

**EFFECTS OF CODE-SWITCHING IN GRADE EIGHT MATHEMATICS TEACHING
AMONG BILINGUALS IN LUSAKA, ZAMBIA**

BY

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**A Dissertation Submitted to the University of Zambia in Partial Fulfilment of the
Requirements for the Award of the Degree of Master of Education in Educational
Psychology**

UNIVERSITY OF ZAMBIA

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DECLARATION

I, **Phiri Genesis**, do hereby declare that this dissertation is my own original work achieved through intensive review of related literature. It has never been previously submitted in any form by anyone at the University of Zambia or at any other University for the award of Master of Education Degree in Educational Psychology or for any other academic award. All the sources of data from previously related works done by other researchers which have been used in the production of this proposal have been rightfully recognised and acknowledged.

Signed.....

Date.....

I, **Bestern Kaani PhD** having supervised and read this dissertation, am satisfied that this is the original work of the author under whose name it is presented. I hereby confirm that the work has been completed satisfactorily.

Signed.....

Date.....

CERTIFICATE OF APPROVAL

This dissertation of Phiri Genesis has been approved as partial fulfilment of the requirements for the award of Master of Education Degree in Educational Psychology by the University of Zambia.

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ABSTRACT

This study sought to determine whether teaching Mathematics using Code-Switching mediated instruction (CSMI) would improve pupils' achievement more than using traditional English mediated instruction (TEMI). The objectives of the study were to: 1) determine whether there is a difference in achievement between pupils taught using CSMI and those taught using TEMI; 2) establish the influence of pupil-level characteristics on CSMI and TEMI in facilitating Mathematics achievement; and 3) assess specific content areas which statistically significantly affect overall Mathematics achievement for CSMI and TEMI.

A non-equivalent control group design was adopted over 209 Grade Eight pupils, selected through convenient sampling of naturally occurring classes, 104 were in the experimental group and 105 were in the control group. Data was collected through the pre-test ($\alpha = 0.82$) and the post-test ($\alpha = 0.88$) with 10 weeks treatment. During treatment the experimental group was taught using CSMI and the control group continued using TEMI. Data was statistically analyzed through Multivariate Analysis of Variance (MANOVA) and Multiple Linear Regression to determine differences in achievement means and variances between the respective groups.

MANOVA results demonstrated a statistically significant mean difference in achievement between the groups. Pupils taught using CSMI achieved better than those taught using TEMI. Regression results on pupil-level characteristics revealed that gender and class attendance had positive influence on CSMI but grade repetition had negative influence, whereas only class attendance, with a smaller beta coefficient, had positive influence on TEMI. Regression results on specific Mathematics content areas indicated that whilst Coordinates and Angles were significant for CSMI, only Coordinates, with a smaller beta coefficient, was significant for TEMI.

Generally, the study established that CSMI was more effective in Mathematics teaching than TEMI. Its use was more effective with all pupil-level characteristics, except grade repetition; and it facilitated performance on specific Mathematics content areas better than the latter. Therefore, the use of Code-Switching was recommended in teaching bilingual pupils who were less competent both in Mathematics and English language.

DEDICATION

To my parents, Mr. Tenson Phiri and Mrs Anastasia M. C. Phiri who, in spite of their humble educational background, have foreseen and believed that I am capable of engraving the family name on the competitive ‘walls’ of academia across the globe.

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ACRONYMS

CDC	Curriculum Development Centre
CS	Code-Switching
DEBS	District Education Board Secretary
ECZ	Examinations Councils of Zambia
HoD	Head of Department
MANOVA	Multivariate Analysis of Variance
MLF	Matrix Language Frame
MoE	Ministry of Education
MoGE	Ministry of General Education
SPSS	Statistical Package for Social Sciences
TE	Traditional English
UN	United Nations

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The chapter provides the introduction to the study on the effects of Code-Switching (CS) mediated instruction in Mathematics teaching. It gives the background of the study and will establish various issues pertaining to the problem to be investigated and the overall theoretical and conceptual guide for the investigation.

1.2 Background of the Study

Learning Mathematics is essential to pupils' success in school and everyday life. However, the acquisition of mathematical skills differs significantly across pupils, schools, and language of instruction (Molotja, 2008). While few pupils acquire such skills easily and nearly effortlessly, the majority have challenges in the process. This skill-acquisition lag is not only attributed to the quality of instruction being provided in Mathematics teaching, but is also influenced by the familiarity of the language of instruction (Jegedi, 2012). Thus, the recent past has seen a growing recognition of the role of CS between the language of instruction and pupils' familiar local languages in teaching and learning to facilitate the acquisition of mathematical skills. CS occurs "when teachers alternate between the mother language and the Language of Learning-Teaching during the learning process" (Web & Web, 2008:29). Setati and Adler (2002:144) perceive CS as "switching by the teachers and learners between the language of learning and teaching and the learners' mother language". It may also be defined as the use of a familiar local language in teaching and learning to supplement the language of instruction (Jegede, 2012).

Studies outside and within Africa revealed that CS as a communicative strategy appears to improve the teaching and learning of Mathematics when teachers or pupils were less competent in the language of instruction (Gwee, 2005; Mahofa, 2014; Md-Ali, Mohd-Yusof, & Veloo, 2014; Neo & Heng, 2012; Setyaningrum, 2015). However, these studies were generic and merely descriptive; and they did not quantitatively show how CS between languages improved

pupils' achievement in Mathematics. They concentrated heavily on CS as a technique of addressing teachers' and pupils' language incompetence in teaching and learning Mathematics, and not necessarily evaluating its effects on pupils' achievement. CS is a valuable communicative way of conveying mathematical ideas, concepts, theories, and methods which appears to enhance the teaching-learning process (Howie, 2003; Setati & Adler, 2002; Web & Web, 2008). However, this notion on the use of CS is restrictive in nature as it is used for purposes of communication only, while neglecting the psychological dimension of it. For instance, focusing on its effects on pupils who were not only incompetent in the language of instruction, but also in Mathematics. The argument concurs with Simon's (2001) assertion that in most classrooms CS is influenced by cognitive, affective, and classroom management factors, as it helps to regain pupils' attention, clarify, enhance, and reinforce lesson materials.

Generally, CS is based on the premise that teaching and learning Mathematics using an unfamiliar language makes it difficult for pupils; they struggle to learn mathematical skills and mathematical communicative competence simultaneously (Noren, 2007). Jegede (2011) argued that learning Mathematics using English mediated instruction was problematic for pupils whose familiar language was not English; and thus argued that CS between English and pupils' familiar language in the teaching-learning process could lead to a better understanding of the Mathematics content. Similarly, Molotja (2008) argued that the problem is established when pupils encountered concepts in Mathematics which were written in English and required to be explained to them in English language. Pupils often struggle to understand these concepts forcing teachers to resort to CS between English and pupils' familiar language to explain concept. However, the arguments by Jegede (2011) and Molotja (2008) are focusing on pupils in general irrespective of whether they are more or less competent in Mathematics, but for the present study the problem of using English mediated instruction in teaching Mathematics is seen to be more acute among pupils who already have incompetencies in the subject.

Unfortunately, CS between English and Zambian languages in the teaching and learning of Mathematics is not favoured, as the current education policy is precise on the language of instruction. Familiar local languages are prescribed as a medium of instruction from Grade 1 through to 4, whereas English language is a medium of instruction from Grade 5 up to Tertiary level (CDC, 2013; Gordon, 2014; Nkolola-Wakumelo, 2013). Thus, the policy does not regard Code-Switching as an alternative in teaching pupils who are less competent in Mathematics and English language. The failure to apply Code-Switching in teaching Mathematics can be traced back to the educational policy planners' viewpoint that the Zambian languages are highly inadequate to provide mathematical and scientific concepts which are equivalent to those in English Language (MOE, 1977). However, there is lack of empirical evidence to support this claim as some mathematical and scientific concepts can be simplified by CS through translating and interpreting them in familiar local languages. This is consistent with Kavwaya's (2009) findings which revealed that Zambian primary school teachers underscored the need for Code-Switching in the teaching of various subjects including Mathematics. They expressed the view that the best approach to teaching and learning was to code-switch between English and a dominant local language to facilitate effective acquisition of skills. The classroom situation was seen as a major factor that should determine the application of CS. The idea behind was that most of the pupils were less competent in English when teachers taught using English mediated instruction.

However, the intention of Kavwaya's (2009) study was not to investigate CS between English and local languages, hence its failure to indicate how teachers were using CS in teaching subjects such as Mathematics, and show whether it had a positive impact on pupils' incompetencies in these subjects. This critique is also levelled against Mulikelela (2013) who found that Zambian primary school teachers taking transitory grades faced challenges in different subjects when teaching pupils in English language forcing them code-switch between

English and Nyanja languages before pupils could respond. This was because pupils usually got used to learning in Nyanja. However, studies indicated that teachers mainly code-switched between English and a familiar local language in teaching pupils reading, writing, and comprehension, and not necessarily in teaching Mathematics literacy. Thus, it is still unknown how the use of CS between these languages in teaching and learning affected pupils who were less competent in Mathematics and English language.

Similarly, Zambian secondary school pupils who are less competent in Mathematics and are more familiar with local languages continue being taught using English mediated instruction as a way of abiding by prescribed education policy guidelines (Curriculum Development Centre [CDC], 2013; Ministry of Education [MOE], 1996). Thus, pupils are deprived of cognitive, affective, and classroom management support which result from CS in teaching secondary school Mathematics; and the level has not been researched adequately in Zambia (Ferguson, 2003; Nyambura, 2015; Setyaningrum, 2015; Yamat, Maarof, Maasum, Zakaria, & Zainuddin, 2011). In this regard, the use of English language in teaching and learning has not been clearly established as a factor that affects achievement of pupils who are less competent in secondary school Mathematics, but instead low achievement in the subject among such pupils is only attributed to various factors such as teaching and learning materials, methods, and modes of assessment (Hakalo, 2014; Kalumbi, 2005; MOE, 1996; Nakawa, 2011; 2012).

The United Nations [UN] (2010) reported that at the end of primary schooling, after using English as medium of instruction in teaching and learning, Zambian pupils were still far less incompetent in the language. The findings further indicated that the majority of these pupils failed examinations because they could not read and understand the instructions in English language and that reading skills were poor, even among secondary school pupils. However, the report did not provide alternatives to the problem of understanding content areas in subjects

such as Mathematics. Thus, Yew and Nathan (2008) argue that CS between English and pupils' most familiar local languages should be used to facilitate the teaching and learning of Mathematics in secondary schools. Similarly, Mahofa (2014) emphasizes the fact that the familiar local language of pupils at this level of education should be fully utilised in the teaching and learning of Mathematics.

1.3 Statement of the Problem

Learning Mathematical skills in English language is difficult for pupils who are low English competent (Jegede, 2011; Setyaningrum, 2015). The problem arises when they encountered concepts in Mathematics, such as parallelogram, acute angle, parallel and diagonal, which are written or presented in English and are expected to be explained to them in English language. This often makes pupils struggle to understand such concepts (Molotja, 2008; Webb & Webb 2008). For this reason, studies outside and within Africa suggest that CS between English and pupils' familiar local language could be an alternative in facilitating effective teaching and learning of primary and secondary school Mathematics among pupils who are more familiar with local languages, but continue being taught using English mediated instruction (Mahofa, 2014; Molotja, 2008; Senyatsi, 2012; Webb & Webb, 2008). However, it is not known how CS would affect pupils who are less competent in Mathematics and are more familiar with local languages, but are taught in English language only. Thus, pupils may continue being deprived of cognitive, affective, and classroom management support that ensues from CS between English and their familiar local languages in learning Mathematics, which in turn may adversely affect their achievement in the subject. Hence, the present study sought to investigate effects of English-Nyanja CS mediated instruction in grade eight Mathematics teaching among bilingual pupils who are less competent in Mathematics and English language.

1.4 Purpose of the Study

The purpose of this study was to examine effects of CS in Grade eight Mathematics teaching among English-Nyanja bilingual pupils in peri-urban primary schools in Lusaka. Specifically, the study sought to determine whether teaching Mathematics using CS mediated instruction would improve pupils' achievement more than using traditional English (TE) mediated instruction.

1.5 Objectives of the Study

The study was guided by the following research objectives:

1. To determine whether there is a statistically significant difference in Mathematics achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction.
2. To establish the influence of pupil-level characteristics on CS and TE mediated instructions in facilitating Mathematics achievement.
3. To assess specific content areas which statistically significantly affect overall Mathematics achievement for CS and TE mediated instructions.

1.6 Research Questions

The research questions for the study were:

1. Is there a statistically significant mean difference in Mathematics achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction?
2. How do pupil-level characteristics influence CS and TE mediated instructions in facilitating Mathematics achievement?
3. Do specific content areas statistically significantly affect overall Mathematics achievement for CS and TE mediated instructions?

