics teachers' attitude towards the teaching of mathematics terminologies, and strategies they used to support pupils' learning of terminologies. In order to identify the ideas and experiences on the kinds of terminologies and strategies that were used in different classrooms, a detailed analysis of each teacher's lesson and the pupils' reflections on the teachers' use of mathematical terminologies are present in this chapter.

Chapter five is a discussion of the findings on the teachers' use of mathematical terminology. The findings of the study are contrasted with what is in the literature. The literature which supported the findings is mentioned and reasons that justifies why some literature did not support the findings are provided in this chapter. The conclusions and recommendations of this study are outlined in chapter six. This chapter provides a summary of the usefulness of the study and closes with a presentation of the direction for further research.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews the literature done by different researchers within and outside Zambia on the teaching and learning of mathematical terminology and discusses the usefulness of this literature to the present study. The literature on the origins and sources of mathematical words, the mathematics register and its acquisition are discussed first, followed by a review of studies on strategies for teaching mathematical vocabulary. Some theories on learning that are concerned with the teaching of mathematical vocabulary are also discussed. The chapter closes with a literature summary, which justifies the present study.

## 2.2 Origins and sources of mathematical words

There have been studies on the origins of mathematical words by scholars such as Aldrich (2009), Jeremy (2002), and Halliday (1978). These researchers seem to agree that most mathematical words that are used in the English language were borrowed from other languages. Aldrich (2009) reported that during the renaissance period Greek mathematical words were included in the English language through Latin, but since the $16^{th}$ century, writers have had direct contact with Greek literature and many English words have been taken from Greek directly into the English language. Halliday (1978) observed that new words in mathematics have been created by using words from, or part

words from other languages. Histogram, for example, is made up of the word ‘gramme’ from French and ‘historia’ from Latin.

The French language also has had a strong influence on the English mathematical language. According to Jeremy (2002), French has always been the language through which ideas from the continent of Europe entered Britain. This could explain why the French and the English languages tend to show some similarity in the basic mathematical vocabulary. For instance, the French word ‘matrice’ is a mathematical twin to the English word ‘matrix’ and the word ‘surface’ has been around English for so long that it no longer looks French.

Most of the mathematical terminologies we encounter in mathematics were coined by great mathematicians. For instance, much of the geometrical terms that are used today were established from Euclid’s Elements. Euclid was a Greek mathematician who lived over two thousand years ago. According to Greenberg (1993), Euclid based his mathematics on a series of definitions of terminologies like point, straight line, surface, angle, circle and triangle, which signified the starting point of the Euclidian geometry. Teachers of mathematics today use definitions of these terminologies in a similar way. For example, mathematics teachers often define a triangle as plane figure with three sides.

The other great mathematician, who has been accredited with a lot of contributions towards the development of mathematical words, is Pythagoras who was active in the sixth centaury BC. In the middle of his life, Pythagoras migrated from Greece, his native

home, to southern Italy where he founded the Pythagorean School. According to Bell (1945), the Pythagoreans advanced the understanding of mathematical terminologies like 'triangle' and 'geometric shapes'. For example, the concept of 'the angle sum of the triangle' was proved by the Pythagoreans. Hogben (1956) observed that Pythagoras regarded the sphere to be the most beautiful of all solids and the circle the most beautiful of all plane figures. He also used deductive reasoning to teach mathematical concepts. In his curriculum, Pythagoras taught perfect numbers, amicable numbers, and triangular numbers, which teachers of mathematics use in the classroom today. Over time, the mathematical vocabulary developed into the mathematics register.

### 2.3 Categories of mathematics register

According to Halliday (1978), the register is characterized by field, tenor and mode. Field refers to the social activity in which participants are given tasks to do and are allowed to verbalise; tenor refers to the relationships among the participants which include group leader during the social activity; and mode refers to the way the social activity is organized and how the participants interact with each other. Green (1988) observed that acquiring a register does not only involve learning the appropriate words but also being able to predict the kind of language appropriate to the field, tenor and mode for a particular context of situation.

Discussing the register of the mathematics classroom, Green (1988) identified two kinds of registers which come into play in different situational context. The first is the register of formal or 'technical' mathematics. Monroe and Panchyshyn (1995) sub-divided the register of formal mathematics into technical terms and sub-technical terms. On one

hand, they pointed out that each technical term has only one meaning which is specific to mathematics. An example of such technical term is 'hypotenuse', a terminology which conveys the mathematical concept. On the other hand, they described sub-technical terms as words whose meanings vary from one subject to another or from a subject to everyday experience. For example, the word 'root' which is part of a tree has a different meaning when used in the mathematical context where it represents values of a variable in an equation.

The second kind of register is the language of instruction used by the teacher in different social activities in the classroom (Chapman, 1997). This register varies according to the nature of the activities pupils are engaged in the classroom. For example, if on one hand the activity is about finding the answers to a given problem, the language of instruction may include words such as calculate, solve or work out. On the other hand, if the activity involves graph work then the language may include words like 'shade', 'label' or 'plot'. The language of instruction also includes a range of imperative forms such as 'let,' 'suppose,' 'define,' 'given' and 'consider' as opening words in sentences. Commenting on the characteristics of the mathematics register, Pimm (1987) observed that:

> The most striking characteristic of the mathematics register is the number of terms it contains which have been borrowed from everyday English. Examples of such words include: face, degree, relation, power, radical, complete, integrate, legs, product, mean, real, rational and natural. The extent to which this happens is great such that it is not just certain nouns and verbs like a 'ring' or to 'differentiate' to which this borrowing applies, but it also involves a wide range

of grammatical constructions… Despite all clocks becoming digital, the word 'clockwise' will still remain (Pimm, 1987:78).

Therefore, the mathematics register is composed of different forms of mathematical language, which also includes symbols and terminologies from everyday language as shown in Figure 2.3.1 which was adapted by Bubb (1994) as cited in Ballard and Moore (1987).

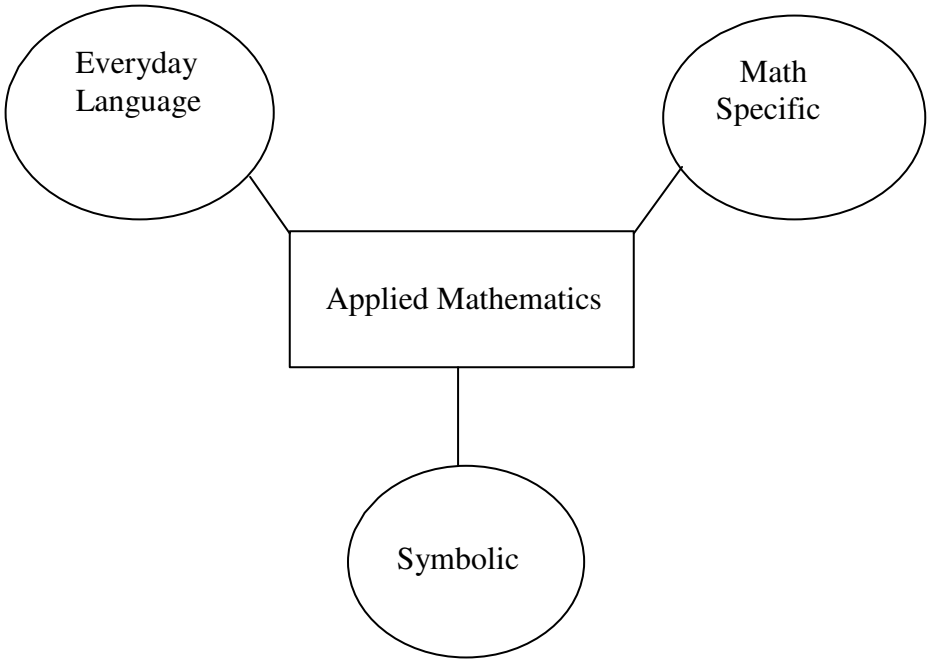



**Figure 2.3.1: Types of mathematical languages**

Furthermore, school mathematics includes different topics or areas of study such as sets, probability, geometry and trigonometry to mention but few. These topics may have their own registers which could be classified as sub-registers. This is true in the sense that the terminologies that are used in one particular topic may not be the same as the ones used in another topic. Therefore, since there are different branches of mathematics, then each branch may have its own registers. For example, there is the algebraic mathematics register.

### 2.4 A framework to analyze the algebra mathematics registers

Davidenko (2006) suggested a framework for analyzing the algebra mathematics register which has four categories. He defined each category of the register as follows.

> *Instrumental register*: This register uses only verbs to denote actions and sequence of actions. For example, add 2, divide by 4, and plug in the value.
>
> *Procedural register*: In this register verbs are used to denote action or sequence of actions and logical connectors such as if/then and this/because are also used. For example, divide by 2 on both sides of the equation because we are applying the inverse operation of multiplication.
>
> *Conceptual register*: This register uses nouns to name the concepts. Adjectives and adverbs may also be used to describe the properties of a concept or procedure. For example, a quadrilateral (noun/concept) is a four-sided (adjective/property) polygon (noun/concept).
>
> *Formal and symbolic register*: In this register symbols are used for concepts ($x$ = variable, $m$ = slop); symbols for procedures or operations (+, -, x, ÷); symbols for relationships (<, >, =) and expressions to denote logical statements (and, or, for all).

The author concluded that the framework could be used to explore the teachers' use of language in the classroom. Since this study was inclined to an exploratory approach about the teachers' use of mathematical terminology, this framework was applied in the analysis of the classroom practices and experiences of both the teachers and pupils in the use of mathematical terminologies in the learning and teaching process.

## 2.5 Difficulties in learning the mathematics register

The nature of mathematical words, as described in the literature sited above makes them difficult to understand. Chapman (1997) pointed out that most statements that involve mathematical terminologies have a standard interpretation and pupils have the task of learning how to interpret them, but more often than not pupils fail to do so successfully. Some examples of the literature done in Zambia that indicated that pupils fail to understand mathematical terminology include Nkwanga (1980) and Examinations council of Zambia (ECZ, 1993; 2005; 2012).

On one hand, the study by Nkwanga (1980) indicated that most words commonly used in Zambia's primary schools were not sufficiently understood. The word 'multiple' was one of the words cited to have been misunderstood by the children in grade six and seven classes. On the other hand, annual examiners' reports published by the Examinations council of Zambia (ECZ, 1993; 2005; 2012) indicated that pupils at Grade 12 level show lack of understanding of commonly used mathematical terminologies. For example, the 1993 report indicated that pupils were not able to discern the difference between the words calculate and simplify.

The studies done outside Zambia also indicates that pupils face challenges when dealing with mathematical terminologies. Warren (2006) indicated that most children face challenges with words involving equivalent situations. In a longitudinal study involving seventy six children the author examined the changes in children's understanding of words that are commonly used in equivalent and non- equivalent situations. The study lasted three years and in each year the children were asked to share their understanding

of the words: ‘equal’, ‘more’, ‘less’ and ‘between’. The results of the study suggested that children had difficulties in understanding ‘more’ and ‘less’. It was reported that the findings were in line with those done in the previous research which indicated that many children experienced difficulties in understanding the word ‘equal,’ a terminology representing things which are the same.

Among the questions that were answered in this study was: How did the teachers’ use of terminologies in the classroom affect the pupils’ learning of mathematical terminologies? Literature on the topic shows that teachers’ use of terminologies may contribute to the difficulties pupil experience when learning mathematical words. For example, Pimm (1987) investigated mathematics discourse involving a teacher and a second year secondary class on the topic ‘Pie Chart’. The results showed that the teacher was insisting on the use of conventional terms and there was no indication of giving pupils the reasons why the conventional terms might be more mathematical or acceptable. The author observed that the wide-spread use of technical vocabulary in mathematical discourse attest to the unequal distribution of authority and power over the language that is used in the classroom.

In a similar manner, Kotsopoulos (2007) reviewed 300 minutes of classroom transcriptions involving sixty words that were identified as belonging to the mathematics register. The results of the study indicated that the teacher used the sixty words 1500 times in the course of the 300 minutes. It was observed that the teachers’ predominant use of the words from the mathematical register was a source of teacher-talk interference

in pupils' learning of mathematical concepts. Nevertheless, teachers have an important role of helping pupils to understand and use mathematical vocabulary.

### 2.6 The teachers' role in teaching mathematical vocabulary

Mathematics teachers need to know the appropriate words and phrases that comprise aspects of the mathematical vocabulary so that they would be able to organise appropriate activities and experiences in which pupils can encounter and use mathematical language. Von Glasersfeld (1995) observed that language is a tool which enables people to construct meanings when they talk to each other in the group to which they belong through social interaction.

The interest in relationship between language and learning in general is not new. Some theories (Vygotsky, 1962; Piaget, 1952) have suggested that language determines and defines thought. Vygotsky had the opinion that language and thinking are inescapably linked, and even though they first appear independently in infants, they quickly merge into a single function as humans develop into fully social beings (Vygotsky, 1962). In this connection, Orton (1992) stated that:

> Language is important not only for communicating but also because it facilitates thinking. The language used for thinking is most likely to be the first language, thus mathematics communicated in one language might need to be translated into another to allow thinking, and would need to be translated back in order to converse with the teacher (Orton, 1992: 141).