1.7 Hypotheses

The hypotheses of the study were:

1. There is a statistically significant mean difference in achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction.
2. Each pupils-level characteristic has statistically significant predictive influence on Mathematics achievement within group.
3. Each specific content area has statistically significant predictive effect on overall Mathematics achievement within group.

1.8 Significance of the Study

The study hoped to extend the current understanding of effects of CS mediated instruction in Mathematics teaching among bilinguals who were less competent in the subject. It was expected to provide an alternative instruction which might improve achievement in Mathematics at junior secondary school level in peri-urban schools. The instruction was expected to provide cognitive, affective, and classroom management support to pupils during the teaching-learning process.

Further, the study hoped that teacher education in Zambia would re-orient instruction in various courses to incorporate CS. This re-orientation would equip trainee teachers with CS techniques to enable them teach Mathematics and other subjects effectively and efficiently in situations where pupils experienced difficulties in these subjects and the language of instruction.

Furthermore, the study hoped that the Ministry of General Education would rethink and revise the language policy regarding secondary education to formalise CS between English and pupils' most familiar Zambian languages as an alternative strategy to the teaching and learning of Mathematics. Thus, at policy level, pupils who are less competent in Mathematics and are more familiar with local languages would not be deprived of the cognitive, affective, and classroom

management support which result from CS mediated instruction during the teaching-learning process. This would also resolve the dilemmas and tensions which may arise through CS since it would be at variance with the current education policy on the language of instruction that does not authorise the use of pupils' familiar local languages in teaching and learning at secondary school level.

1.9 Limitations of the Study

The results of the study would, to some degree, be constrained by the use of a non-equivalent control group design which has an inherent inability to control certain confounding variables, such as pupils' level of cognitive development, commitment to school work, and sickness history, and the use of naturally occurring classes as the control group and experimental group. These variables would make the precise determination of the effects of CS mediated instruction on achievement slightly problematic as they might also exert influence on the outcome of the treatment. However, all the variables patterning to teaching and learning of Mathematics in the classrooms would be controlled, and so the difference in achievement between the experimental group and control group would be attributed to the use of CS mediated instruction. The results would be strengthened by correlations of combined factors with achievement and their explanation of variance in achievement between the two groups of pupils. The variance (in percentage) would indicate the proportion of achievement explained by combined factors and the remaining proportion would be explained by other unknown factors that would include all the confounding variables.

1.10 Delimitation of the Study

The study was confined to Grade 8 pupils from peri-urban Primary Schools in Lusaka who were less competent in Mathematics and were more familiar with Nyanja than English. However, randomization in sampling pupils may allow for wider generalization of the results.

1.11 Conceptual Framework

In Zambia, achievement in Mathematics is one of the major significant outcomes of assessment in secondary schools. This achievement depends heavily on the language of instruction through which the teaching and learning of Mathematics occurs. Teaching and learning Mathematics using TE mediated instruction appears to give rise to low achievement among pupils who are less competent in the subject (Molotja, 2008). This is because such pupils often struggle to grasp mathematical concepts, principles, and procedures being conveyed to them through English mediated instruction. As such teaching and learning Mathematics in a language that is not familiar to pupils is considered problematic, as it denies them cognitive, motivational, and classroom management support (Setyaningrum, 2015; Simon, 2001). Thus, there is growing consensus among researchers that CS between English and most familiar local language may improve the teaching and learning of Mathematics if pupils are linguistically incompetent in English language, but don not show whether CS would improve achievement of bilingual pupils who are less competent in Mathematics.

Studies revealed that CS between English and pupils' most familiar language may be a valuable tool in the teaching and learning of Mathematics, as it is used for clarifying and explaining ideas and concepts, giving instructions, demonstrating procedures, and activities, praising and disciplining pupils (Moschkovich, 2004; Salami, 2008; Setati & Adler, 2001). Research shows that there is a significant relationship between the language of instruction and improvement in Mathematics teaching (Kaphsi, 2003). Thus, the present study was conceptualised on the premise that teaching Mathematics using English-Nyanja CS mediated instruction among bilingual pupils who were less competent in the subject and were more familiar with Nyanja language would lead to higher achievement than using TE mediated instruction. Given the condition that English-Nyanja bilingual pupils less competent in Mathematics and English language form two naturally occurring groups, where one group is taught using CS mediated

instruction, as an intervention, and the other group continues being taught using TE mediated instruction. The expectation is that the group which uses the intervention would perform better on all specific Mathematics content areas and would have considerable higher overall Mathematics achievement than the group which uses traditional instruction. Figure 1 below depicts the conceptual framework for this study.

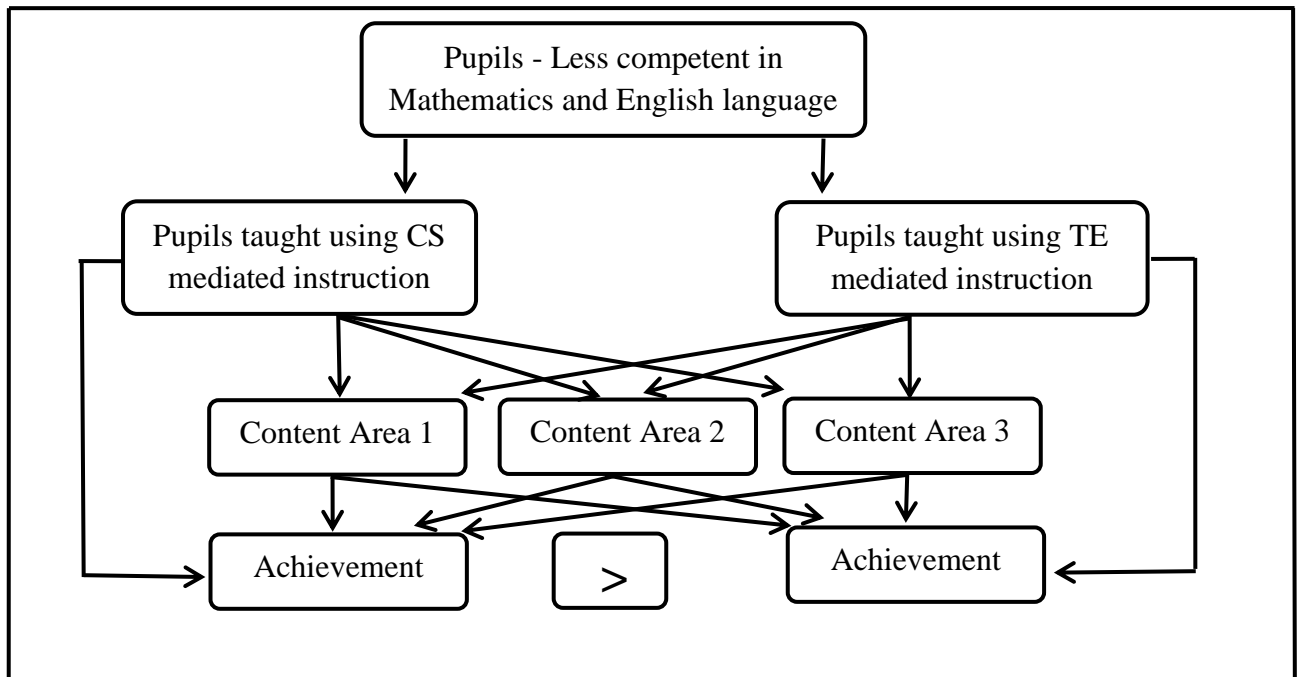


Figure 1: Conceptual framework [Developed from Avendano & Belanio, 2016; Molotja, 2008]

1.12 Theoretical Framework

This study was based on Myers-Scotton’s Matrix Language Frame (MLF) model and Vygotsky’s socio-cultural theory. The theoretical framework applied the two languages, English and Nyanja, in providing cognitive, affective, and classroom management support in teaching and learning Mathematics. The MLF model proposes that in CS there is an unequal participation of two languages. One language acts as a matrix language and the other as an embedded language. The matrix language is the more dominant language and plays the major role when CS arises, and the embedded language is the subordinate language which is inserted

in the matrix language to achieve a given communicative purpose (Myers-Scotton, 1993; 1995; 1998; 2001; 2006). Ferguson (2003) observed that the introduction of the embedded language in CS during teaching and learning is necessary because it helps pupils understand the subject matter, whilst facilitating teaching, enhancing motivation, and instilling discipline in pupils. The MLF model has been used in several studies on CS between languages in the teaching and learning of Mathematics and it has proven to be an appropriate guide (Jegede, 2011; 2012; Senyatse, 2012).

Studies by Jegede and Senyatse, however, have only used the model as a guide to investigate the already existing use of CS in the teaching of Mathematics. They have not verified whether the model is falsifiable because it does not indicate how and when to use CS in the teaching of Mathematics. The model is also not precise on the equal participation of the matrix language and embedded language in CS. One language is the matrix language because of its use in writing Mathematics notes, illustrations, examples, and exercises, but in Mathematics discourse - during the use of different teaching and learning methods - there is a constant interchange in the use of languages, where the matrix language can become an embedded language and vice versa. The dominance of one language in CS between languages in Mathematics teaching methods is not constant.

The MLF model was applied in the present study for the identification and use of both the matrix language and the embedded language in the teaching and learning of Mathematics among bilingual pupils. Thus, CS occurred between English as a matrix language and Nyanja as an embedded language. English is the official language of teaching and learning in secondary schools and Nyanja is the familiar local language for teachers and pupils. English was mainly used for stating and restating mathematical concepts such as equal, angle, degree, and complementary angles; XOY-plane, X-axis, Y-axis, negative, positive, and point, relation,

elements, arrow diagram, and function. Nyanja, on the other hand, was mainly used in interpreting, describing, explaining, and illustrating concepts, and principles and procedures of working out mathematical problems. Therefore, the MLF model was an appropriate guide in investigating effects of English-Nyanja CS mediated Mathematics instruction of less competent pupils, who are more familiar with Nyanja than English.

The Socio-Cultural theory was applied in the present study on the use of a familiar local language as an embedded language identified in the Myers-Scotton's MLF model. In the theory, Lev Vygotsky (1962, 1978) proposed that human interaction with the physical and social world is mediated through mental tools such as language. This implies that through spoken, written and sign language the world affects us, and we in turn affect the world. Vygotsky espoused the idea that language and thought initially develop independent of each other and then merge later as the child grows (Santrock, 2011). He noted that all mental functions have external social origins, and argued that children use a familiar language to communicate with others before they can focus inward on their own thoughts (John-Steiner, 2007).

Vygotsky (1978, p.28) stated that "the specifically human capacity for language enables children to provide for auxiliary tools in the solution of difficult tasks, to overcome impulsive action, to plan a solution to a problem prior to its execution, and to master their own behaviour". Thus, language is considered to be a critical psychological tool which shapes learning and cognitive development by providing a means of expressing meaningful ideas, asking purposeful questions, developing classifications, and concepts for thinking (Wertsch, 1985). Language is, therefore, a cognitive tool used to aid solving problems that cannot be solved in the same way in their absence. It, in turn, exerts an influence on the individual who uses it by giving rise to previously unknown activities and previously unknown ways of conceptualising phenomena in the world. Language, as in the case of other mental tools, is considered subject to modification

as it is passed on from one generation to the next, and each generation reworks it in order to meet the needs and aspirations of its individuals and communities (Turuk, 2008).

Socio-Cultural theory, therefore, regards a familiar language as moving children through the Zone of Proximal Development (ZPD) - which is the “gap between what children can accomplish independently and what they can accomplish when they are interacting with others who are more competent” (Lightfoot, Cole, & Cole, 2009: 24). Unfortunately, the ZPD is not universally the same as it varies from one child to another. The difference in the mean achievement indicated whether the group taught Mathematics using English-Nyanja CS mediated instruction moved more successfully through the ZPD than the one taught using TE mediated instruction.

Theory suggests that in a Mathematics classroom, a familiar language should be the medium and focus of instruction through which academic content was invariably conveyed. Thus, English-Nyanja CS was considered a more familiar mediatory tool for Mathematics teaching. Through the Vygotskian perspective, Nyanja language is more fully developed than English language by the time the majority of pupils reached their eighth grade; and as such their thought process and pattern are, for a longer part of their life, directed by it. Therefore, the supplementary use of Nyanja to English in teaching pupils would make it cognitively easier for them to manipulate mathematical information and engage meaningfully in learning Mathematics. This implies that Nyanja language would serve as a mental tool which would be used to scaffold learning and thinking of these pupils through various teaching methods. The familiarity of Nyanja to both teachers and pupils would make it an effective means of expressing meaningful ideas, asking purposeful questions, solving problems, and developing concepts for thinking in teaching and learning Mathematics. Hence, the need to test the

hypothesis that there is no statistically significant difference in mean achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction.

1.13 Operational Definitions

Code-Switching – Supplementing English language with Nyanja language in teaching and learning through interpreting, describing, illustrating and explaining Mathematics concepts, principles and procedures between the teacher and pupils.