In addition, Cuevas (1984) cited Halliday (1975) argued that teachers ought to use vocabulary in a way that would help pupils understand mathematical concepts:

> Teachers need to keep what they have to say simple and honest when attempting to communicate with learners. Not only must a mathematics teacher take great care to use words and explanations that are socially appropriate and comprehensible to the students, but the teacher must also carefully define and explain new mathematical terms so that the student can begin to develop the appropriate thought processes associated with the mathematical concepts and their labels (Cuevas, 1984: 36)

Macdonald (1990) also found it necessary to develop pupils' language of learning in terms of both the meaning of words in relation to learning and their use, before engaging them in meaningful dialogue during the learning process.

The role of the mathematics teacher is thus to help pupils overcome the challenges posed by mathematical language. Chard (2003) observed that the teacher need to plan instruction that would engage pupils in using appropriate mathematical vocabulary and Murray (2004) encourages the teacher to use classroom discussion when introducing mathematical terminologies and connecting them with more familiar words which pupils knows.

Furthermore, most researchers agree that discussing mathematical words and phrases can help pupils learn mathematical vocabulary accurately and overcome misunderstanding of mathematical concepts (Pressley, 1998; Monroe and Orme, 2002),

but not all the mathematical terminologies can be taught through classroom discussion. Cockcroft (1982) advised the teacher to make use of the pupils' ideas in the process of teaching mathematical terminology:

> The teacher must be willing to pursue the matters… The essential requirement is that pupils should be encouraged to think and that the teacher takes the opportunities which are presented by pupils in the classroom. There should be willingness on the part of the teacher to follow some false trails and not to say at the out set that the trail leads nowhere. Nor should an interesting line of thought be curtailed because there is no time (Cockcroft, 1982, paragraph 250).

In this connection, Stahl (1991) pointed out that if the teacher uses the best instruction then he or she is likely to present to the pupils between 300 to 400 words over the course of a school year. However, in the case were pupils are not taught these words systematically; the only feasible way for pupils to understand them is through classroom activities where pupils can learn words used correctly in meaningful ways (Kuhn and Stahl, 1998).

Beck, McKeown and Kucan (2002) also encouraged teachers to use classroom activities where pupils can encounter words frequently so that they could deepen their understanding of mathematical concepts and studies done by Nagy and Anderson (1994) have recommended repeating mathematical words in appropriate places. However, Stahl and Fairbanks (1986) observed that repeating mathematical words can only be effective if the meaning of such words can be associated to situations which are familiar to the

pupils. Therefore, there is need for the teacher to select appropriate strategies for teaching mathematical vocabulary.

### 2.7 Strategies for teaching mathematical vocabulary

Researchers have suggested specific strategies that teachers can use to support pupils' learning of mathematical vocabulary. In this study, the classroom practice and experiences were analysed and compared to the strategies sited in the following literature:

#### 2.7.1 The four stages in learning mathematical vocabulary

Meaney, Fairhall and Trinick (2007) have outlined four stages of supporting pupils' learning of mathematical vocabulary. The first stage was the 'noticing stage' that was described as the stage where the teacher introduced new words or expressions and added extra meanings to the ones that pupils were familiar with. The second stage was the 'Intake stage' where the students were giving definitions and examples of mathematical words.

The third stage was the 'Integration stage' in which the pupils were making use of the new aspects of the mathematical vocabulary; and the final stage was the 'Output stage' where the pupils were allowed to show fluency in using mathematical vocabulary. It was noted that the teacher's role at each stage was that of providing appropriate opportunities that would allow pupils to use the new aspects of the mathematical vocabulary. Some of the opportunities included engaging the pupils in discussing mathematical terminology

in groups and allowing pupils to answer thought provoking questions about the meanings of mathematical words.

### 2.7.2 Incidental and planned instruction

The National Reading Panel (NRP) (2000) recommended that the teacher's use of mathematical vocabulary should include both incidental and planned instructions where a variety of strategies for supporting pupils' learning of mathematical concepts are used. This recommendation is supported by Stahl and Fairbanks (1986). They suggested that focusing instruction on specific vocabulary from academic subject area can increase understanding of academic content by 33 percent.

Apart from supporting the National Reading Panel (2000)'s recommendation, Stahl and Fairbanks (1986) examined two questions: Does vocabulary instruction have a significant effect on pupil's comprehension of text? What types of vocabulary instruction are most effective? The responses yielded a mean of 0.97, which was attributed to vocabulary instruction for comprehension of passages containing taught words, and 0.30 for a global measure of comprehension, both of which were significantly different from zero. It was suggested that the most effective vocabulary teaching methods included both definitional and contextual information. Involving pupils in deeper processing of words and multiple exposures to learned words, including visual instruction were found to have reliable effects on recall of definitions and sentence comprehension.

In this connection, Marzano (2004) advocated for direct instruction as an intervention for supporting pupils' learning of mathematical vocabulary. Learning vocabulary directly implies that students are taught specific vocabulary and strategies to learn the vocabulary. Pressley (1998) supported direct instruction that allows student to discuss the meaning of mathematical vocabulary as opposed to memorizing the definitions. Direct teaching of mathematical vocabulary is also documented by Monroe and Orme (2002). They suggested two general methods that can be used to develop pupils' mathematical vocabulary. One of the methods is direct teaching of vocabulary itself, which include giving definitions to pupils. The other method is that of using meaningful context in which opportunities are provided for pupils to represent, discuss, read, write and listen to mathematics before vocabulary can be taught directly.

### 2.7.3 Writing and reading about mathematical vocabulary

Chapman (1993) observed that involving pupils in writing down the meanings of mathematical words can help pupils to develop and improve their thinking skills and it could enable the teacher to know whether the pupil understands mathematical terminology or not. This observation is supported by Rubenstein and Thompson (2002) who contend that writing about mathematical vocabulary allows the teacher to plan instruction that focuses on the pupils' misunderstandings of vocabulary meaning. However, Beck and McKeown (2002) have suggested involving pupils in reading mathematics textbooks followed by classroom discussion of mathematical terminologies encountered in the text book. This requires that the teacher plans adequately on the textbook to take to the classroom and identifies the kinds of mathematical terminologies in the textbook to be discussed.

### 2.7.4 Using graphs and diagrams when teaching mathematical vocabulary

Scruggs and Mastropieri (1992) have recommended mnemonics to help slow learners remember mathematical terminologies which convey mathematical concepts. Mnemonic is any aid to memory that the teacher could use to help pupils remember concepts. For example, the teacher can represent a mathematical terminology with a graph or diagram. Similarly, Chard (2003) recommended that teachers should use pictures as aids for helping pupils to form initial meaning of mathematical terminology which could help pupils to extend knowledge of their mathematical vocabulary.

### 2.7.5 Using local language when teaching mathematical vocabulary

The Ministry of Education, Science, Vocational Training and Early Education (MESVTEE) support using local language in the teaching and learning process. The Ministry of Education (1996: 39) stated that, "All pupils will be given an opportunity to learn initial basic skills of reading and writing in a local language." To this effect, a language policy called the Primary Reading Program with the New Break Through to Literacy (NBTL) was introduced as an intervention measure to improve learning of vocabulary in schools.

It was not clear whether the implementation of the policy on using a local language had any influence on the teachers' use of mathematical terminologies in the classroom. However, more recently, the Ministry of Education, Science, Vocational Training and Early Education (2013) has suggested increase in literacy learning hours. This shift in curriculum is important to the teaching of mathematics because according to the

National Council of Teachers of Mathematics (1991), mathematics and literacy are closely linked and interdependent.

Studies done outside Zambia have also discussed the use of local languages in the teaching and learning process. Kazima (2008) discussed a policy which required learners to be taught in their mother tongue in relation to mathematical terminology in the teaching and learning of Mathematics. Two strategies of dealing with mathematical terminology when teaching in the mother tongue were suggested. The first strategy was to develop mathematics registers in the local language and the second was to borrow terminology from mathematical English. However, the author reported that the strategy of teaching mathematics using words in local languages posed some challenges because not all mathematical words could be translated into the local language and some may have different meanings in that language.

Garegae (2008) also discussed language in mathematics education and reported that teachers in Botswana code switch by altering their language to signal a change in context so as to support pupils' understanding of mathematical concepts. Adler (1998) describes code switching as changing from one language to another when using a particular language. The author pointed out that code switching was a good strategy for supporting pupils' learning of mathematical concepts.

In the light of this literature, the present study would assess the teachers' use of mathematical terminologies and determine whether they provide pupils with opportunities to think and use mathematical vocabulary in meaningful ways. In fact the

goal of education is to teach pupils to become effective thinkers (Gough, 1991). To achieve this goal, therefore it is imperative that teachers of mathematics understand different levels of cognitive development. Ferguson (2002) urged teachers to use Bloom's taxonomy in the classroom for them to teach mathematical terminology at more complex level of thinking. According to Bloom's Taxonomy, at the lower level the pupil recalls the meaning of terminology and at the higher level of critical thinking the pupil explores relationships of terminology in real word situations and makes justifications about language use.

### 2.8 Literature Summary

The literature discussed in this chapter showed that the mathematics register has been in existence for a long time. Many of the words were borrowed from languages such as Greek, Latin and French. The mathematical words which were developed by different great mathematicians are used by teachers in different social activities. Some of the words are so technical that they are difficult to express in everyday language. Kazima (2008) observed that the aspects of some mathematical words could be a source of confusion that hinders pupils from understanding mathematical concepts. The teachers' role is to use mathematical vocabulary in a way that would help pupils over come these challenges.

Studies exploring the teaching and leaning of mathematical terminology have identified strengths and weaknesses in strategies used to teach mathematical terminology. For instance, Kazima (2008) observed that the strategy of developing a mathematics register in a local language posed a challenge in that not all mathematical words could be

translated into the local language. However, Marzano (2004) advocated for direct instruction as an intervention for supporting pupils' learning of mathematical vocabulary and Garegae (2008) reported that teachers in Botswana code switch by altering their language to signal a change in context so as to support pupils' understanding of mathematical concepts.

Despite the proliferation of intellectual concerns with challenges posed by mathematical terminologies in mathematics education, there are limited studies that have focused on both the teachers' use of mathematical terminologies and the pupils' reflections on the lessons taught by their teachers with regard to mathematical terminology. The literature mainly focuses on either on teachers' or pupils' perspectives, and not on both aspects especially the evaluation sense of the pupils reflecting on the lessons taught by the teachers with focus on mathematical terminology which is included in this study. As a consequence of this inadequate research, pupils have continued to show lack of understanding of commonly used mathematical terminology. This study therefore examined the teachers' attitudes towards teaching of mathematical terminology, the kinds of terminologies and strategies used in the classroom and how these affected pupils' learning of mathematical concepts.

# CHAPTER THREE

# METHODOLOGY

## 3.1 Introduction

This chapter is about the methodology used in this study and the model that was adopted for the research design. The methodology is discussed under the following sub-headings: Research design, target population and sample, sampling techniques, research instruments, data collection procedure, research sites, and data analysis. The chapter closes with a discussion of the delimitations for the study.

## 3.2 Research Design

The study used both qualitative and quantitative approaches. According to Creswell (2003), using a combination of qualitative and quantitative approaches would give richer data and stronger evidence than using a single approach. However, the dominant-less dominant research design was adopted in which the qualitative approach was dominant. In the dominant-less dominant design the methods and results relate to the dominant paradigm and only a small segment of these relate to the less-dominant paradigm (Creswell, 2003).

## 3.3 Target Population and Sample

The target population of the study consisted of 62 mathematics teachers and their pupils in all the nine secondary schools in Mufulira district. To make the study manageable, four schools were selected from the nine secondary schools. Three schools were selected

from the seven public secondary schools and one school was selected from the two private secondary schools. A sample of 26 mathematics teachers drawn from all the four secondary schools participated in the study. Out of the 26 mathematics teachers, eight were followed-up to the classroom and 96 of their pupils participated in the study. In addition, four heads of mathematics department, one from each secondary school, also participated in the study.

### 3.4 Sampling Techniques

A convenience sampling technique was used to select 26 mathematics teachers who answered the questionnaire and four heads of mathematics department who were interviewed. According to Patton (2002), this technique was ideal to select participants who were available in the four secondary schools. The eight mathematics teachers who were followed-up to the classroom were selected using a purposive sampling technique. This method was suitable to select mathematics teachers who have been performing exceptionally well and others who have not been doing so well. The information about the teachers who were observed was obtained from the heads of department.

After every lesson observation, stratified random sampling technique was used to select the pupils who participated in Focus Group Discussions (FGD). According to Ghosh (2011), this method involves dividing a group into strata, which facilitates a random selection of a sample from each stratum. In this study, pupils in the classroom were divided into strata of boys and girls. Within each stratum, a simple random sampling technique was performed to select the pupils who participated in the Focus Group Discussion.

### 3.5 Research Instruments

The research instruments that were used in the collection of necessary data were: the teachers' questionnaire, structured interview guide, classroom observation field notes and focus group interview guide.