TE mediated instruction – Verbal instruction in Mathematics teaching and learning using the norm English medium between the teacher and pupils.

Code-Switching mediated instruction – Verbal instruction in Mathematics teaching and learning using the medium of supplementing English with Nyanja between the teacher and pupils.

Achievement – A score a pupils obtains in Mathematics pre-test and post-test.

1.14 Conclusion

The chapter has provided the introduction to the study on effects of CS mediated instruction in Mathematics teaching on pupils' achievement in the subject. Thus, it has established various issues pertaining to the problem to be investigated and the overall conceptual and theoretical guide for the investigation. Therefore, the study determines whether the use of CS mediated instruction is more effective in Mathematics teaching than the use of TE mediated instruction.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The reviewed literature relates to Code-Switching between languages as used in Mathematics teaching at different educational levels. Although critiques have been levelled against Code-Switching between languages of instruction and learners' familiar language in Mathematics teaching, there is considerable evidence across the globe supporting its use, except in Zambia where there is a dearth of literature. Thus, this chapter is structured in such a way that it encapsulates two sections. The first section covers a critical review of empirical studies on CS in Mathematics teaching outside and within Africa. The other section deals with bases of criticisms leveled against the use of CS in teaching and learning in general, and in Mathematics teaching in particular.

2.2 Empirical Studies on Code-Switching in Mathematics Teaching

Numerous studies outside and within Africa have been carried out to investigate the nature, occurrences, functions, and effects of Code-Switching in Mathematics teaching. The following discussion focuses on some of those studies, examining in particular their methodologies and findings, which influenced the present study.

2.2.1 Studies outside Africa

Planas and Setati (2009) ascertained how immigrant bilingual learners in Spanish secondary schools code-switched between their languages in the learning of Mathematics. The study used a critical sociolinguistic approach, which drew on social theory in the analysis of how language was involved in the construction of teaching and learning opportunities. It adopted a mixed design and used a sample of 24 learners who were observed in five Mathematics lessons. The findings of the study revealed that there were differences in the ways that the Spanish dominant bilingual learners code-switched their two languages during their engagement in Mathematics

activity. The shifts from Catalan to Spanish, and from Spanish to Catalan, coincided with shifts in the complexity of the learners' mathematical practices. The learners tended to code switch the two languages for different purposes depending on the complexity of the mathematical practices and in relation to different social settings that coexisted within the classroom.

The study, however, used a mixed design when it was merely observational in which data was analysed qualitatively through descriptions and interpretations. It mainly focused on the use and nature of Code-Switching in learning Mathematics among learners in general; but it did not indicate learners' competencies in the subject and the teaching methods they used. The findings of the study also suggested that Code-Switching had an effect on handling complex Mathematics tasks, but it was not certain whether it was the strategy which made learners handle complex tasks as the study was not intended to investigate cause-and-effect of Catalan-Spanish Code-Switching in learning Mathematics. On the contrary, the present study was experimental in nature and sought to determine whether teaching CS mediated instruction had effects on teaching pupils who were less competent in Mathematics at junior secondary school level in Zambia.

In a study on the use of Code-Switching uttered by Indonesian Mathematics and Natural Sciences teachers and its perception by learners, Sari-Hamzah-Refnaldi (2013) employed a descriptive design in which data was collected through questionnaires and recording. The findings of the study revealed that a total of 29 Code-Switching utterances occurred and were of two types, situational Code-Switching and metaphorical Code-Switching. Of the two types it was found that the former was mostly used for purposes of Mathematics and Science. As regards the reasons for Code-Switching, the study showed that teachers intended to explain, emphasise and elaborate a point so as to enhance learners' understanding of the subject content. Code-Switching was also used in the teaching of Mathematics and Science lessons to explain

common formulae; it involved the switch between Indonesian and English. Similarly, learners themselves attested that they understood Mathematics and Science lessons more easily if their teachers code-switched between English and Indonesian.

Nonetheless, the study did not include a sample of teachers and learners; and failed to learners' competencies in Mathematics. It also misapplied questionnaires as the study was purely qualitative. A semi-structured interview guide should have been used to supplement recordings. Moreover, the study merely ended at explaining that English-Indonesian Code-Switching made learners understand Mathematics and Science better; it did not systematically verify this claim through an achievement test. Whereas the present study supports the use of Code-Switching in Mathematics teaching, it sought to take a step further by determining the difference in achievement between pupils taught Mathematics using CS mediated instruction and those taught using traditional TE mediated instruction .

Setyaningrum (2015) established Code-Switching practices, obstacles and attitudes in the teaching and learning of Mathematics in primary schools of Indonesia. A mixed-methods approach was adopted by employing an exploratory research design, sequentially performing surveys, classroom observations and interviews. The survey was distributed to 214 grade seven learners to ask about mathematical challenges and attitudes towards Mathematics learning using English mediated instruction. The classroom observations and interviews with 34 learners were conducted in order to compare and contrast survey findings, explore Code-Switching practices, identify the source of challenges for the learners and discover the resultant impact on attitudes. The study revealed several novel findings. Firstly, Code-Switching by learners existed in the primary schools in order to maintain the communication in both inform and formal academic conversations. This practice was influenced by cognitive, affective and social factors. Secondly, the three main sources of difficult were identified for learners when learning mathematics in

English: the characteristics of mathematical terms, the complexity of mathematical concepts and the status of English as a foreign language. Limited English competencies appeared to be the main source of difficulty in mastering concepts and mathematical terms. Finally, learners in primary schools in Indonesia had positive attitudes towards learning Mathematics in English. These positive attitudes were mostly influenced by Code-Switching and their beliefs in the value of English.

The study was detailed as it did not merely focus on the use of Code-Switching but it also brought out sources of difficulties in the teaching of Mathematics among learners, and cognitive, affective and social dimensions of Code-Switching. However, the study should have brought out quantitative data and not just qualitative data since it used a mixed methods approach; and it failed to appropriately tap into learners' Mathematics incompetence and teaching methods used. On the contrary, the present study would bring out quantitative data as it is experimental in nature seeking to use the cognitive, motivational and classroom management support as functions of CS mediated instruction in teaching Zambian pupils who were less competent in Mathematics and more familiar with Nyanja than English.

A study by Gwee (2005) investigated the functions of Code-Switching between vernacular and Standard English by Singaporean teachers in the multilingual fifth-grade classroom using the conversation analytic approach. One hundred and ten lessons were observed, audio-taped and transcribed for Science, Mathematics, Social Studies and English. The study generated three major findings: teachers seemed to code switch more often in content subject classrooms, particularly in Science and Mathematics classrooms; there was little Code-Switching in English language classrooms; and teachers used Code-Switching for specific functions and they were not switching by deficiency or default in English language. Particularly, teachers code-switched for specific functions: regulation, checking of learner engagement, building of rapport with

learners, emphasis, organization, procedural scaffolding, rephrasing and reiteration; solidarity, humorous effect, softening of a command, eliminating ambiguity, indication that a referentially derogatory comment is not to be taken seriously, and qualification of an assertion.

The study unearthed comprehensive details on the functions of Code-Switching in the teaching of four subjects, and not only for communicative function as indicated by some studies; and it indicated that Code-Switching was not done by linguistic deficiency or default in English language among teachers. However, the study did not indicate the research design which was used and how data was going to be analysed. It merely indicated the number of lessons, subjects and classrooms observed without taking into account the sample of the study participants. It also revealed numerous functions of Code-Switching without indicating their impact on teaching pupils in specific subjects and content areas. The present study concurred with the functions of Code-Switching and it categorises them into cognitive, motivational and classroom management functions. It used these broad functions in light of CS mediated instruction in the teaching of Mathematics among pupils who were less competent in the subject. It would investigate whether there was a difference in achievement between pupils who were taught Mathematics using CS mediated instruction and those who were taught using TE mediated instruction mediated instruction using a non-equivalent control group design.

Neo and Heng's (2012) study determined languages which were used in the primary Mathematics classrooms and the extent to which Malaysian teachers and learners resorted to Code-Switching in the teaching and learning of Mathematics. A total of 16 classroom Mathematics lessons from primary schools in the Kelantan State of Malaysia were observed and recorded. Within the four schools, two were national schools and two were Chinese primary schools. A rural school and an urban school constituted the two schools of the same type. The researcher observed four classes from two levels for each participating school, that is, two

Standard 2 classes from the lower primary level and two Standard 5 classes from the upper primary level. The two classes of each level were in fact comprised of a good class and a weak class. The findings of the study revealed that Code-Switching occurred in Mathematics teaching depending on school type, school location, class level and class type. Although the study seemed to suggest that Code-Switching aided the teaching and learning of Mathematics depending on various factors, it did not attempt to show how the communicative strategy and teaching methods based on it affected achievement of learners in the subject as the present study intends. However, the present study concurred with the findings on the use of Code-Switching in teaching Mathematics among pupils in weak classes.

With a purpose of exploring the role of Code-Switching as a strategy to scaffold learning in the teaching and learning of Mathematics and Science mainly taught in English, a study by Yamat et al (2011, p.20) involved Malaysian secondary school children and teachers in eight schools; and it employed a mixed methods design which involved the use of a survey questionnaire, interview and the development of a competent test. A total of 24 teachers were interviewed. The findings from the questionnaires revealed that the majority of the teachers reported using the national language – Bahasa Melayu between 60% and 70% of the time in teaching Mathematics and Sciences. They used Bahasa Melayu when they needed to: help their learners understand (87.5%), adjust the degree of formality of their English to help learners understand (87.3%), translate from English to Bahasa Melayu or from Bahasa Melayu to English to clarify Mathematics and Science concepts and ideas. The findings also show that teachers rationalised the use of Bahasa Melayu in order to help weak learners (65%), clarify ideas (54.9%), explain ideas (48.5%), discipline learners (25.8%), give instructions (24.7%) demonstrate procedures and activities (24.3%) and praise learners. Interviewed teachers code switched by explaining again using Bahasa Melayu when learners asked to translate English to Malay when the topic was quite difficult. They felt that learners were not attentive and could not give good responses

when English was used because they hardly expressed themselves well in English. Code-Switching also helped teachers themselves because they were not very competent in English language as a medium of instruction.

The study had adequately triangulated the findings and there was consistence between qualitative and quantitative data. However, the study did not indicate the sample of learners who were involved in the study; and it did not show the results of the competent test which was proposed to be developed as well as its validity and reliability. The study was only confined to functions of English-Bahasa Maleyu Code-Switching in the teaching and learning of Mathematics and Science; and it did not investigate effects of Code-Switching on teaching pupils who are less competent in Mathematics as the present study intends. The study would use valid and reliable Mathematics pre-test and post-test to determine differences in achievement between pupils who were taught using CS mediated instruction and who were taught using TE mediated instruction mediated instruction; and the differences in achievement between the two groups would indicate effects of CS mediated instruction in Mathematics teaching.

Md-Ali, Mohd-Yusof, and Veloo's (2014) study investigated oral competencies, communication and discourse practices of Malaysian secondary school Mathematics teachers when delivering the lesson content using English as the medium of instruction. Qualitative data was obtained through interviews with the 5 teachers and 135 learners, as well as observations of teaching episodes encapsulated within video recordings and the employment of retrospective techniques to understand teachers' actions and explanations of Mathematics lesson content. The findings of the study from observations revealed that the teacher's explanation was carried out using both the Malay language and English language in an interweaving manner. The use of English was more of restating the 'terminologies' within the subject (e.g., 'equal', 'plus', 'equation', 'coordinate', etc.), but not used for the purpose of explaining the steps or procedures

in solving the Mathematics questions. Data from interviewed teachers supported Code-Switching between Malay and English as a technique or strategy to help learners understand the Mathematics lesson content. Teachers felt it was insufficient to solely depend on instructions given in English. One of the teachers expressed the view that “when I explained 100% in English, I found that my students were rather slow to understand the Mathematics concept that I am teaching”. Interviewed learners indicated that the learning of Mathematics was problematic when the lesson content was fully taught in a non-native language, a language which they were not competence in, and found difficult to comprehend.

Similarly, the present study would use CS mediated instruction in teaching Mathematics in which English language would mainly be used for stating and restating mathematical concepts such as equal, angle, degree, and complementary angles; XOY-plane, X-axis, Y-axis, negative, positive and point; relation, elements arrow diagram and function; and Nyanja language would mainly be used in interpreting, translating, describing, explaining and illustrating concepts, principles and methods of working out Mathematics problems. However, the study was merely descriptive and did not systematically relate English-Malay Code-Switching in teaching and learning to achievement of pupils in Mathematics as the present study intends through a quasi-experiment at junior secondary school level in Zambia.

To explore the effectiveness of using Code-Switching in teaching Mathematics in a bilingual classroom in Philippines Avendaño and Belanio’s (2016) used an experimental research design over a sample of sixty-six University Engineering students in the course Analytic Geometry. The respondents were grouped into two. Both groups were taught the same lessons by the same teacher using different medium of instruction in two separate sessions. In the first session, group A was first taught without using Code-Switching while group B was taught with the aid of Code-Switching. The test results for two sessions were tallied and statistically treated. Findings

revealed that students from group A tend to pose a higher score than group B. However, t-test results show that there was no significant difference in Mathematics performance between the two groups.

The study used an appropriate research design of determining cause-and-effect. It managed to control some variables such as using the same teacher and teaching students the same Mathematics content area – Analytic Geometry. The study also used the appropriate data analysis procedure. However, using the post-test only with 1 day treatment made it difficult to capture the effect of teaching University students with Code-Switching because the study did not indicate if the two groups of students were initially the same since there was no pre-test results, and if the post-test was reliable or not. The study also did not indicate whether the grouping of students was due to random assignment or not. In contrast, the present study was a quasi-experiment among junior secondary pupils which would employ a non-equivalent control group design using a valid and reliable pre-test and post-test with 10 weeks treatment. Convenient sampling would be used since the study sought to use naturally occurring classes of pupils. Same teacher, topics, lessons, teaching aids and methods would be used except the experimental group would be taught using CS mediated instruction and the control group they would be using TE mediated instruction. Thus, it would provide more robust results on effects of CS mediated instruction on pupils Mathematics achievement. Data would be analysed using one-way MANOVA and multiple regression.

2.2.2 Studies within Africa

A study in Mauritius by Salehmohamed and Rowland (2014) explored the whole-class interactions in Mathematics classrooms at a girls' secondary school. It focused on three teachers and their instructional language practices. Analysis of audio-recordings of lessons showed that all forms Code-Switching was commonly practiced by all the three teachers in the study. The

teachers' views on their use of language within the classroom showed that although they were aware of the language they used, they were not always conscious of their Code-Switching. Different functions of the teachers' Code-Switching practices were identified, indicating that it could be an important support for teaching Mathematics, despite some related tensions that teachers encountered in using Code-Switching in their teaching. However, the study did not focus on how Code-Switching was affecting learners' competencies in Mathematics; and it took Code-Switching as a prerogative of teachers and not learners. The present study would be different in that it would be experimental and quantitative in nature focusing on whether the use of CS mediated instruction in Mathematics teaching would have improvement effects on achievement of pupils who were less competent in the subject.

In an investigation on Code-Switching between Yoruba and English and its implications for teaching Mathematics in selected primary schools in Nigerian, Jegede's (2011) study obtained data from 5 Mathematics teachers and 50 pupils from 5 purposively selected primary schools through ethnographic observation, structured and unstructured interviews. Data collected was analysed using Myers-Scotton's Matrix Language Framework model, as well as descriptive and inferential statistics. The findings revealed that teachers in the schools used Code-Switching as an approach for the acquisition of literacy, in that it allowed each pupil to use each of his/her languages in a natural, meaningful way as the various classroom activities were being implemented. Further, the use of Code-Switching between Yoruba and English in multilingual Mathematics classrooms did not result in a deficiency in learning, but that it was a useful strategy in classroom interactions and an efficient way of transferring mathematical knowledge to learners.

Similarly, the present study sought to validate the MLF model and prove whether the use of CS mediated instruction would not lead to deficiency in teaching and learning Mathematics among

pupils who were less competent in the subject. Although Jegede's (2011) study found that English-Yoruba Code-Switching did not lead to deficiency in the teaching of Mathematics, the achievement of pupils in the subject remained unknown; and it did not ascertain whether achievement in Mathematics was a function of English-Yoruba Code-Switching. On the contrary, the present study sought to investigate whether achievement in Mathematics among pupils who were less competent in the subject is more of a function of using CS mediated instruction than using TE mediated instruction mediated instruction.

Nyambura's (2015) study in Kenya determined the effectiveness of Code-Switching as a communication strategy; whether Code-Switching facilitated interpersonal communication; how it was used to overcome communication difficulties and finally how it was a pedagogically useful communicative resource in schools. The study was conducted at St. Francis Girls' Mang'u and used convenience sampling to get the participants. Data was collected using both qualitative and quantitative methods through audio recordings, Focus Group Discussions, observations and questionnaires. Statistical analysis was conducted for the collected data. Both Ethnography of Communication and Communication Accommodation Theories were used to analyse the data. The findings of the study revealed that Code-Switching was an effective communication strategy for both learners and teachers since it aided in addressing their various needs, it facilitated interpersonal communication for both learners and teachers, it was used as a communication strategy by both learners and teachers to overcome communication difficulties; and it was, therefore, a pedagogically useful communicative resource. This meant that Code-Switching was an effective tool to ease communication between teachers and learners thereby making learning much easier and enjoyable enabling both the teachers and learners express themselves freely in class.

Nevertheless, the study was too generic as it did not focus on Code-Switching within specific subjects. This was different from the present study whose focus was on effects of CS mediated instruction in the teaching and learning of Mathematics among pupils who were less competent in the subject. The study also mainly emphasised the primary function of Code-Switching, that is, for communication at the expense of secondary functions of providing cognitive, motivational and classroom management support for the pupils. In the present study both primary and secondary functions of Code-Switching in teaching pupils who were less competent in Mathematics would be considered.

A study by Senyatsi (2012) explored the use of Code-Switching as a teaching and learning strategy among grade 11 Mathematics literacy learners in selected high schools in South Africa. The study used a mixed research design and a sample of 30 learners 10 from each of the three schools with balanced gender. Data was collected through questionnaires and interviews. The collected data was analysed thematically and descriptively. The findings of the study revealed that there were language problems faced by these learners in the Mathematics literacy classroom for instance the use of verbs, tenses, spellings, punctuations and parenthesis. Language seemed to be the major barrier in the understanding of concepts in Mathematics literacy; and the material being delivered to them. Further, the study found out that the use of Code-Switching, from English to mother tongue, in explaining some of the concepts greatly helped the learners understand their scope of work. The study, therefore, recommended the use of Code-Switching during Mathematics literacy lessons to better facilitate the process of learning and teaching and to improve language performance of the learners.

The study, however, did not indicate the sample of teachers who were interviewed and it was not clear how the study measured learners' understanding of Mathematics. Moreover, the study hinged heavily on language difficulties learners had in learning Mathematics and not on their

incompetence in the subject. The present study would be different in that it would determine pupils' understanding of Mathematics through achievement in the pre-test and post-test to be administered to those who were taught using CS mediated instruction and those who were taught using TE mediated instruction mediated instruction. Thus, the study would determine effects of using CS mediated instruction on teaching pupils who were less competent in Mathematics. By implication, significant improvement effects on achievement would entail a significant reduction in Mathematics incompetence among learners.

Mahofa's (2014) study established the effects of Code-Switching in the learning of Mathematics word problems in Grade 10 in South African secondary schools. The study used Cummins' language acquisition theory to inform the study. It employed ethnographic qualitative research design whereby classroom observations and semi-structured interviews were used as data collection techniques. The use of multiple data collection techniques was to ensure validity and credibility of the study. The sample consisted of sixty learners and two Mathematics teachers. The sample was drawn from a population of 1235 learners and 49 teachers. The study has shown that even though Code-Switching could be beneficial in the learning and teaching of Mathematics, it was difficult for learners and teachers to use it in a way that enhanced the learning of Mathematics word problems because of the barriers in the use of mathematical language. It was thus recommended that teachers should exercise care when using Code-Switching, especially with the topics that involved word problems; as such topics were more aligned to certain mathematical language that could not be translated to IsiXhosa.

The present study concurred with Mahofa's (2014) study on the caution of using Code-Switching in teaching Mathematics word problems; and it for this reason that the study was based on three topics: Coordinates, Angles and Functions; which mainly involve diagrammatic representations. However, the study did not use an appropriate research design because an

ethnographic study involves studying a group of participants for a much longer period of time than the one used in the study. The descriptive research design would have been the most appropriate to use. This makes it difficult to deduce whether Code-Switching in the teaching and learning of Mathematics is beneficial or not. The present study would use a non-equivalent control group design to investigate effects of CS mediated instruction on teaching pupils less competent in Mathematics over a period of 10 weeks. The design was appropriate for determining a causal relationship between CS mediated instruction and pupils' achievement in Mathematics.

A study by Molotja (2008) explored the problem that arises when learners encounter concepts in Mathematics which are written in English and needed to be explained to them in English. Learners often struggled to understand these concepts with the results that teachers resort to using their familiar local language to try to explain what these concepts meant. To understand the nature of this problem and how it affected teaching and learning, two South African secondary schools were purposefully sampled for the study. The findings revealed that the school where Code-Switching was applied performed better in Mathematics than the school where Code-Switching was not employed. The study recommended that educators should use the learners' familiar local language in instances where their knowledge impeded them to convey mathematical meaning clearly.

Similarly, the present study sought to determine whether achievement in Mathematics would improve more for pupils who were taught using CS mediated instruction than those who were taught using TE mediated instruction. However, the study overlooked the fact that Code-Switching may not have been the actual factor which influenced the performance of learners in the school where the strategy was applied in teaching Mathematics. The two groups were compared on different topics, the Code-Switching group on Angles and the other

group on Algebra, which made it difficult to be conclusive on the positive effects of Code-Switching. Moreover, this was a qualitative study, so confounding variable such as teacher qualification and experience, and teaching methods in the two schools were not controlled in order to precisely determine the causal relationship between Code-Switching and Mathematics achievement. Moreover, the study did not indicate the how pupil level characteristics correlated with performance in Mathematics at the two schools. The present study was to be a quasi-experiment and as such the confounding variables would be controlled, and thus, more precise determination of effects of CS mediated instruction on pupils' achievement in Mathematics was expected.

2.3 Critique of Code-Switching in Mathematics Teaching

There are various criticisms which have been levelled against Code-Switching in education in general and in Mathematics teaching in particular. These include impediment to learning; failure to learn grammatical rules; dilemma between 'access to meaning and access to English'; lowering status of teaching and learning; and abrogating education language policy.

2.3.1 Impediment to Learning

A study by Moji and Grayson (1993) criticised Code-Switching between English and learners' familiar local languages in teaching and learning. The findings showed that the technique might impede learning mainly in cases where familiar local languages were deficient in vocabulary to express Code-Switching. As regards translation, it was found that scientific terminologies such as energy, power, force or momentum could not be explained in local languages because they lacked vocabulary to explain exactly what is said in English. Molotja (2008) argued that the same problem might be there in Mathematics where certain terminologies were easily explained in the learners' familiar local language and others were not; for instance there was no adequate word in the familiar local language to explain concepts such as "parallelogram" and "acute

angle”. The use of familiar local language in such instances might end up giving wrong meaning. For the present study, however, most of the Mathematics concepts would be retained in the matrix language (English) and the embedded language (Nyanja) would be used to interpret, describe and explain concepts and procedures of solving Mathematics problems in teaching pupils using CS mediated instruction.

Payawal-Gabriel and Reyes-Otero’s (2006) study showed another problem of Code-Switching in the classroom. The study claimed that the practice by Mathematics teachers in their instructions was reported to negatively affect learning. The findings revealed that Code-Switching between languages confused learners and consequently affected their lesson comprehension. The use of Code-Switching in the classroom had also been negative viewed by bilinguals themselves. Shin (2005: 18), for example, noted that “bilinguals may feel embarrassed about their Code-Switching and attribute it to careless language habits”. Similar views on the practice of Code-Switching in Malaysia had also been reported by Martin (2005: 88), that “the use of a local language alongside the ‘official’ language of the lesson is a well-known phenomenon and yet, for a variety of reasons, it is often lambasted as ‘bad practice’, blamed on teachers’ lack of English language competence... or put to one side and/or swept under the carpet”. On the contrary, in the present study the teacher would be very competent both in Mathematics and English language as well as in Nyanja language which was familiar to both the teacher and pupils. In this case it was pupils who were less competent in Mathematics and in English. They were denied cognitive, affective and classroom management support which emanated from Code-Switching during teaching and learning, and as such poor achievement in the subject ensued.

2.3.2 Failure to Learn Grammatical Rules

Grosjean (1982) cited in Adler and Setati (2002) criticised Code-Switching by arguing that many people regard it as grammarless mixture of languages. This entailed that the strategy led to learners failing to learn the grammar of either language. For this reason Code-Switching was perceived not to be a good practice which could be used in the classroom. Moreover, monolinguals saw Code-Switching as an insult to their own-rule governed language. These people were conservatives who did not want their language to be mixed or diluted by other languages. They saw their language as grammatical, governed by rules. These people want to protect their language. However, Molotja (2008) argued that this criticism did not provide teachers and learners with any alternative for the problem of not comprehending mathematical concepts in English. It rather conditioned the speakers of familiar local language to fear that they would not be fluent in the language of teaching and learning. For the present study, the main argument was that English was taught as a subject, and pupils could learn its grammatical rules during its allocated time on the class time-table; but for the purpose of teaching and learning Mathematics among pupils who were less competent in the subject, Code-Switching between English and Nyanja would be a necessary communicative technique which would be used to try and enhance pupils' achievement. Moreover, the familiarity of Nyanja language implies that it was more developed in pupils than English language and their thought patterns and processes had to a greater degree already been shaped by it.