#### 3.5.1 Questionnaire

The questionnaire was administered to 26 mathematics teachers in four secondary schools. A sample questionnaire is included in Appendix A and had three parts: The first part had its purpose to help determine the demographical characteristics of the mathematics teachers. The second part consisted of two questions, which included both closed-ended and open ended questions. These questions had the purpose to determine the teachers' attitude towards the teaching of mathematical terminologies. The third part had also two questions which were intended to determine the strategies teachers thought were appropriate for teaching mathematical words.

#### 3.5.2 Structured interview guide

The second means of data collection instrument was the structured interview guide. The sample interview guide is shown in Appendix B. This instrument was administered to the heads of mathematics departments in the four secondary schools. The structured interview guide had the purpose to provide necessary information about the mathematics teachers and to indicate the involvement of the heads of mathematics department in the teaching of mathematical terminologies.

### 3.5.3 Classroom observation field notes

The third means of data gathering instrument was classroom observations field notes. This was the main data collection instrument because it facilitated the collection of data about the kinds of terminologies the teachers used in the classroom and the strategies which mathematics teachers used to support pupils' learning of mathematical terminologies.

### 3.5.4 Focus Group Interview guide

The fourth means of data collection instrument was the focus group interview guide (Appendix D). The instrument had the purpose to determine how teachers' use of mathematical terminology in the classroom affected the pupils' learning of mathematical concepts. The first question of the focus group interview guide was intended to indicate whether or not pupils were familiar with the terminologies that were used in the classroom. The second question had its purpose to indicate whether or not the teachers explained mathematical terminologies that they used in the classrooms. Question three was supposed to indicate which terminologies used by mathematics teachers were difficult to understand and the reasons why pupils considered them to be difficult to understand, and the last question was intended to indicate if the pupils appreciated the teacher's explanation of mathematical terminologies.

## 3.6 Data collection procedure

The questionnaires were first distributed to the teachers of mathematics in the four secondary schools. Then the heads of mathematics department in each of the four secondary schools were interviewed. Following the information obtained from the heads

of mathematics department, two mathematics teachers from each secondary school were selected and then observed. Each teacher was observed for forty to eighty minutes during each observation. A second observation was again conducted in each classroom after a week to see how closely the teachers' use of mathematical terminologies agreed with the earlier observations.

A research assistant was used during classroom observation so that two sets of data were obtained simultaneously and recoded separately, but at the same time in the same classroom. The data was recorded on a form whose format is shown in Appendix C. According to Johnson (1997), to ensure reliability of the data collected through observation, it is necessary to have two or more observers. In this regard the field notes which were obtained by the two observers were compared to see how closely the notes agreed. The researchers observed the lessons from the back of the classroom which caused the least amount of distraction to both the pupils and the teachers.

Immediately after each lesson observation, one Focus Group Discussion (FGD) with pupils was conducted outside the classroom. In each Focus Group there were six pupils equally divided between boy and girls. Since every teacher was observed twice, a total of 16 Focus Group discussions were conducted in the four secondary schools. Each Focus Group Discussion was audio-recorded.

Prior to carrying out the study, permission was obtained to conduct observations and discussions in the schools from both the District Education Board Secretary (DEBS) and authorities from the schools including classroom teachers. The permission to conduct the

study in Mufulira district was guaranteed through the letters shown in Appendix E. The participants were informed in advance about their participation in the study and they were assured that the information obtained was meant for research purposes only.

### 3.7 Research sites

The study took place in four secondary schools which were located in different locations of Mufulira district. School A was a grade one secondary school, located in the mine township, while school B and school C were grade two secondary schools, which were located in the central and western parts of the town respectively. School D was a private secondary schools located in the southern part of the district.

### 3.8 Data Analysis

Data from the questionnaire were summarized and scored accordingly in terms of positive and negative attitudes. Descriptive analyses were used to describe the teachers' responses regarding their attitude towards the teaching of mathematical terminology. In this regard, frequencies were used to describe the teachers' responses and the results were presented on tables, bar chart and pie charts.

The discourse analysis technique was used to analyse classroom practices and experiences regarding the teachers' use of mathematical terminology. This technique was ideal because it involved selecting texts of a wide range of possible data sources; that is transcripts of recorded interviews and field notes (Willing, 2008). The field notes from classroom observations and transcripts of audio recording of Focus Group Discussions with pupils were typed in word document and then the data were coded by

teacher and by school. The patterns in the data were used to generate the themes about the teachers' use of mathematical terminology in the classroom.

### 3.9 Delimitations of the study

The quantitative aspect of this study was descriptive: it compared the responses of mathematics teachers on the teaching of mathematical terminology in four secondary schools in Mufulira district. The findings of this study would be limited to the teachers' opinions in the four secondary schools. The qualitative part of the study was exploratory: It compared the lessons of eight teachers of mathematics in four secondary schools. The study was context specific, which examined the ideas and experiences of the teachers and their pupils as produced in classroom interaction. Therefore, the findings were limited to the teachers' use of mathematical terminologies in the four secondary classes. However, since participants to the study were well defined, the findings might provide insights on how teachers of mathematics in Zambia use mathematical terminology in the classroom.

# CHAPTER FOUR

# FINDINGS

## 4.1 Introduction

The findings presented in this chapter describe how mathematics teachers used mathematical terminology in the classroom. The chapter opens with demographic characteristics of the mathematics teachers. The teachers' responses on how they regarded the teaching of mathematical terminologies are discussed followed by a presentation of findings from classroom observations. The findings are also compared according to the Teachers' use of terminology. The chapter closes with the summary of the findings.

## 4.2 Demographic characteristics of mathematics teachers

The data about the mathematics teachers was obtained from a Teacher's questionnaire (Appendix A). Table 4.2.1 shows the demographic characteristics of the teachers.

**Table 4.2.1: Demographic characteristics of mathematics teachers**

| | | Sex | | Qualification | | Experience in years | |
|---|---|---|---|---|---|---|---|
| school code | No. of teachers | male | female | diploma | degree | 5 and below | above 5 |
| A | 9 | 9 | 0 | 7 | 2 | 5 | 4 |
| B | 7 | 4 | 3 | 5 | 2 | 1 | 6 |
| C | 5 | 5 | 0 | 5 | 0 | 3 | 2 |
| D | 5 | 5 | 0 | 4 | 1 | 2 | 3 |
| Total | 26 | 23 | 3 | 21 | 5 | 11 | 15 |

The information displayed on the table showed that there were 26 teachers who completed the questionnaire. Of the 26 mathematics teachers 23 were male and three were female, showing that male teachers dominated the teaching of mathematics in secondary schools. There were more diploma holders than degree holders who taught mathematics at senior secondary school level. However, majority of the teachers had taught mathematics for more than five years.

### 4.3 Comparison of mathematical terminology with words from everyday language

The data in Table 4.3.1 represents responses from the teacher's questionnaire on whether mathematical terminologies were difficult to understand than words from everyday language.

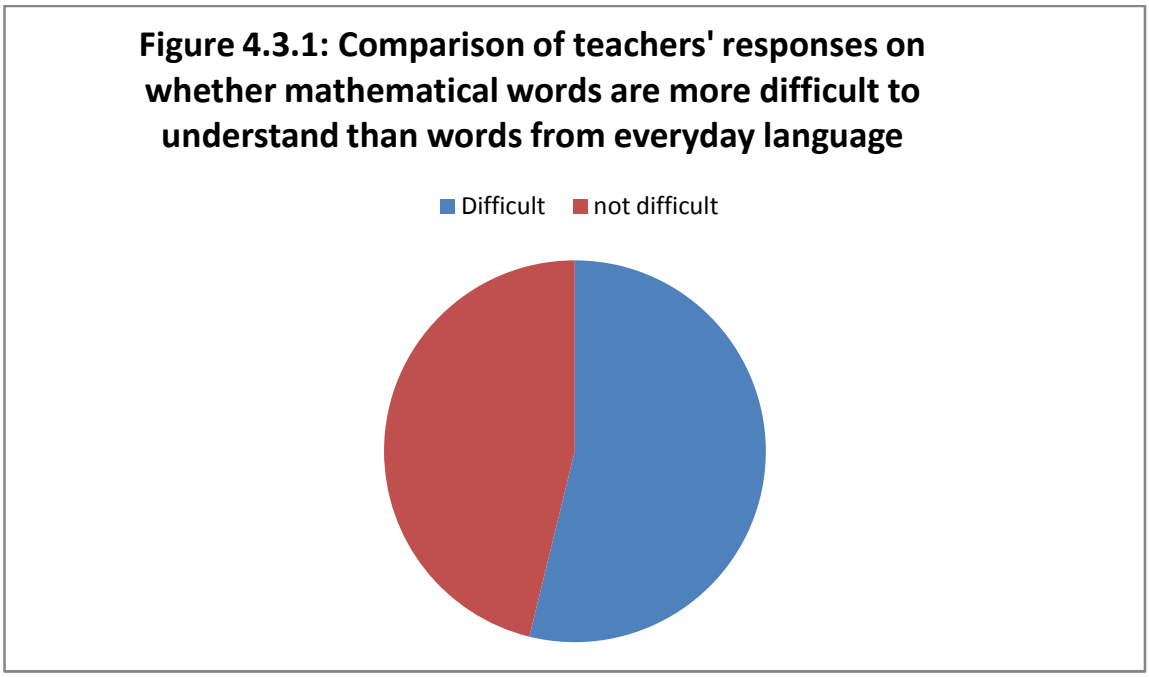
**Table 4.3.1: Mathematics teachers' responses on whether mathematical words are more difficult to understand than words from everyday language**

| | Do you think mathematical words are more difficult to understand than words from everyday language? | |
|---|---|---|
| | Yes | No |
| school A | 4 | 5 |
| school B | 5 | 2 |
| school C | 3 | 2 |
| school D | 2 | 3 |
| Total | 14 | 12 |

The information displayed showed that the number of mathematics teachers who indicated that mathematical words were more difficult to understand than words from everyday language exceeded those who indicated that mathematical words were not difficult to understand by two. An analysis by school showed that more teachers from

School B gave positive responses than any other schools. Figure 4.3.1shows a comparison of mathematics teachers' responses on a pie chart.

**Figure 4.3.1: Comparison of teachers' responses on whether mathematical words are more difficult to understand than words from everyday language**




Of the 14 mathematics teachers who indicated that mathematical words were more difficult to understand than words from everyday language, eight stated that, "mathematical words are rarely used in everyday life and are like a foreign language to the pupils" and six teachers stated that "mathematics is a science with its own terminologies that are different from ordinary English language."

### 4.4 Focusing on mathematical terminology when teaching mathematics

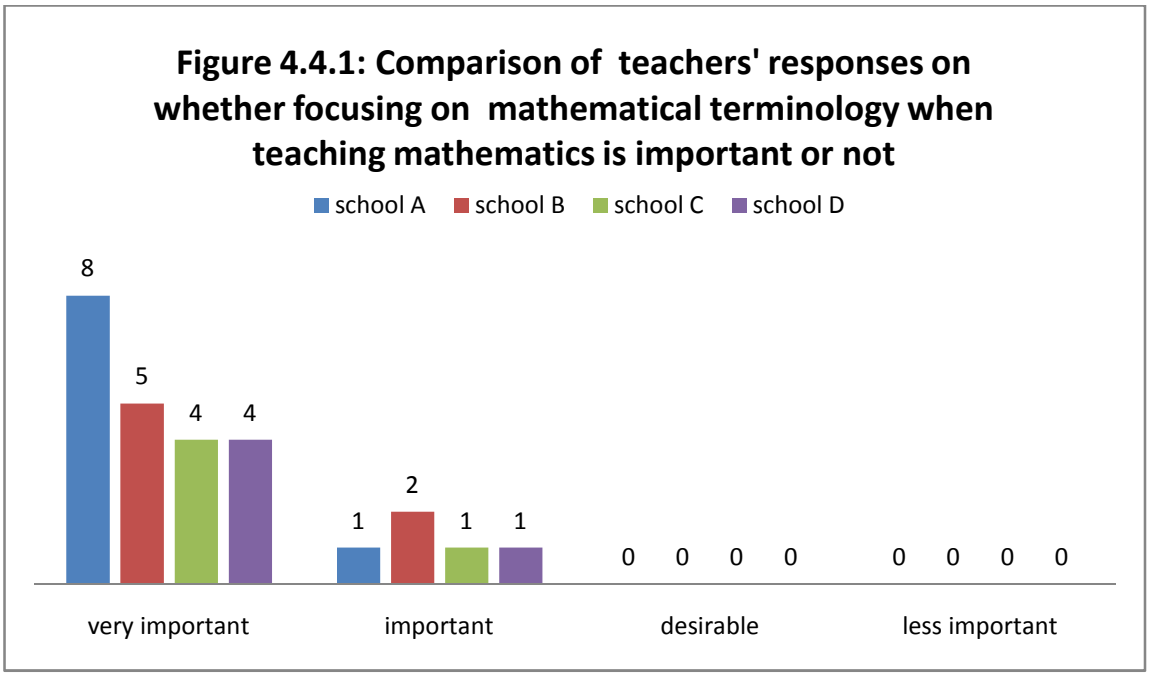
The data in Table 4.4.1 represents the responses from the teacher's questionnaire on whether it was important to focus on mathematical terminology when teaching mathematics.