2.3.3 Dilemma between Access to Meaning and Access to English

Code-Switching was seen as causing dilemma among teachers between “access to meaning and access to English” (Setati, et al., 2002, p. 140). This was because although they could reformulate the concepts in the learners' familiar local language, learners needed to receive and produce the content in English as it was the language through which assessment was done. The use of the method in the classroom was seen jeopardising learners' ability to answer

examination questions in pure English. For the present study, however, there would be no dilemma concerning access to meaning and access to English because CS mediated instruction would only involve verbal interpretation, description and explanation of Mathematical concepts and procedures in teaching and learning Mathematics among learners who were less competent in the subject. Nyanja language would only be used to supplement English in Mathematics discourses and not to replace it in writing. This entails that even if a Mathematics achievement test was designed purely in English language, pupils who would be taught using CS mediated instruction would have an added advantage in solving problems in the test. Similarly, a study by Jegede (2011) shows that Code-Switching between Yoruba and English in multilingual Mathematics classrooms did not result in a deficiency in learning, but that it was a useful strategy in classroom interactions and an efficient way of transferring mathematical knowledge to learners.

2.3.4 Lowering Status of Teaching and Learning

Mawasha (1993) cited in Ralenala (2004) stated that the use of learners' familiar local language was perceived as lowering the status of teaching and learning and that of African languages. The argument was that these languages were not developed enough to be used in the teaching and learning of subjects such as Mathematics and physical sciences. The present study concurred with the argument to some extent, however, in the use of English-Nyanja CS mediated instruction in teaching Mathematics, English language would mainly be used for stating and restating mathematical concepts such as equal, angle, degree, and complementary angles; XOY-plane, x-axis, y-axis, negative, positive and point; relation, elements arrow diagram and function; and Nyanja language would mainly be used in interpreting, describing, explaining and illustrating concepts, principles and methods of working out Mathematics problems. Thus, the introduction and use of Nyanja language in Code-Switching would provide some explanatory power by providing cognitive, affective and classroom management support

to the pupils. Thus, even though Nyanja language might be considered less developed the present study would experiment its use to supplement English in an attempt to improve pupils' achievement in Mathematics. Moreover, the present study would use English as a matrix language and Nyanja as an embedded language. This view was supported by Molotja's (2008) findings which revealed that in Code-Switching the learners' familiar local language was not used entirely throughout the lesson. It was only in situations where the teacher's linguistic ability in English as a language of instruction failed. The findings further revealed that despite the fact that the familiar local language was not technically developed to be used in the teaching and learning of Mathematics and science, it still served as a good resource in the explanation of difficult concepts.

2.3.5 Abrogating Education Language Policy

Kaphesi's (2003) study revealed that although Code-Switching was useful in teaching and learning Mathematics, it led to dilemma and tensions for Malawian teachers as it meant abrogating the policy directives on the language of instructions. However, for the present study dilemma and tension would not arise regarding CS mediated instruction in the teaching and learning of Mathematics among pupils who were less competent in the subject, because permission would be sought from the Ministry of General Education to conduct the study; and it would give recommendations on the findings to inform the education policy. Similarly, a study by Viriri and Viriri (2013) in Zimbabwe recommended rethinking and revising the language policy of the country so that it could embrace and reflect the teaching-learning reality on the ground. This was after the findings revealed that teachers deliberately used Code-Switching at times to enhance learners' understanding and performance in the classroom and public examinations, which they felt could be hindered if they stuck to English mediated instruction only.

2.4 Conclusion

Reviewed literature has shown that studies have found Code-Switching between languages to have pedagogical functions and benefits in Mathematics teaching outside and within Africa. However, these studies are generic, largely descriptive and non-experimental in nature. They mainly focus on the nature and use of Code-Switching and not necessarily how the strategy affect pupils' competencies in Mathematics, that is, whether it may bring about higher achievement in the subject or not. Thus, the present study seeks to differentiate achievement between pupils taught Mathematics using CS mediated instruction and those taught using TE mediated instruction.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the methodology for determining whether teaching Mathematics using CS mediated instruction more effective than using TE mediated instruction. The methodology covers an outline and discussion of the research paradigm, research design, and methods of data collection and analysis. Key issues under data collection will be study site, population, sample, sampling technique, and data collection instruments and data collection procedures. Under data analysis the focus is on instruments and procedures for analysis. The chapter winds up by discussing ethical considerations to be upheld during the data collection process.

3.2 Research Paradigm

As a quasi-experiment, the study was informed by post-positivism (Feilzer, 2010) because it sought to determine the cause-and-effect of social phenomena, that is, effects of teaching Mathematics using CS mediated instruction on pupils' achievement, where CS mediated instruction was a cause and achievement was an effect. Post-positivism is the modified Scientific method for the social sciences that aims at producing objective and generalizable knowledge about social patterns, seeking to affirm the presence of universal properties/laws in relationships amongst pre-defined variables (Crowther & Lancaster, 2008). It holds a deterministic philosophy in which causes probably determine effects or outcomes (Creswell, 2009). Thus, the problems studied by post-positivists reflect the need to identify and assess the causes that influence outcomes, such as found in the experiments. The paradigm also informs quasi-experimental research designs that utilize treatment, outcome measures, and experimental units, but do not use random assignment to create comparison from which the treatment that caused change is inferred (Depoy & Gitlin, 1998; Feilzer, 2010). The approach is very similar to the positivist approach of comparing means, but depends on non-equivalent groups that differ from each other in many ways other than the presence of the treatment whose effects are being

tested. The knowledge that develops through a post-positivist perspective is based on careful observation and measurement of the objective reality that exists "out there" in the world (Creswell, 2009; Ernest, 1994). The development of quantified measures of observations and studying the behaviour of individuals becomes paramount for a post-positivist. Therefore, data collected through post-positivist lenses are meant to either verify or refute a theory or law so as to make necessary refinements before additional tests are conducted (Creswell, 2009; Crotty, 1998).

This paradigm was appropriate because it underpinned the entire methodology for the present study. It guided the measurement of objective reality as it existed by administering pre and post Mathematics test with 10 weeks CS treatment to determine the efficacy of the treatment. The achievement scores between the experimental group and control group were statistically compared. In spite of the experimental group and control group being non-equivalent groups, various variables such as the teacher, topics/lessons, teaching aids and methods were controlled between the two groups to enable the making of inferences about effects of CS treatment. Hence, the generated data were expected to verify or refute the MLF model and Socio-Cultural theory.

3.3 Research Design

The study adopted a non-equivalent control group design, as the experimental and control groups were not randomly assigned. Both groups took a pre-test and a post-test, but only the experimental group was treated (Creswell, 2009). The difference in the post-test scores between the two groups was expected to be the treatment effect. The treatment group was taught Mathematics using CS mediated instruction whilst the control group received TE mediated instruction.

3.4 Study site

The study was conducted from one of the primary schools in one of the peri-urban areas of Lusaka which continued offering junior secondary classes and conducting grade nine examinations even after the restructuring of basic schools and high schools into primary schools and secondary schools respectively. Mainly, pupils who were enrolled in Grade eight in these schools were those with low marks after those with higher marked were selected for secondary schools. The school under study is located in the heart of densely populated shanty compounds where the majority of pupils are drawn. Although the compounds were multilingual in nature, Nyanja was the most familiar Lingua Franca, which pupils grew up speaking and taught as a subject at primary school level. Therefore, the school was a suitable study site as it had the majority of pupils with low marks, indicating less competencies in various subjects, especially in Mathematics, and were more proficient in Nyanja than English language. Thus, the study site was expected to facilitate the investigation on effects of CS mediated Mathematics instruction.

3.5 Study Population

All Grade Eight pupils in government primary schools in peri-urban areas of Lusaka, who were less competent in Mathematics and were more familiar with Nyanja than English, constituted the study population. The population had recently passed the National Grade Seven bridging examinations. However, Multiple-Choice Questions (MCQs) in these examinations are weak, which pupils can easily answer by guessing without understanding how to arrive at a particular answer. A pass in examinations may not necessarily imply conceptual understanding, as such pupils' competencies may not be adequately assessed.

3.6 Study Sample

The sample constituted 209 pupils, 104 of whom were taught using CS mediated instruction and 105 continued with TE mediated instruction. In the CS mediated instructed group were 61 boys

and 43 girls, while the remaining 52 boys and 53 girls were in TE mediated instructed group. Pupils' ages in both groups ranged from 13 to 17, where the respective group mean ages were 14.19 ($SD = 1.07$) and 14.25 ($SD = 1.06$).

3.8 Sampling Technique and Procedure

The study used convenient sampling technique as it sought to use naturally occurring classes of Grade Eight pupils. Creswell (2009) argued that in many experiments only a convenient sample is possible because the researcher must use naturally formed groups such as classrooms, organizations, family units, or volunteers. School records indicated that the four classes selected were those with similar consistent average score of about 20% in Mathematics and less than 20% in English language based on two consecutive term tests. The means indicated that pupils were low Mathematics and English language competent. Two classes constituted the experimental group and the other two constituted the control group. The experimental group had the mean scores of 21.52 and 20.67 in Mathematics and 19.47 and 18.89 in English language for two consecutive school terms. The control group had 20.39 and 21.97 in Mathematics and 19.63 and 19.99 for the corresponding school terms.

A preliminary observational assessment regarding which language was more familiar than the other was carried out. The results revealed that in the experimental group, 76 pupils were more familiar with Nyanja than English, while 28 were more familiar with English than Nyanja. In the control group, 79 pupils were more familiar with Nyanja than English, and 26 were more familiar with English than Nyanja. Thus, it was envisaged that the initial means and frequencies between the two groups would enable effective determination of whether Mathematics achievement improved as a function of CS mediated instruction. Kombo and Tromp (2006) argued that in both the experimental group and control group the dependent variable must be initially equivalent to determine the cause and effect in an experiment.

3.8 Data Collection Instruments

Data for the study was collected using two equivalent Mathematics achievement tests ($r = .99$), one was the pre-test and the other was the post-test. The tests also elicited for gender, age, class attendance and grade repetition to determine effect of pupil-levels characteristics in instructional methods. The section assessing Mathematics achievement was designed based on prescribed Grade Eight Mathematics textbooks for Zambian secondary schools and Grade nine ECZ past examination papers. The selection of questions for assessment was based on content areas covered in class. The content areas were Coordinates, Angles, and Functions. Each content area consisted 10 questions. The specification of the content areas would enable the determination of how each content area affected achievement as a results of instruction between groups. Kombo and Tromp (2006) contends that tests can be used as instruments in the collection of data, and that in the absence of a standardised test, the researcher may design a particular test of interest to achieve a given purpose.

A Code-Switching guide (Appendix A) was developed to be used in Mathematics teaching. The guide indicated that Code-Switching served three general functions; it provided pupils with cognitive, motivational and classroom management support. The guide was developed through an extensive review of relevant literature on Code-Switching in the teaching and learning of various subjects in primary and secondary schools within and outside Africa. Specifically, the guide showed how the teacher was to apply Code-Switching between English and Nyanja in teaching pupils Coordinates, Angles and Functions. It showed how Nyanja was used to supplement English in the teaching of Mathematics by way of interpreting, describing and explaining concepts, principles and procedures, whereas English was mainly used for stating and restating such concepts.

Lesson plans were also designed for teaching CS mediated classes and TE mediated classes. This ensured that the teacher planned, prepared, and delivered lessons to pupils in an effective and consistent manner.

3.8.1 Validity

The content validity of the two tests was preserved by reconciling them with the Zambian junior secondary Mathematics syllabus and scheme of work. The items of the tests were examined by the two Mathematics teachers and the HOD at the selected school and their suggestions were included prior to testing. Thus, the test items matched the requirements of the syllabus at junior secondary level. Therefore, the tests were adequately representative to measure pupils' achievement in Mathematics.

3.8.2 Reliability

The tests were piloted among Grade Nine pupils at a school with similar demographic characteristics in Lusaka district, and the results were subjected to internal consistency reliability test. The pre- and post-test results yielded Cronbach's alpha of .82 and .88 respectively.

3.9 Data Collection Procedure

The teaching intervention lasted 10 weeks. Before the beginning of the intervention period a pre-test was administered to the experimental and control groups. Then the experimental group was taught Mathematics with CS mediated instruction and the control group continued receiving TE mediated instruction.

The CS guide was provided for the Mathematics teacher, who was proficient in both English and Nyanja languages, to use in teaching the experimental group. The teacher studied the three measures of the guide regarding cognitive, motivational, and classroom management support; and how to code-switch in teaching each content area. The criterion for Code-Switching in

Mathematics teaching mainly involved the teacher using English for stating and restating mathematical concepts such as equal, X-axis, positive, degree, angle, and function, and using Nyanja for describing and explaining principles, and methods of working out Mathematics problems. Where possible, the teacher translated and interpreted mathematical terminologies into Nyanja using the guide. Thus, the teacher was able to overcome the lack of cognitive, affective, and classroom management support among pupils. On the other hand, pupils were code-switching freely by alternating between English and Nyanja languages in Mathematics learning activities. This enabled them to experience cognitive support by freely expressing themselves during classroom interactions and demonstrating their conceptual understanding. As regards motivational support, the teacher was code-switching to provide affective support for the pupils. The introduction of Nyanja in code-switching was expected to have an inherent ability to motivate learners in describing and explaining mathematical procedures and steps. It also reinforced learning of Mathematics material. This increased their levels of interest, morale, and confidence in learning Mathematics concepts, principles, and procedures. The teacher also used code-switching for the purposes of classroom management to maintain attentiveness and discipline among pupils during lessons. This ensured that teaching and learning of Mathematics ran smoothly without disruptive behaviour from pupils.

During the treatment intervention, the experimental group and the control group had the same teacher with the same teaching qualification, experience and skills. For both groups the teacher taught the same content areas – Coordinates, Angles and Functions – using the same lesson plans, learning activities, teaching methods (teacher exposition, question-and-answer and group discussion), and teaching aids. Thus, the teaching variables were controlled to enable the precise determination of effects of CS mediated Mathematics instruction on pupils' achievement. Kombo and Tromp (2006) emphasise that in such an experiment the researcher must be certain of the dependent and independent variables and must guard against the influence of extraneous

variables. At the end of the treatment period, a post-test was administered to both the experimental and control groups. The scripts of the pre- and post-tests were marked and the marks were converted to percentages. In this way, the data collected were analysed statistically to determine whether the mean differences in achievement between CS mediated instruction and TE mediated instruction were statistically significant.

3.10 Data Analysis Instruments and Procedures

The collected data on pupil-level characteristics, overall achievement, and performance on specific Mathematics content areas in both the pre- and post-tests were statistically analysed. Parametric tests were used in the analysis of data as Shapiro Wilk's test of normality demonstrated no statistical significance ($p > .05$) in the pre- and post-test results. Thus, data was taken to be normally distributed. Objective 1 data was analysed through MANOVA procedures, whereas objectives 2 and 3 data were analysed using Multiple Linear Regression Analysis. In addition to Regression Analysis for objective 3, Pearson's Product Moment Correlation was used to analyse the data.

The analysis procedures were appropriate because (1) the MANOVA has the ability to simultaneously determine the differences in the pre- and post-test achievement between the CS and TE groups; (2) Multiple Linear Regression has the ability to establish influence of pupil-level characteristics on CS and TE mediated instructions in facilitating Mathematics achievement. The analysis procedure also has the ability to assess specific content areas which statistically significantly affect overall Mathematics achievement for CS and TE mediated instructions. Pearson's Product Moment Correlation has the ability to evaluate the strength of associations among the content areas for CS and TE based instructions. Hence, statistical significance was tested in Mathematics achievement between the two groups of pupils.

3.11 Ethical Considerations

In the study, the following research ethics were upheld; authorization was sought from the University of Zambia, District Education Board Secretary's office, and School Head Teacher's office before conducting the study at the school. The purpose of the study was explained to the Head, Deputy Head, and teachers of Mathematics who consented on behalf of the pupils after being satisfied with the explanation. Prior to the beginning of the treatment period, the purpose of the study was explained to the pupils, and what was involved, who also consented. The treatment process was to ensure that the rights of pupils were respected and they were not physically and psychologically harmed in any way.

The teaching and learning of Mathematics for the treatment group which was conducted using CS mediated instruction was not compromised as Nyanja language was only used to supplement English to scaffold pupils' learning of Mathematical concepts, principles, and procedures. Thus, the introduction and use of Nyanja language in CS mediated Mathematics instruction was to be an added advantage to pupils' conceptual understanding. Although the use of CS intervention interrupted the norm of using TE mediated instruction, it was expected to provide stronger cognitive, motivational and classroom management support for pupils. At the end of the treatment period, pupils in the CS treated group were told that the use of TE mediated instruction had resumed. During data entry of the pre- and post-test results pupils' names were not captured, and upon data entry the marked scripts were immediately returned to the pupils without announcing the marks.

3.12 Conclusion

The chapter has outlined and discussed the research paradigm, research design, methods of data collection, and data analysis. Key issues under data collection and data analysis were established, and an explanation of how research ethics were upheld has been provided. Therefore, the chapter provided the methodology expecting to determine whether CS mediated

Mathematics instruction would improve pupils' achievement more than TE mediated instruction.

CHAPTER FOUR: PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the results of the study. Results are reported in three sections according to the objectives of the study. The first section covers descriptive and inferential statistics from MANOVA used for testing significant differences in pre- and post-test results between pupils taught with CS mediated Mathematics instruction and their counterparts who received TE based instruction. The second section deals with Multiple Regression results assessing the influence of pupil level characteristics on achievement between the two groups of pupils. Similarly, the final section also covers Multiple Regression results evaluating specific content areas which statistically significantly affect achievement between the corresponding groups. In addition, the final section include Pearson's Product Moment Correlation results evaluating the strength of associations among the Mathematics content areas for CS and TE mediated instructions.

4.2 Effects of CS and TE Mediated Instructions on Mathematics Achievement

The main objective of the study was to determine whether there was a statistically significant difference in overall achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction. Table 1 displays descriptive statistics in form of means and standard deviations for the pre- and post-test results between CS and TE groups. The pre-test results revealed slightly lower mean achievement for pupils taught using CS mediated Mathematics instruction ($M = 21.08$; $SD = 8.16$) than those taught with TE mediated instruction ($M = 22.86$; $SD = 10.89$). The post-test results revealed the opposite case, a greater mean for the CS mediated group ($M = 39.91$; $SD = 11.04$) than for the TE mediated group ($M = 33.27$; $SD = 11.10$).

Table 1: Descriptive Statistics Results for Pre- and Post-test Results between Groups

Test	CS Mediated Group		TE Mediated Group	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Pre-test	21.08	8.16	22.86	10.89
Post-test	39.91	11.04	33.27	11.10

Table 2 shows MANOVA results to determine whether the mean differences in the pre- and post-test achievement were statistically significant between the CS and TE groups. The mean difference between the two groups was not statistically significant in the pre-test data, $F(1,207) = 1.79, p > .05$, but was statistically significant in the post-test data, $F(1,207) = 6.46, p < .05$. Thus, the null hypothesis that there was no statistically significant mean difference in achievement between the two groups was supported by the pre-test results, but not by the post-test results.

Table 2: MANOVA Inferential Statistics Results for Pre-test and Post-test Achievement

Source	Dependent Variable	<i>Df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Medium	Pre-test achievement	1,207	165.59	1.79	0.18
of Instruction	Post-test achievement	1,207	845.15	6.46	0.01

4.2 Influence of Pupil-level Characteristics on CS and TE Mediated Instructions

The second objective of the study was to establish the influence of pupil-level characteristics on CS and TE mediated instruction in facilitating Mathematics achievement. Two Multiple Linear Regression models to evaluate the predictive influence of pupil level variables on Mathematics achievement were carried out in separate analyses for the CS medium and TE medium data. Gender, age, grade repetition, and class attendance were used to predict Mathematics achievement variance. Table 3 shows both unstandardized and standardized regression

coefficients of the predictors of achievement. The regression model was statistically significant in both the CS medium, $F(4,99) = 23.25, p < .05$, and the TE medium data, $F(4,100) = 9.66, p < .05$, with the four variables explaining about 48% ($R^2 = .48$, Adjusted $R^2 = .46$) and 28% ($R^2 = .28$, Adjusted $R^2 = .25$) of the achievement variances respectively. Using the regression results as a measure of goodness of fit of the models, it appeared that the CS data fitted the regression model better than the TE data, judging by the 20% (48% – 28%) difference in variance between the two models.

Results demonstrated that pupils' gender had a statistically significant influence on Mathematics achievement for the CS mediated instruction model, $\beta = 3.90, t(104) = 2.37, p < .05$ and not for the TE model ($p > .05$). Thus, taking the achievement of boys between the groups as a standard since the scores were approximately the same, achievement scores of girls had a standard deviation of 3.90 from the scores of boys for the CS model. For the TE mediated instruction model, achievement scores of girls had a standard deviation of $-.04$ from the scores of boys. Judging by the magnitude and direction of the two standard deviations, girls in the CS mediated group had far much higher achievement than their counterparts in the TE mediated group.

Age did not have statistically significant effects on Mathematics achievement in both the CS model, $\beta = .05, p > .05$, and the TE model, $\beta = -.22, p > .05$. However, the predictive power was positive in the CS data and negative in the TE data. By implication, one year increase in age for the CS model there was .05% corresponding increase in achievement while for the TE model there was $-.22\%$ corresponding decrease in achievement, which is indicated counter-achievement with advances in age.

There was a statistically significant predictive influence of grade repetition on Mathematics achievement for the CS mediated instruction model, $\beta = -.24$, $p < .05$ but not for the TE mediated instruction model ($p > .05$). The predictive effect of grade repetition in the CS model was negative, every one increase in frequency in grade repetition, Mathematics achievement decreased by $-.24\%$. While Grade repetition tended to negatively affect code-switching, it did not affect TE mediated instruction. This suggested that CS mediated Mathematics instruction was not as effective for teaching pupils who had repeated the Grade at least once as was TE mediated instruction.

Results further illustrated a predictive influence of class attendance on Mathematics achievement for both the CS and TE medium models. The influence was statistically significant, $\beta = .55$, $t(104) = 7.12$, $p < .05$ and $\beta = .50$, $t(105) = 5.69$, $p < .05$ in both the CS and TE medium based instruction respectively. However, the predictive power was greater in the CS model than in the TE model. In the CS model, for one day increase in class attendance there was $.55\%$ corresponding increase in achievement whereas in TE based instruction model achievement increased by $.50\%$. Therefore, the results suggest that, with the exception of grade repetition, CS mediated Mathematics instruction was more effectively facilitated by pupil-level characteristics affecting achievement than TE mediated instruction.

Considering regression correlation coefficients, unlike beta coefficients, results demonstrated that gender still had statistically significant predictive power for the CS medium model, $r = .32$, $p < .05$ but not for the TE medium model, $r = -.14$, $p > .05$. Unexpectedly, age had statistically significant effect for TE mediated Mathematics instruction, $r = -.19$, $p < .05$ but not for CS mediated instruction, $r = -.12$, $p > .05$. Grade repetition still remained statistically significant for the CS model, $r = -.35$, $p < .05$ but not the TE model, $r = .05$, $p > .05$. Class attendance

retained the predictive effect for both models. The influence was still statistically significant, $r = .64, p < .05$ and $r = .48, p < .05$ for both the CS and TE based instruction respectively.

Table 3: Multiple Linear Regression Results Summary - Unstandardized Weights, Standardized Weights and Correlation Coefficients for Pupil-level Characteristics and Achievement

Model	B	β	r
CS Mediated Instruction			
Gender	3.90	.18*	.32*
Age	.52	.05	-.12
Grade repetition	- 6.41	-.24**	-.35*
Class Attendance	.64	.55**	.64*
TE Mediated Instruction			
Gender	-.91	-.04	-.14
Age	- 2.45	-.22	-.19*
Grade repetition	3.09	.12	.05
Class Attendance	.73	.50**	.48*

Note. The dependent variable was Mathematics achievement. $R^2 = .48$ and $.28$; Adjusted $R^2 = .46$ and $.25$ in CS mediated instruction and TE mediated instruction respectively. * $p < .05$ and ** $p < .01$

4.4 Specific Content Areas Affecting Overall Mathematics Achievement

The third and final objective was to assess specific content areas which statistically significantly affected overall Mathematics achievement for CS and TE mediated instructions. Similarly, two Multiple Linear Regression analyses were run to evaluate the degree of predictability of achievement in Mathematics with specific achievement variables. Scores on Coordinates, Angles, and Functions predicted Mathematics achievement variance. Table 4 shows both unstandardized and standardized regression coefficients of the predictors of overall

Mathematics achievement. Generally, the overall regression model was statistically significant in both the CS medium, $F(3,100) = 5.59, p < .05$, and the TE medium data, $F(3,101) = 3.31, p < .05$, with the three variables accounting for approximately 15% ($R^2 = .15$, Adjusted $R^2 = .12$) and 8% ($R^2 = .08$, Adjusted $R^2 = .06$) of the achievement variances respectively. Taking the regression results as a measure of goodness of fit, it seemed that the CS data fitted the regression model better than the TE data, judging by 6% (15% – 8%) gap in variance, accounted for R^2 , between the two models.