**Table 4.4.1: Mathematics teachers' responses on whether it is important to focus on mathematical terminology when teaching mathematics**

| | How important do you think focusing on mathematical terminology can be in the understanding of mathematical concepts? | | | |
|---|---|---|---|---|
| | very important | important | Desirable | less important |
| School A | 8 | 1 | 0 | 0 |
| School B | 5 | 2 | 0 | 0 |
| School C | 4 | 1 | 0 | 0 |
| School D | 4 | 1 | 0 | 0 |
| Total | 21 | 5 | 0 | 0 |

The results showed that of the 26 mathematics teachers who participated in this study, none of them indicated that it was either desirable or less important to focus on mathematical terminologies when teaching mathematics. Twenty one of the mathematics teachers stated that focusing on mathematical terminology was very important in the understanding of mathematical concepts and five indicated that it was important. The bar chart in Figure 4.4.1 shows a comparison of secondary schools with regard to mathematics teachers' responses.

The mathematics teachers from School A gave more positive responses than teachers from the other three secondary schools. Of the nine mathematics teachers from School A, eight indicated that it was very important to focus on mathematical terminology when teaching mathematics. The high number of mathematics teachers who indicated that it was very important to focus on mathematical terminology when teaching mathematics, describe how the teachers valued the teaching of mathematical terminology.




The information in the bar chart indicated that teachers acknowledged the importance of focusing on mathematical terminology when teaching mathematics. Of the 26 teacher who participated in this study, 17 stated that, "mathematics, being a specialised subject requires the teacher to teach effectively" and four teachers stated that "focusing on mathematical terminology gives pupils the freedom to learn mathematics. These responses reflect the teachers' positive attitude towards the teaching of mathematical terminology.

### 4.5 Mathematics teachers' responses on substituting mathematical terminology

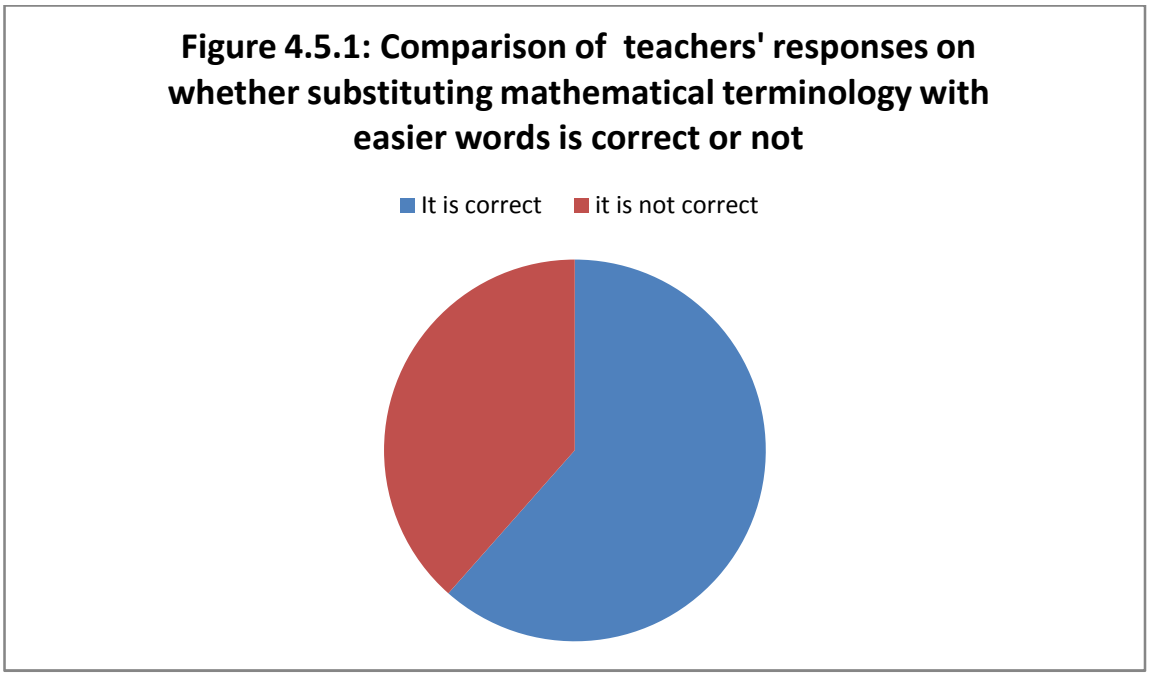
The data in Table 4.5.1 represents the responses from the teachers' questionnaire on whether substituting mathematical terminologies with easier words for the concept was correct.

**Table 4.5.1: Mathematics teachers' responses on whether substituting mathematical terminology with easier words is correct or not**

| | Do you think it is correct to substitute mathematical terminology with what we believe to be easier words for the concept | |
|---|---|---|
| | Yes | No |
| school A | 5 | 4 |
| school B | 6 | 1 |
| school C | 2 | 3 |
| school D | 3 | 2 |
| Total | 16 | 10 |

The results showed that of the 26 mathematics teachers who participated in the study 16 indicated that it was correct to substitute mathematical terminologies with what was believed to be easier words for the concept. This number was six more than those who stated that it was not correct to substitute mathematical terminology with easier words.

An analysis according to the secondary schools showed that more mathematics teachers from School B gave positive responses than teachers from other three secondary schools. Figure 4.5.1 shows a comparison of the teachers' responses on a pie chart. Of the 16 mathematics teachers who indicated that it was correct to substitute mathematical words what they believed to be easier words for the concept, nine teachers stated that, "substituting mathematical terminologies with easier words was convenient in that the easier words are used in day to day life" and seven teachers stated that "it is okay because words that are easier can be used to help pupils to understand mathematical terminologies." These statements describe how mathematics teachers who participated in this study supported pupils' learning of mathematical terminology.




### 4.6 Strategies for teaching mathematical terminology

Four strategies for supporting pupils' learning of mathematical terminologies were included in a Likert scale. Mathematics teachers were required to indicate the strategies they thought was ideal and effective in supporting pupils' learning of mathematical terminology.

The information displayed in Table 4.6.1 indicated that to a larger extent, mathematics teachers agreed that "a list of definitions can help pupils to understand mathematical words." Of the 26 mathematics teachers who participated in this study, 23 gave positive responses and acknowledged that using a list of definitions could enhance pupils' learning of mathematical terminologies. These responses describe how mathematics teachers who participated in this study supported pupils' learning of mathematical terminologies.

**Table 4.6.1: Mathematics teachers' responses on how they regarded different strategies for teaching mathematical words**

| | | Strongly Agree | Agree | Uncertain | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| 1 | Learning mathematical words occur through direct teaching. | 8 | 14 | 3 | 1 | 0 |
| 2 | A list of definitions can help pupils to understand mathematical words. | 13 | 11 | 2 | 0 | 0 |
| 3 | Using local language to explain mathematical words can help pupils understand mathematical concepts. | 6 | 9 | 5 | 4 | 2 |
| 4 | Learning mathematical words occur through indirect teaching | 2 | 5 | 5 | 11 | 3 |

In addition, the information displayed in the table indicated that mathematics teachers supported direct teaching of mathematical terminology in which definitions were given to pupils. In fact 22 out 26 mathematics teachers gave positive responses to the statement "learning of mathematical words occurs through direct teaching."

### 4.7 Involvement of heads of department in teaching mathematical terminology

The success of teaching mathematics in any school depends largely on the role played by the supervisors and the team-work efforts of the teachers in the department. In order to ascertain if heads of mathematics department in the four secondary schools valued the teaching of mathematical terminology, an item about the importance of focusing on mathematical terminology when teaching mathematics was included in the interview guide. The data in Table 4.7.1 represents the heads of mathematics department's responses about how they regarded the teaching of mathematical terminology.

**Table 4.7.1: Heads of mathematics department's responses on whether it is important to focus on mathematical terminology when teaching mathematics**

| Response item | Number |
|---|---|
| very important | 2 |
| important | 2 |
| desirable | 0 |
| less important | 0 |
| Total | 4 |

The information displayed showed that the four heads of mathematics department indicated that focusing on mathematical terminology when teaching mathematics was very importance. None of the heads of department indicated that it was either desirable or less important. This result was consistent with the teachers' responses in the questionnaire.

The head of department stated that, "focusing on mathematical terminologies would encourage and motivate pupils to have a broader understanding of mathematical concepts" and "it would enable pupils to understand the meanings of mathematical words." These statements describe how the heads of department valued the teaching of mathematical terminology.

The heads of department's responses suggest that they were fully involved in the teaching of mathematical terminology. However, the second item in the interview guide yielded different results. The data in Table 4.7.2 represents the heads of mathematics department's responses on their involvement in teaching mathematical terminology.

**Table 4.7.2: Heads of mathematics department's responses on whether they were involved in teaching mathematical terminology**

| | | never | sometimes | often | very often |
|---|---|---|---|---|---|
| 1 | Do you encourage teachers to assess pupils' understanding of mathematical terminologies? | 0 | 2 | 2 | 0 |
| 2 | Do you encourage your teachers to use textbooks in the classroom? | 0 | 2 | 2 | 0 |
| 3 | Do teachers share experiences about how to use mathematical terminologies? | 0 | 3 | 1 | 0 |
| 4 | Do you check how teachers use mathematical terminologies for concept development? | 1 | 3 | 0 | 0 |
| 5 | Does your continuous professional development (CPD) programmes involve use of mathematical terminologies in the classroom? | 3 | 1 | 0 | 0 |

The results showed that of the four heads of mathematics department who participated in the study, three indicated that they never discussed the use of mathematical terminologies in continuous professional development (CPD) programmes and none of them often checked how their teachers used mathematical terminologies for concept development.

### 4.8 Findings from Classroom observations

The names of the teachers who were observed were suggested by the heads of mathematics department and the selection was based on their performance during the past year. Table 4.8.1 shows the demographic characteristics of the mathematics teachers who were followed-up to the classroom. Of the eight teachers who were

observed only one was female. This is because there were few female teachers who taught mathematics at senior secondary school level. For the similar reason, only one teacher with a degree qualification was observed in this study. The data in the table shows that the teachers who were observed had taught mathematics for three years or more.

**Table 4.8.1: Demographic characteristics of mathematics teachers whose lessons were observed**

| Teacher code | School code | Sex | Grade | Qualification | Experience |
|---|---|---|---|---|---|
| 1 | A | male | 10 | diploma | 14years |
| 2 | A | male | 10 | diploma | 8years |
| 3 | B | female | 10 | diploma | 11years |
| 4 | B | male | 10 | diploma | 7years |
| 5 | C | male | 12 | diploma | 6years |
| 6 | C | male | 11 | diploma | 4years |
| 7 | D | male | 10 | diploma | 38years |
| 8 | D | male | 10 | degree | 3years |

### 4.8.1 Comments on Teacher 1‘s lessons

The most critical feature of Teacher1’s lesson was the manner in which he defined mathematical terminologies. He did this by using letters of the alphabet to explain their meanings.

> Teacher 1: You recall that a ‘variable’ is a letter which represents a number. Algebra uses letters of the alphabet. We are going to learn how to simplify algebraic expressions.

What was critical is the use of letters to explain two different terminologies, “variable is a letter…” and “algebra uses letters…” The teacher also related the terminology

‘algebraic expressions’ to ‘variable’. He asked pupils, “Is 15+4 an algebraic expression?” and gave an example, “3x + 5y is an algebraic expression in two variables.” This indicated that an ‘algebraic expression’ also uses letters of the alphabet. However, the teacher explained the difference between the terminologies ‘like terms’ and ‘unlike terms’ by relating them to pupils themselves.

> Teacher 1: We can simplify algebraic expressions by adding like terms. Examples of ‘unlike terms’ are boy and girl.

The second critical feature of the lesson was the manner in which the teacher assumed that pupils were familiar with the terminologies he was using. He mentioned ‘expression’ and ‘simplify’ without any elaboration as a result pupils identified these words as the most difficult to understand, “Simplify is difficult to understand because the teacher did not tell us its meaning, but told us to add like terms” (FGD, Pupil). This statement describes how the teacher’s use of mathematical terminology affected the pupil’s learning of mathematics. The pupils felt that had the teacher explained the terminology, they might have understood the meanings of the mathematical terminologies.

During the second visit to this classroom, the teacher was teaching about algebraic fractions. He used the concept of ‘common fractions’ to develop the idea of ‘algebraic fractions’ He did this by using differences in symbolic representation of the two concepts to help pupils reflect on their differences.

Teacher 1: When ‘common fractions’ use letters then we have ‘algebraic fractions’.

The most critical feature of this lesson was the manner in which the teacher’s introduction of the concept of ‘algebraic fraction’ interfered with the pupil’s understanding of the word ‘variable’ which was discussed in the previous lesson. Although the pupils regarded these terminologies to be familiar, they later on identified them to be the most difficult to understand.

> Algebraic fractions is most difficult to understand because the teacher said it involves letters and last time he said variables involve letters, it would have been better if he was using variables which I am familiar with (FGD, Pupil).