Results revealed that Coordinates had considerable high predictive power on overall Mathematics achievement in both the CS and TE models, $\beta = .25, t(104) = 2.68, p < .05$ and $\beta = .23, t(105) = 2.23, p < .05$ respectively. However, the predictive power was greater in the CS medium model than in TE medium model. This implies that 1% increase in performance on Coordinates for CS based instruction there was .25% corresponding increase in overall achievement whereas for TE mediated instruction it increased by .23%.

Angles had statistically significant predictive effect on overall achievement for CS mediated instruction only, $\beta = .26, t(104) = 2.73, p < .05$. The predictive power was, as expected, greater by group comparison, but unexpectedly stronger within the CS mediated group. For 1% increase in performance on Angles in the CS medium model there was .26% corresponding increase in overall achievement while in TE medium it increased by .19%. Results further indicated that Functions had no predictive impact on overall achievement in both models.

Using regression correlation coefficients instead of beta weights, results revealed that Coordinates and Angles still had statistically significant predictive power in the CS medium and TE medium models, $r = .26, p < .05$ and $r = .31, p < .05$ respectively. Similarly, the corresponding content areas also statistically significantly predicted achievement in the TE medium model, $r = .24, p < .05$ and $r = .21, p < .05$ respectively. This was unexpected realizing

that Angles had no statistically significant predictive effect when beta coefficients were considered. Functions remained without predictive influence for both models. The impact was still not statistically significant, $r = .15, p > .05$ for CS mediated instruction and $r = -.04, p > .05$ for TE mediated instruction.

Table 4: Multiple Linear Regression Results Summary - Unstandardized Weights, Standardized Weights and Correlation Coefficients for Specific Content Areas and overall Achievement

Model	B	β	r
CS Mediated Instruction			
Coordinates	.17	.25*	.26*
Angles	.17	.26*	.31*
Functions	.10	.10	.15
TE Mediated Instruction			
Coordinates	.25	.23*	.24*
Angles	.16	.19	.21*
Functions	-.09	-.10	-.04

Note. The dependent variable was Mathematics achievement. $R^2 = .15$ and $.08$; Adjusted $R^2 = .12$ and $.06$ in CS mediated instruction and TE mediated instruction respectively. $*p < .05$

Additionally, Pearson’s product-moment correlation was computed to assess the strength of associations among the content areas for CS and TE mediated instructions. Close associations among variables were hypothesized because of similarities in their graphical representations. Results of the correlation analysis are displayed in table 5. There were very low to moderate correlations ranging from $.05$ to $.35$. For CS based instruction, only 2 out of 3 bivariate correlation coefficients were statistically significant and were greater or equal to $r = .20, p < .05$, one-tailed. The coefficient was largest between Angles and Coordinates ($r = .22$) and

smallest between Angles and Functions ($r = .05$). For TE mediated instruction, all the 3 correlation coefficients were statistically significant and were greater or equal to $r = .25$, $p < .05$, one-tailed. The correlation was strongest between Angles and Functions ($r = .35$) and weakest between Angles and Coordinates ($r = .05$).

Table 5: Pearson's Product Moment Correlations Results for Associations among Specific Content Areas for CS and TE mediated Instructions

Variable	CS Mediated Instruction			TE Mediated Instruction		
	1	2	3	1	2	3
1. Coordinates	1			1		
2. Angles	.22*	1		.25**	1	
3. Functions	.20*	.05	1	.34**	.35**	1

*Note: * $p < .05$ and ** $p < .01$*

4.5 Conclusion

The results from MANOVA and Multiple Linear Regression Analysis have provided salient insights into how the medium of instruction affects Mathematics achievement between pupils taught using CS and TE mediated instructions. Generally, CS mediated instruction had significantly greater effects on Mathematics achievement than TE mediated instruction. Its use was more effectively facilitated by pupil-level characteristics affecting achievement than TE mediated instruction. Code-Switching instruction appears to favour performance on all the three content areas affecting overall Mathematics achievement more than TE mediated instruction.

CHAPTER FIVE: DISCUSSION OF RESULTS

5.1 Introduction

This chapter presents a discussion of results of the study. The study sought to: 1) determine whether there was a statistically significant difference in overall Mathematics achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction; 2) establish the influence of pupil-level characteristics on CS and TE mediated instructions in facilitating Mathematics achievement; and 3) assess which specific content areas statistically significantly affected overall Mathematics achievement. Thus, the discussion is divided into three sections. The first section covers a discussion on results from MANOVA while the second and final sections cover a discussion on results from Multiple Regression Analyses.

5.2 Effects CS and TE Mediated Instructions on Overall Mathematics Achievement

The main objective of this study was to determine whether there was a statistically significant difference in achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction. The study compared the means of pupils' Mathematics achievement as measured by pre- and post-tests to determine differences in the effects of CS and TE mediated instructions. This was based on the hypothesis that there is a statistically significant difference in achievement between the groups of pupils. The hypothesis was based on the assumption that the overarching purpose of any medium of instruction is to facilitate effective teaching and learning (Cummins, 2000; Salami, 2008).

Generally, results of the study revealed a statistically significant group difference in overall Mathematics achievement. Pupils taught using CS mediated Mathematics instruction outperformed their counterparts taught using TE mediated instruction. This implies that supplementing English language with pupils' familiar local language in Mathematics teaching

facilitated higher achievement than teaching using English language only. This was consistent with Molotja's (2008) findings which revealed that the pupils taught Mathematics using CS mediated instruction out-performed their counterparts who were taught using English mediated instruction. The result also concurred with findings from Jegede's (2011) study which establish that the use of CS medium in Mathematics teaching did not result in a deficiency in the quality of learning outcomes, but that it was useful in the classroom interaction as it was an efficient way of transferring Mathematics knowledge to pupils. However, the results contradicted Avendanio and Belanio's (2016) results which revealed that CS mediated instruction had no effect on performance in Mathematics among University students. It was found that the scores of students under English medium tended to be higher than for those under CS medium.

The magnitude of within-group variances was greater for pupils taught using CS based instruction than their counterparts using TE based instruction. Thus, the use of CS medium appeared to have significant effects on pupils' Mathematics achievement than the use of TE mediated instruction, even more effective in teaching bilingual pupils less competent in the subject and English language than traditional instruction. This result supported prior studies which revealed that CS between English and the most familiar language in Mathematics teaching aided pupils to understand the subject matter better, and at the same time helping teachers to explain and clarify concepts, demonstrate procedures, motivate through praise, organize learning activities, and manage and instill discipline pupils (Ferguson, 2003; Nyambura, 2015; Setyaningrum, 2015; Yamat et al., 2011). Thus, consistent with Molotja's (2008) findings, the results of the study revealed that CS mediated instruction was a good alternative to pupils' problem of comprehending Mathematics when taught in English language only. However, the results appeared to contradict the findings of Setati et al. (2002) indicating that although teachers could reformulate the concepts in familiar local language, pupils needed to receive and produce the content in English as it was the language of assessment. The findings

also indicated that CS instruction in teaching and learning Mathematics was perceived as jeopardizing pupils' ability to answer questions in English.

On the other hand, the results of the study revealed that TE mediated instruction was a disadvantage to pupils less competent in Mathematics and English language. This appeared to support Md-Ali, Mohd-Yusof, and Veloo's (2014) findings that solely depending on English language in teaching and learning Mathematics was insufficient as pupils were slow in understanding concepts and principles being taught. Similarly, Yamat et al (2011) found that pupils were not attentive and could not give correct responses when English mediated instruction was used because they failed to express themselves well in English. Consistently, Viriri and Viriri's (2013) findings revealed that teachers deliberately used CS mediated instruction to enhance pupils' conceptual understanding and performance in the classroom and public examinations, which they felt could be hindered if they stuck to English mediated instruction.

The results seemed to concur with Garegae's (2007) study which established that pupils who were taught Mathematics using English mediated instruction experienced challenges related to language proficiency. The findings suggested that to be successful in Mathematics teaching, pupils' most familiar language needed incorporation to aid their conceptual and procedural understanding, since they had difficulties in learning both Mathematics and English language. Similarly, results support Jegede's (2012) observational findings which revealed that learning Mathematics using English medium was problematic for pupils whose familiar language was not English. As such the use of Code-Switching between English and pupils' most familiar language facilitated better understanding of Mathematics contents.

Viewed through a theoretical lens, the results of the study seemed to validate Myers-Scotton's MLF model, which states that in CS there is an unequal participation of the matrix and

embedded languages which are used to achieve a given communicative purpose (Myers-Scotton, 2006). This was because, to a greater extent, higher Mathematics achievement among pupils taught using CS mediated instruction resulted from the use of English as a matrix language and Nyanja as an embedded language. As established by Md-Ali, Mohd-Yusof and Veloo's (2014) study on CS in Mathematics teaching, the present study used English for stating and restating concepts and principles, while Nyanja was used for the purpose of explaining procedures in problem-solving. However, results suggested some modification in the model as it did not demonstrate how and when to use CS in teaching. Results from CS mediated Mathematics instruction were based on translation and interpretation of certain mathematical concepts from English into Nyanja unlike mere switching between the languages as propounded by the model (Myers-Scotton, 2006). CS instruction was used when pupils expressed difficulty understanding concepts and procedures (cognitive support); when they lacked humorous effect (affective support); and when they were not paying attention (classroom management support). Thus, these psychological functions of CS - which made pupils learn concepts with less difficulty - required systematic analysis and incorporation into the model to make it more applicable for research in Mathematics teaching.

Similarly, results supported the socio-cultural theory, which postulates that "the specifically human capacity for language enables children to provide for auxiliary tools in the solution of difficult tasks, to overcome impulsive action, to plan a solution to a problem prior to its execution, and to master their own behaviour" (Vygotsky, 1978, p. 28). The theory treats a familiar language as an important psychological tool for scaffolding the learning process and cognitive development because it allows pupils to express meaningful ideas, asking purposeful questions, developing classifications, and concepts for thinking (Vygotsky, 1978; Wertsch, 1985). In support of language as cognitive tool, Turuk (2008) asserts that teaching in a familiar language exerts an influence on pupils who use it to tap into previously unknown activities and

ways of conceptualizing phenomena. Therefore, results suggested that CS mediated instruction helps pupils to move successfully through Zones of Proximal Development. Hence, the use of CS medium in teaching serves as a mental tool with scaffolding effect on the learning and thinking processes of pupils who are less competent in both Mathematics and English language. However, the theory, as in the case of the MLF model, required some modification because it merely posits that language is a cognitive tool that scaffolds learning and cognitive development. It does not demonstrate how language is used to bring about scaffolding. The results also suggest that CS mediated instruction is based on cautious selection and simplification of words between English and Nyanja to make pupils learn Mathematics concepts with less difficulty.

5.4 Influence of Pupil-level Characteristics on CS and TE Mediated Instructions

The second objective of this study was to establish the influence of pupil-level characteristics on CS and TE mediated instructions in facilitating Mathematics achievement. Thus, the study evaluated the contribution of pupils' gender, age, and grade repetition and class attendance to their Mathematics achievement between the two teaching methods. It was hypothesised that these pupil-level characteristics have statistically significant predictive effects on pupils' achievement between the CS and TE mediated groups. The hypothesis was premised on the assumption that Mathematics instruction works effectively with all pupil-level characteristics in facilitating achievement.

Generally, results revealed that the pupil-level characteristics explained less than half of the variance in the two models of pupils' Mathematics achievement. However, the proportion of the achievement variance-explained was considerably larger in the CS mediated instruction model than in the TE based model. Thus, gender, age, grade repetition, and class attendance explained the achievement variance better under CS medium model than under TE medium model. This

implies that CS works more effectively with gender, age, grade repetition, and class attendance in facilitating Mathematics achievement than TE instruction.

The major distinction between the CS and TE regression models was based on the number of variables predicting corresponding achievement variances. For the CS model, gender, grade repetition, and class attendance had statistically significant predictive influence, whereas Mathematics achievement variance for the TE medium was only statistically significant for class attendance. The greater predictive power of gender and class attendance in the CS medium model was as expected because familiar medium of instruction is well facilitated by most pupil-level characteristics. However, the inverse association of grade repetition, defined by negative beta weights and correlation coefficients, for CS mediated instruction implied counter-achievement. This implies that pupils who repeated a grade were prone to produce poor Mathematics achievement (Jimerson et al, 2006). The fact that class attendance was the only statistically significant predictor of overall achievement in the TE medium model, was not surprising because the medium facilitated by certain pupil-level characteristics affected Mathematics achievement positively (Howie, 2003).

Pupils' age, on the other hand, was the only predictor that had no statistically significant power in the CS medium model, whereas the TE medium model had age, gender and grade repetition with non-significant predictive power. The inverse association of age and gender, defined by negative beta and correlation coefficients, in the TE medium model implied counter-achievement. Thus, achievement decreased with increasing age (Jabor et al, 2011); and as for gender, boys had higher achievement than girls. In spite of age not having statistically significant predictive influence on achievement in CS model, it still retained a positive influence. This was expected because CS mediated instruction was more familiar among bilingual pupils with different ages.