It appears that the teachers’ use of letters to define two different mathematical terminologies in two successive lessons resulted in pupils’ misunderstanding of both terminologies. In an attempt to explain the division of algebraic fractions the teacher stated:

Teacher 1: “Interchange the number on top with the number at the bottom”

In this lesson, the teacher repeatedly substituted the mathematical terminologies ‘numerator’ and ‘denominator’ with everyday language ‘the number on top’ and ‘the number below’ respectively.

### 4.8.2 Comments on Teacher 2‘s lessons

The lessons were characterized by graphical representation of mathematical terminologies. This was done in a variety of contexts. Graphs were drawn and used to

interpret the meaning of mathematical terminologies. For example, the teacher showed the ‘solution set’ by shading on the number line and used the graph to explain what ‘split point’ was. He told pupils that the point where the circle is drawn is a ‘split point’.

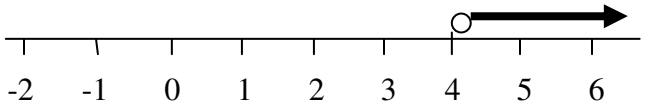



**Figure 4.8.2.1: Graphical representation of mathematical concepts**

The most critical feature of the lesson was the manner in which the teacher rephrased different terminologies. For example, he said, ‘4 is not included in the solution set’ because the circle is not shaded, but he later rephrased the statement as, “4 is not part of the solution set”. Rephrasing mathematical terminology in this manner was seen to be critical because it was seen to be one way the teacher used to support the pupils’ learning of mathematical terminologies.

At another instance during the lesson, the teacher acknowledged the terminology ‘dotted line’, but later on he emphasised that, ‘broken line’ was more appropriate terminology to use. What was notable also in this lesson is the teachers’ predominant use of mathematical terminologies such as linear inequation, boundary line, Cartesian plane, wanted region, split point and so on. In the process of solving inequation the teacher substituted mathematical terminologies with everyday language.

Teacher 2: Any mathematical statement joined by equality sign is called an inequation. When we multiply each term in the inequation by a negative number the sign changes or it reverses.

The teacher's frequent use of the statements "sign changes" and "sign reverses," which were used interchangeably was critical to the pupils' understanding of the concept of 'greater than' and 'less than'. When the teacher said "the sign changes" he meant the symbol representing the concept of 'greater than' (>) would change to the symbol (<) which represents the concept of 'less than'. However, the phrase "the sign changes" may carry a different meaning when discussing signs in another context such as traffic signs.

The other feature of the lesson was the manner in which the pupils become aware of appropriate mathematical terminologies. They considered terminology to be appropriate if it was recommended by the teacher. Hence the pupil's response was obvious and brief, "A 'broken line' is not the same as a 'dotted line' (FGD, Pupil). The pupils also expressed concern about the teacher's use of some mathematical terminology without any elaboration, "Linear is difficult to understand because the teacher did not explain its meaning" (FGD, Pupil). This response describes the pupils' concern over the teacher's tendency to mention mathematical terminologies without any explanation.

### 4.8.3 Comments on Teacher 3's lessons

In this lesson, the teacher provided visual experiences of terminologies in suitable contexts. She did this by allowing pupils to practice how to draw tables and graphs which were used to explain the meanings of words such as 'values', 'coordinates', 'plot' and 'solution'. The most critical feature of this lesson was the manner in which the teacher assumed that pupils were familiar with the terminologies that were used in the classroom.

Teacher 3: To draw a graph of a linear equation we first make a table then we express the x and y values in coordinate form. Plot the coordinates on the x and y planes. You recall that the 'origin' is the point where the x and y axes meet.

The way the teacher introduced the terminologies in this lesson was seen to be critical to the pupils' learning of mathematics. The teacher simply mentioned the mathematical terminologies without any elaboration. No wonder the pupils expressed concern about the teacher's use of mathematical terminology, "Coordinates is most difficult to understand because the teacher said we can represent the values in coordinate form without telling us the meaning of coordinates" (FGD, Pupil) and "Planes is most difficult to understand because the teacher simply said we plot the coordinates on the x and y planes" (FGD, pupil). These statements describe how the teachers' use of mathematical terminology affected the pupils' understanding of mathematical concepts.

In addition, the pupils' responses showed that their understanding of mathematical terminologies could be influenced by everyday meaning of the words, "Real numbers are numbers that can be visible" (FGD, Pupil). Therefore, it is necessary that the teacher explains mathematical terminologies rather than simply mentioning them. In the process of solving inequations the teacher used everyday language.

Teacher 3: To solve the inequation $5x - 3 \geq 2x + 9$ where x is a member of real numbers we first collect the like terms so that 3 'goes to the other side' of the inequation and 2x 'comes to this side' of the inequation.

The teachers' use of everyday such as "goes to the other side…" and "comes to this side…" was appreciated by the pupils "It helps us to solve the inequation" (FGD, Pupil). It appears that the use of everyday language to explain mathematical terminology facilitated the learning of mathematical concepts.

### 4.8.4 Comments on Teacher 4's lessons

The lesson started with comparison of symbolic representations of 'linear equation' and 'quadratic equation', which yielded terminologies such as 'power' and 'raised to first degree'

Teacher 4: A linear equation is an equation whose variable has been raised to the power one. What is the difference between the equations $2x^2$ + 6x = 4 and 4x – 2 = 5?

Pupil: In the first equation, x has the power 2, but in the second equation x has no power.

Teacher 4: The first equation is not linear because x is raised to the power 2 or x has been raised to the second degree, while the second equation is linear because x has been raised to the first degree.

Despite using new terminologies, 'power' and 'raised to first degree' no further discussion took place to explain their meaning. It appears as if the teacher assumed that pupils were familiar with the terminologies. What was interesting was the manner in which the pupils became aware that these terminologies were also used in other subjects, "Degree is more like raised to the power. We learnt about degree in geography, but the teacher was talking about degree in linear equations" (FGD, Pupil).

In the process of using linear equations, the teacher transformed his everyday language into mathematical language.

> Teacher 4: When the term 'crosses' the equal sign of an equation it 'changes the sign'. I mean using the 'additive inverse' of that term.

The teacher used everyday language to support pupils' learning of mathematical terminologies, then he realised that there was need to mention the mathematical terminology under discussion.

### 4.8.5 Comments on Teacher 5's lessons

The lesson was characterised by the use of definitions to support pupils' learning of mathematical terminology. The teacher defined terminologies verbally, wrote the definitions on chalkboard and encouraged the pupils to record them in their note books.

> Teacher 5: A transformation is an operation which maps a geometric shape from one position to another following certain set of rules. When a geometrical shape does not change shape then it is isometric.

In this exposition, the teacher used the terminologies 'isometry' and 'geometry' without any discussion. As consequence of this the pupils found the two terminologies to be confusing, "Isometry is difficult to understand because I confuse it with geometry" (FGD, Pupil). This statement describes the pupils' concern over the teacher's tendency to give definitions without discussing the terminologies that are used in the definition.

The other critical feature of this lesson was the manner in which the teacher used local language to explain some mathematical words. He did this by defining a mathematical terminology and then changing the language in order to explain the concept under discussion.

> Teacher 5: A mapping refers to an object undergoing a transformation. B' denotes an image of the object B. In the process of mapping an object onto its image, object *'kuti yasela, yaya panshi nangu kuti yaya pa mulu'* (That is, the object can be translated either downwards or upwards depending on the translation vector).

The use of local language to explain mathematical terminology was critical to pupils' learning of mathematical concepts. The teacher appeared to have utilised this strategy very well. In addition, during the second visit to the classroom, the teacher used materials to introduce mathematical terminologies. He did this by asking pupils to reflect on what happens to a rotating disk. Then he defined the terminology 'rotation'. He also explained the difference between the words 'clockwise' and 'anticlockwise' by using the hands of a clock.

### 4.8.6 Comments on Teacher 6's lessons

In this lesson the teacher related known mathematical terminologies to unknown ones. He used mathematical terminologies which were discussed in the previous lesson to introduce new mathematical terminologies.

Teacher 6: You recall that a solid with a circular base is a 'cone'. If we cut a 'pyramid' of any kind, a 'frustum' is formed. Some pyramids have rectangular base while others have circular base.

The teacher also used a metal bucket to show pupils how a 'frustum' looked like. He did this by comparing the sketches of the frustum and the metal bucket. The bucket was also used to identify 'slant height' of the frustum and the concept of 'invisible pyramid'.

Teacher 6: The bucket I am holding is an example of a frustum with rectangular base. The distance from the corner of the base to the top of the frustum is called the slant height. When the slant heights are extended an invisible pyramid is formed above the frustum.

The lesson was characterized by statements such as "we visualize the invisible height of a frustum…" and "we use our imagination to see an invisible pyramid above the frustum…"What was critical in this lesson was the manner in which pupils appreciated the teachers' use of mathematical terminology, "I do not know the meaning of pyramid but I can identify it if I see it" (FGD, pupil). The use of diagram and sketches was seen to be critical because the teacher used this strategy to support the pupils' learning of mathematical concepts.

During the second visit to the classroom the teacher discussed matrices with the pupils. He used the everyday term 'entries' to introduce a mathematical terminology 'elements' and represented both 'matrices' and 'elements' symbolically.

Teacher 6: Equal matrices have the same order and corresponding entries are equal. The entries are called elements. The two matrices on the chalkboard are equal therefore corresponding elements are equal.

$$\begin{pmatrix} 3-x & -1 \\ 1-y & -5 \end{pmatrix} = \begin{pmatrix} -5 & -1 \\ 1 & w \end{pmatrix}.$$

The most critical feature of this lesson was the manner in which the teacher assumed that pupils were familiar with the mathematical terminologies. He did this by simply mentioning the terminologies with any discussion. This behaviour by the teacher could have contributed to pupils' failure to understand the context in which the terminology 'element' was used, "Elements are numbers in a set" and also "Elements are numbers used in mathematics" (FGD, Pupil). This response show that the pupils were familiar with the terminology 'elements' as they are used in the context of elements in a 'set', which is different from 'elements' as they were used in 'matrices' during classroom discussion. It appears when the teacher assumes that pupils are familiar with the terminology pupils may experience confusion.

In the process of finding elements of the matrices the teacher used everyday language to support pupils' learning of mathematical terminologies.

Teacher 6: To find the element x, '3 crosses the bridge…' When we say 3 crosses the bridge…" we are transferring 3 to this side of the equation so that we find the value of x. This is the language we use for the 'additive inverse' of 3.

In this exposition, the teacher justified his use of everyday language "crosses the bridge…"by calling it another language which can substitute the mathematical terminology. What was interesting was the manner in which the pupils acknowledged that the language the teacher used was appropriate, "additive inverse is the same as a crossing the equal sign" (FGD, Pupil). This indicated that a culture had been established in the classroom. The teacher and pupils have agreed upon a common language which they use although it may not necessarily be mathematical.

### 4.8.7 Comments on Teacher 7's lessons

In this lesson the teacher defined mathematical terminologies by naming the concepts and their properties.

> Teacher 7: An isosceles triangle is a three sided polygon which has two equal sides and a parallelogram is a four sided polygon with opposite sides equal and parallel.

The teacher identified the properties of the concept of 'isosceles triangle' as being three sided with two equal sides and a 'parallelogram' as being four sided with opposite sides equal and parallel. The lesson was also characterized by the use of geometrical figures to illustrate the properties of mathematical concepts. In another lesson the teacher used a geometrical diagram and everyday language to signal the mathematical concepts under discussion.

> Teacher 7: You realize that the lines form a 'Z-shape' and so alternate angles are equal.

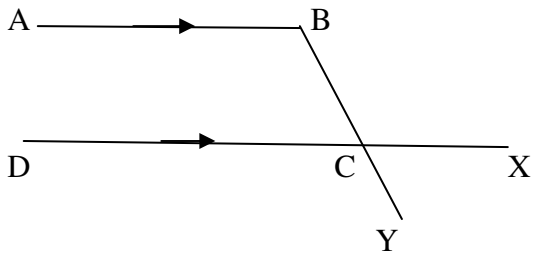



**Figure 4.8.7.1: Geometrical representation of properties of mathematical concepts**

When the teacher said, "The lines form a Z-shape," he was signaling a concept of 'alternate angles' so that the pupils can begin to think about it. The pupils appeared to be familiar with the teacher's unconventional language, "When the teacher said lines formed a Z-shape, he was talking about that alternate angles" (FGD, Pupil). This statement describes the culture of the classroom. The teacher and the pupils have established a particular language which they used during discussion of mathematical concepts.

### 4.7.8 Comments on Teacher 8's lessons

The lesson was characterized by symbolic representation of mathematical terminologies. When the teacher mentioned a mathematical terminology, he also gave the symbolic representation of the terminologies.

Teacher 8: An equation of first degree is called a linear equation. An example of a linear equation is $2x + 3 = 5$.

In the definition of a linear equation, the teacher used another mathematical terminology, 'first degree'. However, the terminology 'first degree' was not discussed in the classroom. It seems the teacher assumed that pupils were familiar with the

terminology. Later in the lesson, the teacher exclusively used everyday language to explain the procedure for solving linear equations.

> Teacher 8: To find the value of m: 2(m – 2) – 3 = 25, negative 3 will become positive when it jumps the equal sign.

The teacher's use of everyday language "It will become positive when it jumps…" was seen to be a critical feature to the pupils' learning of mathematical concepts. What was critical was the manner in which the pupils demonstrated that they understood the unconventional language which the teacher used in the classroom. They did this by explaining the meaning of the everyday language that the teacher used during classroom discussion, "When the teacher said the number will jump the equal sign he meant a number changes the sign" (FGD, Pupil).

The pupils' responses further revealed that a particular culture has been established in the classroom, "I only know of the terms' jump' and 'cross' which the teacher uses and it helps us to solve equations" (FGD, Pupil). However, some pupils found everyday language that was used in the classroom to be confusing, "Transferring numbers to the other side of the equal to sign can be confusing if you don't know what they are talking about" (FGD, pupil). It appears everyday language may not be meaningful to some pupils. There is need for teachers to engage pupils in discussing mathematical terminologies.

### 4.9 Comparison of findings on teachers' use of mathematical terminology

This section compares the findings from classroom observations of lessons taught by eight teachers of mathematics from four secondary schools in relation to the kinds of terminologies used in the classrooms; how the teachers supported pupils' learning of mathematical terminologies and how this affected the pupils' learning of mathematical concepts. These findings are also compared with the findings from the questionnaire which was administered in this study and the findings from heads of department's responses about their involvement in teaching mathematical terminologies.

#### 4.9.1 Kinds of terminologies mathematics teachers used

An analysis of kinds of terminologies used by mathematics teacher in the classroom resulted in the generation of two themes identified as: technical terminologies and everyday terminologies.

##### 4.9.1.1 Technical terminologies

Technical terminologies were considered from two sub-themes which included technical terms and sub-technical terms.

**(a) Technical terms**

Technical terms were described as mathematical terminologies that convey mathematical concepts and were created to be utilised only in mathematics (Monroe and Panchyshyn, 1995). All the teachers used this kind of terminologies. Table 4.9.1.1 shows some technical terms together with sample statements of how they were used in the classroom by mathematics teachers who participated in this study.

**Table 4.9.1.1: Technical terms mathematics teachers used**

| Teacher | technical term/sample statements of how it was used by the teacher |
|---|---|
| 1 | algebra, algebraic expression, algebraic fraction, e.g. algebra uses letters of the alphabet |
| 2 | linear equation, solution set, split point e.g. solution set can be shown on a Cartesian diagram by shading |
| 3 | linear inequation, number line, coordinates, real number e.g. real numbers can be shown on a number line by shading |
| 4 | linear equation, coefficient, multiplicative inverse e.g. use the multiplicative inverse before finding the solution to the equation |
| 5 | column vector, locus, Cartesian diagram, e.g. locus is a set of points defined by given conditions |
| 6 | frustum, pyramid, cone, matrices, e.g. some pyramids have rectangular base |
| 7 | isosceles triangle, base angles, alternate angles, e.g. in a parallelogram opposite sides are equal and parallel |
| 8 | linear equations, fractions e.g. express fractions under a common denominator |

Data from lessons which were observed showed that mathematics teachers had a tendency to assume that pupils were familiar with mathematical terminologies: Teacher 3 told pupils that the 'solution set' belonged to 'real numbers' and no explanation was given as to what 'real numbers' were; Teacher 4 and Teacher 8 compared two linear equations by referring to 'first degree' and 'second degree' without elaborating on the meanings of these terminologies.

Some teachers constructed sentences which involved two or more technical terms. For example, Teacher 5 used the terminologies 'isometry, and 'geometry' in the same statement, "When geometric shapes do not change shape then the transformation is said

to be isometric." Geometry in the context it was used had to do with properties and relationships of points, lines and plane figures, while isometry referred to the geometric transformation in which length is preserved, but no explanation of the differences between these terminologies was given to the pupils.

**(b) Sub-technical terms**

Sub-technical terms were described as terminologies with multiple meanings and these meanings vary from one subject to another or from one subject to everyday experience (Monroe and Panchyshyn, 1995). All the teachers whose lessons were observed used this kind of terminologies. Table 4.9.1.2 shows the sub-technical terms together with sample statements of how they were used by mathematics teachers.

**Table 4.9.1.2: Sub-technical terms mathematics teachers used**

| Teacher | sub-technical terms/sample statements of how it was used by the teacher |
|---|---|
| 1 | Variable, an expression, value, simplify, cancel, e.g. variable is a letter that represents a number. |
| 2 | Linear, variable, expand, value, cancel, solution, formula, subject, e.g. make x the subject of the formula. |
| 3 | Degree, plot, origin, table, solution, value, variable, real, linear, e.g. the origin is a point were the x and y axes meet. |
| 4 | Expression, variable, degree, value, formula, subject, e.g. 2x + 4y is an expression. |
| 5 | Transformations, translation, rotation, origin, plot, mapping, e.g. rotation is a circular movement about a fixed point. |
| 6 | Solid, volume, element, base, e.g. a cone is a solid with circular base. |
| 7 | Angle, base, parallel, degree, e.g. parallel lines extend indefinitely. |
| 8 | Degrees, value, linear, cancel, e.g. the word cancel is the same as dividing. |

The teachers who participated in this study had a tendency to assume that pupils were familiar with the sub-technical terms. For example, Teacher 1 mentioned the terminologies 'simplify' and 'expression' without explaining the context in which the words were used. However, Teachers 5 used the sub-technical term, 'mapping' together with a corresponding verb 'to map' which provided more sense to the concept of mapping. The teacher said, "To map the object onto its image…" The teacher explained that 'mapping' is "an object under going a transformation…", but the word 'mapping' represents an entirely different meaning in everyday language.

#### 4.9.1.2 Everyday terminologies

Everyday terminologies were described as unconventional or "inventive words and phrases" which teachers use to explain mathematical terminology (Chard, 2003). Table 4.9.1.3 shows sample statements of everyday terms mathematics teachers used.

**Table 4.9.1.3: Sample statements of everyday terms mathematics teachers used**

| Teacher | Sample statements used by mathematics teachers |
|---|---|
| 1 | 'Interchange' the number on 'top' and the number 'below'. |
| 2 | When we multiply by negative number the 'sign changes' or 'reverse the sign' |
| 3 | The term goes to the other side of the inequation…; Transfer' the term to the right of the inequation; |
| 4 | We 'cancel' both sides of the equation by 4 or we use the multiplicative inverse of 4; open the brackets. |
| 6 | When the term 'jumps' the equal sign it changes the sign. |
| 7 | When lines form a 'Z-shape' the angles so formed are equal. |
| 8 | When the term 'crosses' the equal sign it changes the sign; The number on 'top' of the fraction is a numerator. |

A comparison of how the teachers used everyday terms in the mathematics classroom shows that Teacher1 and Teacher 3 used everyday terms exclusively without discussing the mathematical terminology involved. For instance, in the process of dividing the fractions, Teacher 1 said, “Interchange the number on top and the number below.” In this case, the teacher substituted the technical terms ‘reciprocal’, ‘numerator’ and ‘denominator’ with the words ‘interchange’, ‘number on top’ and ‘number below’ respectively. However, Teacher 6 used everyday terms along side with the technical terms. The teacher said, ‘When the number “jumps” the equal sign it becomes negative.’ Then he mentioned the mathematical terminology involved, ‘Is the same as adding the “additive inverse” of a number to both sides of an equation.’

These comparisons indicated that all the mathematics teachers who participated in this study used both technical terms and everyday terms. However, they predominantly used technical terms and sub-technical terms. Some teachers used everyday terms to signal the mathematical terminology that denotes the concept under discussion, while others exclusively substituted mathematical terminologies with what they considered to be easier words for the concept. This was consistent with the teachers’ responses in the teacher’s questionnaire where majority of the teachers indicated that it was correct to substitute mathematical terminologies with easier words for the concept.

### 4.9.2 Strategies for teaching mathematical terminologies

An analysis of data from classroom observations showed that mathematics teachers used a variety of strategies to support pupils’ learning of mathematical terminologies. The

strategies were categorized under three themes identified as: Oral strategies, visual strategies and written strategies.

**(a) Oral strategies**

The oral strategies for teaching mathematical terminologies were described as approaches which utilises speaking and listening (Silver, Kilpatrick and Schlesinger, 1990). Speaking and listening takes place when people talk to each other in a group to which they belong through social interaction (Von Glasersfeld, 1995). Table 4.9.2.1 shows 10 oral strategies which were used by the mathematics teacher who participated in this study. The frequency indicates the number of mathematics teachers who used the strategy.

**Table 4.9.2.1: Oral strategies mathematics teachers used**

| Strategy | Frequency |
|---|---|
| - Asking pupil to give example of terminology. | 4 |
| - Asking for definition or explanation of a terminology. | 3 |
| - Having pupils answer questions leading to using new terms and elaborating on their responses. | 4 |
| - Using local language to explain, describe or give examples of a terminology | 2 |
| - Giving a definition of terminology verbally | 8 |
| - Reminding pupils to think about the terminology they already know | 3 |
| - Repeating new terminologies in appropriate places | 3 |
| - Rephrasing the expression by using other terms | 2 |
| - Relating a new terminology to already known ones | 4 |
| - Substituting mathematical terminology with easier words for the concept | 5 |

The results indicated that the oral strategy with the highest number of teachers was that of giving definitions of terminologies. This shows that all the mathematics teachers who were observed used gave verbal definitions of mathematical terminologies. Examples of the definitions included the following: Teacher 1 reminded the pupils, "You recall that a variable is a letter that represents a number"; Teacher 2 started his lesson by saying, "Any mathematical statement joined by equality sign is called an inequation"; Teacher 3 defined 'origin' as "the point where the x and y axes meet"; Teacher 4 defined 'linear equation' as "an equation whose variable has been raised to the 'power' one"; Teacher 5 defined a 'transformation' as "an operation which maps a geometric shape from one position to another following certain set of rules;" and Teacher 8 opened his lesson with a definition, "An equation of first degree is called a linear equation."

Some definitions were used to name the concepts, such as the ones by Teacher 6 and Teacher 7. Teacher 6 said, "If we cut a pyramid (Concept) of any kind, then a frustum (concept) is formed." The classroom talk in Teacher 6's classroom was characterized by statements such as "we visualize the invisible height of a frustum," and "we use our imagination to see an invisible pyramid above the frustum" and Teacher 7 identified the properties of the concepts in his definitions, "An isosceles triangle (concept) is a three sided (property) polygon (concept) with two sides equal (property)."

The other oral strategy that mathematics teachers used in the classroom was that of repeating new terminology in appropriate places. On one hand, Teacher 1 repeated the terminology 'algebraic expression' three times such as, when introducing the terminology; "we are going to learn how to simplify algebraic expressions," when

assessing pupils; “is 15+4 an algebraic expression?” and when giving an example; “3x + 5y is also an algebraic expression in two variables.” On the other hand, Teacher 4 repeated the terminology, ‘linear equation’ three times in appropriate places such as, when giving a definition, “An equation of first degree is called a linear equation,” when giving an example, “x + 4 = 7 is an example of a linear equation” and when relating the terminologies, “It is a linear equation of first degree because the variable x has no power.”

Mathematics teachers also used relating of new terminologies to known ones as an oral strategy for supporting pupils’ learning of mathematical terminology. While Teacher 1 used ‘variable to introduce an ‘algebraic expression’, Teacher 3 and Teacher 4 established the relationship between a ‘linear equation’ and a ‘variable’. Teacher 6 started by reminding pupils that a ‘cone’ is an example of a ‘solid’ with ‘circular base’ and then related ‘frustum’ to a ‘pyramid’, the terminology which was known by pupils. However, the oral strategies which teachers used varied according to planned instruction. Teacher 1 encouraged pupils to use a local language during classroom discussion, but Teacher 5 himself used the local language to explain the concept of ‘translation’.

Furthermore, mathematics teachers used everyday language to substitute mathematical terminology. Teacher 1 and Teacher 8 called the numerator in a fraction the number on ‘top’ while Teacher 3 and Teacher 4 used the statements “’transfer’ the terms to the ‘right’…” and “’Put’ the terms to the ‘left’…” respectively to signal the concept of ‘additive inverse’. In a similar manner, Teacher 8 used statements such as “it ‘crosses’ to

the right of…" and "it 'jumps' the equal sign…" These results were consistent with the teachers' responses in the survey in which majority of the teachers indicated that it was correct to substitute mathematical terminologies with easier words or ideas for the concept.

**(b) Visual strategies**

Visual strategies for teaching mathematical terminologies were described as approaches which utilized graphs, diagrams and materials which can reinforce the word meaning or concepts (Scruggs and Mastropieri, 1992). Table 4.9.2.2 shows five visual strategies that were used by mathematics teachers. The frequency indicates the number of teachers who used the strategy.

**Table 4.9.2.2: Visual strategies mathematics teachers used**

| Strategy | Frequency |
|---|---|
| - Using material to show a particular terminology | 3 |
| - Elaborating on the pupils' responses with diagrams | 4 |
| - Show pupils the relationship between what they already know and the new terminology in diagram or symbolic form | 4 |
| - Encouraging pupil to use appropriate terminology through diagram | 1 |
| - Show the difference in symbolic representation of terminology | 2 |

The result showed that the visual strategies that were utilised by the teachers, involved use of symbols, diagrams and materials. For example, Teacher 1 used pupils themselves to show the difference between 'like terms' and 'unlike terms'. He mentioned boy and girl as examples of 'unlike terms' and Teacher 3 used tables and graphs to discuss mathematical terminologies such as 'coordinates', 'plot' and 'origin'. While Teacher 5

used a rotating disk to explain the concept of 'rotation', Teacher 6 used a metal bucket to reinforce the meaning of the terminology 'frustum'. The frustum is not quite common as other solids that are taught in secondary schools therefore, the teacher used the terminologies together with their sketches to enable pupils visualize the concepts.

Furthermore, Teacher 1 used symbols to show similarities between the concepts of 'common fractions' and 'algebraic fractions', so as to help pupils reflect on their differences. The approach by Teacher 2 was equally good in that, he used the graphs to represent mathematical terminology. When a pupil identified the straight line as 'dotted line', he acknowledged the pupil's response but encouraged the pupil to use 'broken line' which was regarded to be an appropriate terminology. Furthermore, Teacher 1 used symbols to show similarities between the concepts of 'common fractions' and 'algebraic fractions', so as to help pupils reflect on their differences.

**(c) Written strategies**

Written strategies for teaching mathematical terminologies were described as approaches which encourage pupils to put their thoughts about terminology in written form (Rubenstein and Thompson, 2002). Only two written strategies were identified which included: The teacher writing definition of terminology on the chalkboard and asking pupils to record definitions in their note books. Table 4.9.2.3 shows the written strategies that were used by mathematics teachers whose lessons were observed. The frequencies indicate the number of teachers who use these strategies.

**Table 4.9.2.3: Written strategies mathematics teachers used**

| Strategy | Frequency |
|---|---|
| - Recording definitions on chalkboard. | 2 |
| - Asking pupils to record definitions in their note books. | 3 |

Teacher 1 utilised these strategies by recording definitions on the chalkboard. He wrote the definition of the terminology 'algebra' on the chalkboard before engaging pupils in a discussion and allowed individual pupils to write on the chalkboard. Teacher 4 utilised these strategies by writing word 'Problem' on the chalkboard and the derived 'linear equations' from the 'Problem'. Pupils were also allowed to copy the word 'Problems' in their note books.

In a similar manner, Teacher 5 recorded definitions on the chalkboard and encouraged pupils to copy them in their note books. However, apart from recording definitions on the chalkboard, Teacher 5 also underlined key words in the definitions. For example, the term 'transformation' was defined as "An operation which maps a geometrical shape from one position to another following a set of rules." In this definition, the teacher underlined the words 'operation', 'maps' and 'geometrical shape'.

A comparison of the frequencies of the three categories of teaching mathematical terminology which teachers from the four secondary schools used showed that the oral strategies were utilised most. Of the 10 oral strategies, giving verbal definitions was used by all the teachers of mathematics, implying that most teachers supported pupils' learning of mathematical terminologies through verbal utterances.

### 4.9.3 How teachers' use of terminology affected pupils' learning of mathematics

The pupils' understanding of mathematical terminology was obtained through Focus Group Discussions (FGDs). Pupils discussed the questions which were based on the mathematical terminologies that were used in the classroom. It was found that pupils had the view that their mathematics teachers used some mathematical terminologies without any explanation. They felt that the teachers had contributed to their failure to understand some mathematical terminologies that were used in the classroom.

The teachers' predominant use of technical terms in the absence of explicit explanation affected pupils' learning of mathematical terminologies. For instance, "Linear is difficult to understand because the teacher did not explain its meaning" and "Coordinates is difficult to understand because the teacher just said we can represent the value in coordinate form without telling us the meaning of coordinates" (FGD, Pupils). It seems when words are just mentioned without any discussion, they may be considered to be difficult to understand.

The teachers' use of geometrical shapes to explain mathematical terminology in the absence of elaboration of the meaning of the terminology left pupils knowing only the geometrical shapes, "I cannot define a pyramid, but I can tell when I see it" and "I do not know the proper definition of the word base, but I can identify the base angles in a triangle" (FGD, Pupil). Similarly, graphical representation of mathematical terminology proved to be problematic to the pupils, "Boundary line and split point are just the same because both demarcates whether it is part of the solution set or not" and "broken line is

not the same as dotted line" (FGD, Pupil). Thus, visual representation alone might have an effect on pupils' understanding of mathematical concepts if not accompanied by explicit explanation.

The mathematics teachers' tendency to substitute mathematical terminologies with unconventional terms deprived pupils of the opportunity to use mathematical terminologies. For example, the pupils failed to associate the teachers' unconventional language to any mathematical terminology, 'I only know of "jump and cross" which the teacher uses' (FGD, Pupils). They also showed concern over the teachers' use of unconventional language, "Transferring the number to the other side of the equal to sign is confusing if you do not know what they are taking about" (FGD, Pupil). Therefore, unconventional language might not be meaningful to some pupils and deprive pupils with the opportunity to use mathematical terminology.

The use of local language in the classroom also affected pupils if the teacher takes it for granted that pupils are familiar with the language used, "I am not comfortable when local language is used" and "English language is much easier to understand" (FGD, Pupils). These responses show that local language may not be meaningful to some pupils. Therefore, explanation of terminology in a local language should be accompanied with translation of that language into English language.

### 4.10 Summary of the findings

The finding presented in this chapter described the teachers' use of mathematical terminologies in the teaching and learning of mathematics. The mathematics teachers' responses indicated that they regarded mathematical words to be difficult than words from everyday language and to a greater extent agreed that focusing on mathematical terminologies when teaching mathematics was very important. These responses were consistent with the heads of mathematics department who observed that focusing on mathematical terminology would enable pupils to understand mathematical words. This showed that mathematics teachers had a positive attitude towards the teaching of mathematical terminology.

In addition, mathematics teachers indicated that it was correct to substitute mathematical terminologies with what was believed to be easier words for the concept and to a larger extent agreed that a list of definitions can help pupils to understand mathematical words. However, the heads of mathematics department's responses indicated that they were rarely involved in the teaching of mathematical terminologies.

The results from classroom practice indicated that mathematics teachers used predominantly technical and sub-technical terms. The data yielded three strategies which included oral strategies, visual strategies and written strategies. Mathematics teachers predominantly used the oral strategies in which giving of definitions was utilised most. This was consistent with the teachers' responses in the questionnaire where majority of the teachers agreed that a list of definitions can help pupils to understand mathematical words.

The pupils' responses indicated that the teachers' use of mathematical terminologies affected their learning of mathematical concepts. The teachers' predominant use of technical terms in the absence of explicit explanation affected pupils' learning of mathematical terminologies. The mathematics teachers' tendency to substitute mathematical terminologies with unconventional terms deprived pupils of the opportunity to use mathematical terminologies. The teachers' predominant use of oral strategies in which the definition method was most utilised promoted low level cognitive skills.

# CHAPTER FIVE

# DISCUSSION OF FINDINGS

## 5.1 Introduction

This chapter is divided into four sections that directly reflect the purpose of the study and the research questions. It begins with the discussion about the teachers' attitude towards teaching of mathematical terminology. The teachers' attitude is seen to be a factor that can influence the teachers' use of mathematical terminology. Then the discussion moves into addressing the question of different kinds of terminologies which mathematics teachers used in the classroom and the strategies that were used to support pupils' learning of mathematical terminologies. The chapter closes with the discussion about how the teachers' use of terminologies affected the pupils' learning of mathematical concepts.

## 5.2 Mathematics teachers' attitude towards teaching mathematical terminology

This study found that mathematics teachers regarded mathematical terminologies to be more challenging than words from everyday language. The teachers' statements such as, "mathematical words are difficult to understand because they are rarely used and are like a foreign language to pupils" and "mathematics is a science with its own terminologies that are different from ordinary English language" indicated that mathematics teachers who participated in this study were aware of the challenges mathematical terminologies poses to the pupils. The teachers' view that mathematical terminology are difficult to understand, is supported by Chapman (1997). The author observed that most statements

that involve mathematical terminologies have a standard interpretation and pupils have a task of learning the standard interpretation.

The findings also indicated that to a larger extent teachers agreed that focusing on mathematical terminologies when teaching mathematics was very important. They stated that, "focusing on mathematical terminology gives pupils the freedom to learn mathematics." This result was consistent with what was indicated by the heads of mathematics department from the four secondary schools who observed that focusing on mathematical terminology would enable pupils to understand mathematical words. Literature done by Stahl and Fairbanks (1986); Marzona and Pickering (2005) also advocates for teaching mathematical terminology using a systematic approach.

Furthermore, the majority of the teachers indicated that it was correct to substitute mathematical terminologies with easier words for the concept. Their statements such as "easier words were the ones pupils used in day to day life" and "This is okay because words that are easier can be used to help pupils to understand mathematical terminologies" describe how mathematics teachers who participated in this study taught mathematical terminologies. They sought approaches which could resolve some of the challenges pupils faced when dealing with mathematical terminologies. Hence, to a larger extent mathematics teachers agreed that a list of definitions can help pupils to understand mathematical words.

This section demonstrates that mathematics teachers who participated in this study had a positive attitude towards the teaching of mathematical terminologies; they indicated that

mathematical terminologies were more difficult to understand than everyday language and so they accepted that focusing on mathematical terminologies when teaching mathematical terminologies was very important. Thus, they acknowledged some strategies which they thought were ideal for supporting pupils' learning of mathematical terminologies such as substituting mathematical terminologies with easier words and using a list of definitions.

### 5.3 Kinds of terminology mathematics teachers used in the classroom

The different kinds of mathematical terminologies which have existed since ancient time to the present time confirm their importance as an indispensable part of teaching mathematics in the classroom. This study identified three kinds of terminologies which mathematics teachers used in teaching and learning mathematics. These were categorized as technical terms, sub-technical terms and everyday terms. The study indicated that mathematics teachers used predominantly technical terms and sub-technical terms. The teachers' predominant use of technical terminologies is supported by literature done by Pimm (1987). The author observed that the wide-spread use of technical vocabulary in the teaching of mathematics attests to the unequal distribution of authority and power over the language that is used in the classroom.

### 5.4 Strategies teachers used to support pupils' learning of mathematical concepts

This study identified three strategies which were utilised by mathematics teachers to support pupils' learning of mathematical terminology. These strategies were categorized as oral strategies, visual strategies and written strategies. The results of this study indicated that mathematics teachers utilised oral strategies most than visual strategies

and written strategies put together, which showed that the lessons were characterised by classroom discussion of mathematical terminologies through verbal utterances.

The oral strategies that were utilised by mathematics teachers emphasised explaining, defining, rephrasing and repeating mathematical terminologies. However, the results indicated that of the oral strategies, giving definitions of mathematical terminologies was used by all the teachers who were observed. Research shows that relying upon the definitions of mathematical terminology when teaching mathematics does not support understanding of mathematical concepts. Baumann, Kame'enul and Ash (2003) contend that instruction that uses definition alone has no impact on comprehension and Pressley (1998) supports instruction that allows pupils to discuss mathematical words than merely memorising their definitions.

The results from classroom observations indicated that all the mathematics teachers used unconventional language to explain mathematical terminologies and some exclusively substituted mathematical terminologies with what they believed to be easier words for the concept. This finding was consistent with the teachers' responses in the questionnaire where majority of the teachers indicated that substituting mathematical terminologies with easier words for the concept was correct. However, literature on the topic does not support the use of unconventional language to substitute mathematical terminologies. Chard (2003) considered the use of, what he called "inventive words and phrases" as a way of avoiding to teach standard mathematics. He pointed out that using informal everyday language would deprive pupils of the vocabulary they might need in discussing mathematical concepts. In this connection, Pimm (1987) observed that the

use of unconventional vocabulary was the source of confusion which contributed to the misunderstanding of mathematical concepts.

The teachers' use of unconventional language when teaching mathematics could be attributed to lack of cooperation among mathematics teachers in the departments. It is a well known fact that the effective teaching of mathematics largely depends on the involvement of the heads of department and the cooperative efforts of the teachers in the department. However, this was not the case with the mathematics teachers who participated in this study because the result showed that the heads of mathematics department in the four secondary schools where this study took place were not fully involved in the teaching of mathematical terminologies.

Furthermore, the result indicated that majority of the mathematics teachers who answered the questionnaire agreed that "using a local language to explain mathematical words can help pupils to understand mathematical concepts." However, only two of the eight mathematics teachers who were observed were found using both English language and local language to support pupils' learning of mathematical terminology. Adler (1998) described the strategy of teaching mathematical terminology by changing from one language to another (code switching) to be ideal for fostering pupils' understanding of mathematical concepts. Garegae (2008) also reported that teachers in Botswana code-switch by altering their language to signal a change in context so as to enhance pupils' understanding of mathematical concepts.

The use of local language is also supported by Zambia's education policy which states that, "All pupils will be given an opportunity to learn initial basic skills of reading and writing in a local language" (MOE, 1996). However, Orton (1992) observed one of the challenges that the use of local language when teaching mathematics could pose to the teacher.

> Mathematics communicated in one language might need to be translated into another to allow thinking, and would need to be translated back in order to converse with the teacher (1992: 141).

This statement is supported by literature done by Kazima (2008) who observed that the use local language in teaching mathematical terminology poses some challenges in that not all mathematical terminologies could be translated into a local language and some mathematical terminologies may have different meanings in such languages.

### 5.5 How teachers' use of terminology affected pupils' learning of mathematics

This section discusses how the teachers' use of terminology affected the pupils' understanding of mathematical concepts. An analysis of pupils' responses showed that several pupils were familiar with most terminologies that were used in the classroom. Some of their responses included, "We learned about them in lower grades," and "There were no new words" (FGD, Pupils). However, some of the terminologies which the pupils considered to be familiar were later on identified as the most difficult to understand.

> Algebraic fractions is difficult to understand because the teacher said it involves letters and last time he said variables involve letters, it would have been better if he was using variables which I am familiar" (FGD, pupil).

This response was recorded during the Focus Group Discussion (FGD) after observing Teacher 1's lesson. During the lesson the word 'variable' was described as a letter which represents numbers and 'algebra' was said to involve letters of the alphabet. In the second lesson Teacher 1 told pupils that, "Algebraic fractions involve letters." The use of letters of the alphabet to describe several mathematical terminologies affected the pupils' understanding of concepts of 'variable' and 'algebraic fractions'.

The confusion with the use of letters to explain mathematical terminologies, as illustrated in the pupils' response is well documented. A study by Hart (1981) yielded similar results which indicated that many pupils do not progress beyond the stage of letters in their understanding of algebra. Lakoff and Jonson (1980) observed that a letter or metaphor may not adequately structure a concept. Therefore, it is important for the teachers to clarify the meanings attached to metaphorical utterances to avoid confusing the pupils.

The pupils' responses in the classes taught by Teacher 2 and Teacher 3 indicated that teachers only mentioned the terminologies without any explanation. "Linear is difficult to understand because the teacher did not explain its meaning" and "Coordinates is difficult to understand because the teacher just said we can represent the value in coordinate form without telling us the meaning of coordinates" (FGD, Pupils). This finding is supported by the Examinations Council of Zambia (1993) which observed that

most teachers regard mathematical terminology to be self-explanatory, but there are the same words pupils consider to be difficult to understand.

In an effort to support pupils' learning of mathematical terminology, Teacher 1 and Teacher 5 used a local language to explain some mathematical terminology. However, pupils' responses suggested that the use of local language may have some effect on the pupils' learning of mathematical terminology especially if the teacher takes it for granted that pupils are familiar with the language used, "I am not comfortable when local language is used" and "English language is much easier to understand" (FGD, Pupils). These responses show that local language may not be meaningful to some pupils. Therefore explanation of terminology in a local language should be accompanied with translation of that language into English language.

The pupils associated the terminologies according to how the teacher represented them, but some pupils could only do this without explanation, "I cannot define a pyramid, I can tell when I see it" and "I do not know the proper definition of the word base, I can identify the base angles in a triangle" (FGD, Pupil). While the experiences of identifying the geometrical shape for concepts might play a role in shaping the meanings of mathematical terminologies, it was not the case in Teacher 2's class where two terminologies which were represented differently were thought to represent the same concept. "Boundary line and split point are just the same because both demarcates whether it is part of the solution set or not" and "broken line is not the same as dotted line" (FGD, Pupil). Thus, visual representation alone might have an effect on pupils' understanding of mathematical concepts if not accompanied by explicit explanation.

The pupils were not able to associate the unconventional language the teachers used to any mathematical terminology, 'I only know of "jump and cross" which the teacher uses' (FGD, Pupils). They also showed concern about the teachers' use of unconventional language, "Transferring the number to the other side of the equal to sign is confusing if you do not know what they are taking about" (FGD, Pupil). Therefore, unconventional language might not be meaningful to some pupils This finding is supported by Kotsopoulos (2007) who pointed out that pupils experience interference when they encounter everyday language used in mathematical context.

Finally, the results of this study did not reflect a specific way of using mathematical terminologies in the classroom. This is because no particular way of using mathematical terminology was determined. Therefore, the teachers' use mathematical terminology could not be said to have been influenced by any predetermined method. In this connection, the following conclusions were based on what was indicated by the teachers in the questionnaire, the classroom practices that were observed together with the pupils' reflections on the teachers' use of mathematical terminology in the classroom.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

This study investigated how teachers of mathematics used mathematical terminology in the classroom. The teachers indicated that mathematical terminologies were more difficult to understand than words from everyday language. They compared mathematical terminologies to learning a foreign language. However, the teachers to a larger extent agreed that it was very important to focus on mathematical terminologies when teaching mathematics. This showed that mathematics teachers had a positive attitude towards teaching of mathematical terminologies.

The teachers were aware of the challenges mathematical terminologies pose to pupils and the results of the survey showed that mathematics teachers who participated in this study believed that substituting mathematical terminologies with easier words for the concept would resolve the challenges mathematical terminologies poses to pupils. To a larger extent the teachers agreed that a list of definitions can help pupils to understand mathematical words. The findings from classroom experiences showed that teachers used predominantly oral strategies involving technical and sub-technical terms and the most utilised oral strategy was that of giving definitions of mathematical terminologies.

The pupils' responses indicated that the teachers' predominant use of technical terms and sub-technical terms in the absence of explicit explanation caused interference with

pupils' learning of mathematical concepts. The teachers' tendency to substitute mathematical terminology with easier words for the concept deprived pupils of the opportunity to use mathematical terminology during classroom discussion.

### 6.2 Recommendations

In order to improve the teaching of mathematical terminology in schools, it is important that some measures are put in place. This study, therefore recommended that l mathematics teachers should desist from substituting mathematical terminology with what they consider to be easier words for the concept. This would enable pupils to start using mathematical terminology as they engage in discussing mathematical concepts.

In this study the strategy for teaching mathematical terminologies which mathematics teachers utilised most was giving definitions to pupils. It was recommended that schools reform their teaching approaches so that emphasis should be on focusing on mathematical terminology when teaching mathematics. Focusing on mathematical terminology should not begin with giving definitions of mathematical terminology, but teachers should provide opportunities for pupils to discuss and represent mathematical terminologies before they could be defined.

The teaching of mathematical terminology is linked to the ability of the teacher to understanding mathematical concepts (Ball, 1991), therefore the results of this study point towards the need for the heads of mathematics department to be fully involved in guiding mathematics teachers on how to use mathematical terminology in the classroom by conducting continuous professional development (CPD) meetings with focus on

mathematical terminology. During these meeting mathematics teachers should discuss strategies that would resolve some of the difficulties that pupils face in dealing with mathematical terminology.

### 6.3 Further research

Further research on the teachers' use of mathematical terminology in the classroom should take place since very little research of Zambian origin exists on this topic. Further investigations of junior secondary or primary school classes may add more knowledge into this topic. In addition, researchers who may wish to extend knowledge on this topic should take into account the fact that the data in this study were collected from four secondary schools in one district over a short period of time. Observing more lessons from a number schools in different districts over a long period of time might allow investigating the teachers' use of mathematical terminology over a wide range of topics from the mathematics curriculum.

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Appendix A

## TEACHERS' QUESTIONNAIRE

This questionnaire is for teachers of mathematics in secondary schools in the year 2012. The questionnaire serves as one of the tools for conducting a study on teachers' use of mathematical terminologies in Mufulira district of Zambia.

Dear respondent,

I hope you will find it interesting to answer questions in this questionnaire. Your opinion will help the researcher to come up with the rightful information about the teachers' use of mathematical terminology in teaching and learning of mathematics.

The questionnaire is anonymous and your answers to this questionnaire will be kept strictly confidential. The results of the research will strictly be used for research purposes only. I therefore request that you answer the questions as accurately as possible, by this I mean, you should give real and true answers.

I wish to thank you in advance for your cooperation. Should you require further information or clarification, please do not hesitate to contact me at the contact details below.

Signed

**Webby Kapembwa**
Butondo Secondary School, P. O. Box 40095, Mufulira.
Cell No. 0967841736, Email:webbykapembwa@yahoo.com

## TEACHERS' QUESTIONNAIRE

This questionnaire is for teachers of mathematics in secondary schools in the year 2012. The questionnaire serves as one of the tools for conducting a study on teachers' use of mathematical terminologies in Mufulira district.

**Instructions:**

The questionnaire is in two parts. The first part is about your personal details, the second part is on attitude of teachers towards the teaching of mathematical terminology and the third part is about your opinion on teaching of mathematical terminologies.

Mark with an 'X' where applicable.

**1. Personal data**

1.1 Name of your School: ----------

1.2 Your qualification

| Diploma | Degree | Others |
|---|---|---|
| | | |

1.3 Subject(s) qualified to teach ----------

1.4 Teaching experience (indicate number of years) ----------

1.5 Sex

| Male | Female |
|---|---|
| | |

1.6 Indicate the grades that you teach.

| 10 | 11 | 12 |
|---|---|---|

| | | |
|---|---|---|
| | | |

**2. Teachers' attitude towards teaching mathematical terminology**

2.1 Do you think mathematical words are more difficult to understand than words from everyday language? ----------

Give reasons for your answer ----------

---

2.2 How important do you think explicitly teaching of mathematical terminologies can be in the understanding of mathematical concepts?

| Very important | Important | Desirable | Less important |
|---|---|---|---|
| | | | |

Give reasons for your answer: ----------

---

**3. Strategies for teaching and learning mathematical terminologies**

3.1Do you think it is correct to substitute mathematical terminologies with what we believe to be easier words or ideas for the concept?

| It is correct | It is not correct |
|---|---|
| | |

Give reasons for your answer ----------

---

3.2 Indicate to what extent you agree or disagree with the following statements. Mark 'X' in the appropriate box that corresponds with your opinion to the given statement.

| | Statement | Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|---|---|
| 1 | Learning mathematical words occur through direct instructions. | | | | | |
| 2 | A list of definitions can help pupils to understand mathematical words | | | | | |
| 3 | Using local languages to explain mathematical words can help pupils to understand mathematical concepts. | | | | | |
| 4 | Learning mathematical words occur through indirect instructions. | | | | | |

Appendix B

## STRUCTURED INTERVIEW GUIDE

This interview guide is for heads of mathematics department in secondary schools in the year 2012. It serves as one of the tools for conducting a study on teachers' use of mathematical terminology in Mufulira district.

**Instructions:**

The interview guide is about your involvement in the teaching of mathematical terminology. Mark with an 'X' where applicable.

1. Name of your school: ----------

2. Sex

| Male | Female |
|---|---|
| | |

3. Which ones among your teachers would you say performed exceptionally well during the year and which ones did not perform so well?

---

---

4. How important do you think explicitly teaching of mathematical terminology can be in the understanding of mathematical concepts?

| Very important | Important | Desirable | Less important |
|---|---|---|---|
| | | | |

Give reasons for your answer: ----------

---

5. Mark ‘X’ in the appropriate box that corresponds with your opinion to the given statements.

| | **Statement** | **Never** | **sometimes** | **often** | **very often** |
|---|---|---|---|---|---|
| 1 | Do you encourage your teachers to assess pupils’ understanding of mathematical terminologies? | | | | |
| 2 | Do you encourage your teachers to use mathematics pupils’ textbooks in the classroom? | | | | |
| 3 | Do your teachers share ideas and experiences about how they use mathematical terminologies in the classroom? | | | | |
| 4 | Does your continuous professional development (CPD) programmes based on how to use mathematical terminologies? | | | | |

Appendix C

## FORM FOR RECORDING LESSON OBSERVATIONS

Name of school: ----------

Teacher's Code: ---------- Sex: ----------

Grade/Class: ---------- Date: ----------

Topic: ----------

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Appendix D

## FOCUS GROUP INTERVIEW GUIDE

1. I noticed that some of the classroom activities included mathematical words and expressions. Are you familiar with some of the mathematical words used in the classroom?

   Probe: Which of these do you consider to be new words or expressions?

2. Would you say the teacher explained the mathematical words that were used in the classroom?

   Probe: Can you explain the meaning of one of the mathematical words?

3. If you were asked to name the most difficult mathematical word among these, what would you say?

   Probe: Why do you say so?

4. Did the teacher's explanation help you to understand the mathematical words?

   Probe: Do you always learn mathematics in this way?

Appendix E

Butondo High School
P.O. Box 40095
Mufulira

4th September, 2012

The District Education Board Secretary
Ministry of Education
Mufulira

Dear Sir / Madam

REF: Permission to Conduct a Research study in Mufulira District High Schools

I am a student with the University of Zambia pursuing masters degree in Mathematics Education. I would like to ask for permission to conduct the research study in high schools in your district, which is entitled Teachers' use of mathematical terminology in teaching and learning mathematics.

This research is a part fulfillment of my masters' degree program with the said University. The information gathered from this study will help in making recommendation to teachers of mathematics on good use of mathematical terminology that is likely to promote pupils' learning and consequently improve pupils' performance in mathematics.

I would be grateful if my request receives positive response from your esteemed office.

Yours Sincerely,

Webby Kapembwa
Masters student - UNZA