Class attendance, gender, and age, in the order of decreasing magnitude, were the major contributors of achievement in the CS model followed by the contribution of grade repetition. This implied that CS medium was most effective on achievement with improved class attendance (Aden, Yahye, & Dahir, 2013), and least effective with grade repetition. Interestingly, the order of pupil-level characteristics for the TE mediated model was different, that is, class attendance, grade repetition, and gender were found to be the main contributors of achievement followed by age. This suggested TE mediated instruction was most effectively facilitated by class attendance and was least facilitated by age. The foregoing implies that the two media of instruction did not always work with pupil-level characteristics facilitating achievement in the same order.

Additionally, the dynamics and nature of the predictive power of the four predictors were retained in the CS medium model, but were altered in the TE medium model when regression correlation coefficients, instead of beta weights, were interpreted. For the CS medium model, gender, grade repetition, and class attendance still had statistically significant correlation coefficients in line with corresponding beta coefficients, and the flow of the magnitude of prediction was maintained. Correlation coefficients indicated that the three predictors accounted for the larger proportion of the variance-explained followed by grade repetition. Surprisingly, for the TE medium model, age and class attendance had statistically significant correlation coefficients in comparison to one beta weight, though the order of the magnitude of prediction was not altered. Variations in the dynamics of prediction for TE mediated instruction could be attributed to the suppression effects among variables. Thus, Thompson (2006) perceives the interpretation of both beta weights and correlation coefficients in Linear Regression to be important. However, an analysis of the magnitude of the correlation coefficients all the same revealed that CS was more effectively facilitated by all pupil-level characteristics, except grade repetition, than was English mediated instruction.

5.4 Specific Content Areas Affecting Pupils' Overall Mathematics Achievement

The third and final objective was to assess specific content areas which statistically significantly affected overall Mathematics achievement for CS and TE mediated instructions. The study also compared the variance in pupils' overall achievement explained by Coordinate, Angles, and Functions to determine differences in their predictive effects between CS mediated and TE mediated instructions. This was based on the hypothesis that each specific content area has statistically significant predictive effect on overall Mathematics achievement for the two instruction types. The assumption was that Mathematics instruction is effective in teaching pupils all specific content areas that contribute to overall achievement (Molotja, 2008).

Overall, results indicated that both regression models explained less than half of the variance in pupils' Mathematics achievement. However, the proportion of the achievement variance-explained was moderately larger in the CS mediated model than in the TE mediated model. This implies that Coordinates, Angles, and Functions explained the achievement variance better for CS mediated instruction than for TE mediated instruction. The result was expected because the CS mediated Mathematics instruction was familiar to pupils and facilitated their comprehension of specific content areas. This was consistent with Jegede's (2011) findings that the use of CS between English and pupils' most familiar language in teaching led to a better conceptual understanding of Mathematics contents.

The major Mathematics achievement differences between the CS medium and TE medium regression models was the number of variables predicting respective achievement variances. For the CS mediated model, Coordinates and Angles problem-solving skills had statistically significant predictive effects, whereas achievement variance in the TE mediated model was to greater extent contributed by Coordinates problem-solving skills. The greater predictive power of Coordinates and Angles for the CS medium model was as expected because familiar

Mathematics instruction had the better ability of facilitating effective teaching and learning of specific contents than the less familiar one. This was supported Molotja's (2008) results which revealed that the use of CS mediated instruction did not impede, but aided teachers and learners in the teaching and learning of Angles. The fact that Coordinates were the only statistically significant contributor of overall achievement for the TE medium model was not entirely unexpected, as TE mediated instruction had also the ability to effectively facilitate certain specific content areas more aligned to mathematical language (Mahofa, 2014).

Functions problem-solving skills did not have statistically significant effect for both CS and TE mediated instructions. The plausible explanation is that Functions appeared to have the most difficult mathematics language for pupils among the three content areas. The inverse association of Functions, defined by negative beta and correlation coefficients, for TE mediated instruction implied counter-achievement. This appeared to support Jegede's (2012) findings which showed that learning Mathematics using English medium was problematic for pupils whose familiar language was not English. Similarly Molotja (2008) found that English mediated instruction led to poor pupils' performance on Basic Processes of Algebra. Despite Functions not having statistically significant effect on achievement in the CS mediated instruction model, they still retained a positive predictive power. This was expected because in spite of the content area having difficult mathematics language for pupils, CS between English and Nyanja languages all the same appeared to be more effective in its teaching.

As expected, Coordinates and Angles, in the order of decreasing magnitude, were the major contributors to achievement in the TE mediated model followed by Functions. This suggested that TE instruction was most effective in teaching Coordinates and least effective in teaching Functions. Surprisingly, the order of the content areas for the CS mediated model was different, that is, Angles and then Coordinates were found to be the main contributors to achievement

followed by Functions. Thus, suggesting that the instruction was most effective in teaching Angles and least effective in teaching Functions. The implication was that the two media of instruction did not always affect the order of performance on the content areas in the same way. Moreover, the magnitude of the beta coefficients suggested that CS mediated instruction was more effective in teaching all the three content areas than was TE mediated instruction.

In addition, the dynamics and nature of the predictive impact of the three specific content areas were maintained in CS medium model, but were altered in the TE medium model when regression correlation coefficients, instead of beta coefficients, were interpreted. For CS mediated instruction model, only Angles and Coordinates had statistically significant correlation coefficients in line with corresponding beta coefficients. The order of the magnitude of prediction was retained, with Angles and Coordinates accounting for the larger proportion of the achievement variance-explained followed by Functions. For the TE mediated model, Coordinates and Angles had statistically significant correlation coefficients in comparison to one beta weight, but the order of the magnitude of contribution was not altered. The differences in the dynamics of prediction in the TE medium model could be attributed to the suppression effects among variables (Thompson, 2006).

Nonetheless, an examination of the magnitude of the correlation coefficients still demonstrated that CS mediated instruction was more effective in aiding pupils' comprehension of all the three content areas than was TE mediated instruction. Results seemed to corroborate Mahofa's (2014) assertion that teaching on 'Area of Geometrical Shapes' using CS instruction facilitated pupils' understanding of concepts and as such answered question effectively. However, results appeared to contradict results from Avendaño and Belanio's (2016) study that CS based instruction had no effect on teaching 'Analytic Geometry'. The contradiction could have resulted from students' prior long experience and higher level competency in Mathematics

between the tested groups, and their cognitive development could have already been shaped by two languages, and the different nature of the content area investigated on.

The strength of associations among the specific content areas suggests that when using TE mediated instruction, Angles required to be taught first, followed by Functions and then Coordinates. However, the strength of associations in the CS medium model suggests that Angles required to be taught first, followed by Coordinates and then Functions. Thus, CS medium model appeared to organize the content areas in a more logical simple-complex order than the TE medium model.

5.5 Conclusion

The chapter has provided an in-depth discussion of the results. Generally, it has been established that CS mediated instruction is better in facilitating Mathematics achievement than TE mediated instruction. CS instruction was more effectively facilitated by almost all pupil-level characteristics and favored performance on all the three content areas more than traditional instruction. Therefore, an examination of differences in the magnitude of means, variances, beta weights, and correlation coefficients revealed that CS mediated instruction had more improvement effects on Mathematics achievement than TE mediated instruction.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study determined the difference in Mathematics achievement between pupils taught using CS mediated instruction and those taught using TE mediated instruction. Generally, results demonstrated a statistically significant mean difference in achievement between the CS and TE mediated groups. Pupils taught with CS based Mathematics Instruction out-performed their counterparts taught with traditional instruction. This implies that CS between English and Nyanja facilitated pupils' achievement better than English mediated instruction. The magnitude of the mean difference in achievement within group was larger for CS mediated instruction than for TE based instruction. This implies that teaching using CS instruction had more significant improvement effects on Mathematics achievement than using traditional English instruction.

The influence of pupil-level characteristics on CS and TE mediated instructions in facilitating Mathematics achievement was also established. Results showed that gender, age, grade repetition and class attendance explained the achievement variance better in the CS medium model than in the TE medium model. Differences were found in the number of variables statistically significantly explaining achievement variance for CS and TE mediated instruction. Gender, grade repetition and class attendance had statistically significant predictive influence for CS instruction, whereas under TE based instruction only class attendance had significant effect. This implies that CS based instruction was more effectively facilitated by pupil level characteristics, except grade repetition, than TE based instruction.

Finally, the study assessed specific content areas which statistically significantly effected overall Mathematics achievement for CS and TE mediated instructions. Results indicated that Coordinates, Angles, and Functions explained the achievement variance better for CS medium than for TE medium. Whereas Coordinates and Angles had statistically significant effects on

overall achievement for CS instruction, only Coordinates had significant contribution under TE based instruction. The magnitude of the beta and correlation coefficients suggest that CS mediated instruction facilitated the teaching of all the three content areas better than TE mediated instruction. Additionally, CS medium model appeared to organize the teaching of the content areas in a more logical simple-complex order than the TE medium model, that is, Angles, Coordinates and then Functions.

6.2 Recommendations

Generally, the results of this study revealed new insights into Mathematics achievement between groups of pupils taught with different media of instructions. Achievement was higher for pupils taught using CS mediated instruction than for those taught using TE mediated instruction. Teaching using the CS instruction had more improvement effects on achievement than using the English based instruction. A close examination of results also showed that CS mediated instruction worked more effectively with different pupil level characteristics affecting achievement, and facilitated the teaching of content areas better than TE mediated instruction. Additionally, CS medium model appeared to organize the teaching of the content areas in a more logical simple-complex order than the TE medium model, that is, Angles, Coordinates and then Functions. The results of the study and their interpretations suggest three main recommendations.

1. Teaching among bilingual pupils, who are less competent in both Mathematics and English language, requires that teachers use CS mediated instruction more than the norm English mediated instruction. This is because pupils will be provided with cognitive, motivational, and classroom managerial support to learn as the medium of instruction becomes more familiar to them.

2. Teachers need to be cautious when teaching Mathematics using CS based instruction because they may lose meaning of concepts and principles which are aligned to specific mathematical language. Code-Switching should involve the use of English language more for purposes of stating and restating concepts and familiar local language for interpreting, describing and explaining principles and procedures for working out mathematical problems.
3. Since Mathematics performance of girls is generally poor in schools, teachers should use Code-Switching mediated instruction as alternative strategy of teaching given that the majority of pupils in a particular class are girls. Code-Switching seems to favor Mathematics achievement of girls more than boys.
4. Teachers should be cautious when using Code-Switching instruction in classes with the majority of Grade repeaters as Grade repetition seems to have a negative influence on the instruction. Pupils who repeat a Grade seem prone to produce poor Mathematics achievement
5. Teachers should look for strategies to improve Class attendance as it facilitates the use of CS mediated instruction. The instruction appears to work more effectively with improved class attendance.
6. The use of CS mediated Mathematics instruction requires that teachers teach Angles first, then Coordinates followed by Functions which is a more logical simple-complex sequence. Each content area appears to create anchors in the minds of the pupils for learning the next content area.
7. The Ministry of General Education should re-examine the education language policy and make it more flexible for teachers to formally use CS mediated instruction in Schools

which have pupils with low English language competence in peri-urban and rural secondary schools. The formalisation of CS will help teachers not to abrogate the 'use-English-only' policy in their attempt to meet the learning needs of pupils through the use of CS mediated instruction. This goal can be achieved successfully through resolving, at policy level, that CS between English and familiar local languages is a good alternative to teaching secondary school pupils with less competencies in both Mathematics and English language.

6.3 Direction for Future Research

Future research in Code-switching requires a shift from focusing on descriptive oriented studies to quantitative paradigms, especially of the experimental nature, to enable various comparisons between CS and TE mediated instructions. A mere description of learning outcomes as affected by Code-switching mediated instruction makes research results to be highly superficial and inconclusive. Additionally, future research should involve larger scale longitudinal studies to effectively test effects of Code-Switching based instruction in Mathematics teaching. Such studies should evaluate effects of various pupil-, home- and school-level characteristics on Mathematics achievement, and assess the predictive power of specific content areas statistically significantly contributing to pupils' overall achievement. Code-switching based instruction should also involve English and other familiar Zambian languages, besides Nyanja, to test its effects on achievement cross-linguistically. Code-switching should involve the translation of some mathematical concepts from English into familiar local languages to make the use of the CS mediated instruction more relevant and effective in Mathematics teaching.

REFERENCES

- Aden, A. A., Yahye, Z. A. & Dahir, A. M. (2013). Effects of Students' Attendance on Academic Performance: A Case Study of SIMAD University Mogadishu, *Academic Research International*, 4 (6), 409-417.
- Adler, J. & Setati, M. (2002). Researching Mathematics Education and Language Education in Multilingual South Africa. *The Mathematics Educator*, 12 (2), 6-20.
- Ajai, J. T. & Imoko, B. I (2015) Gender Differences in Mathematics Achievement and Retention scores: A Case of Problem-based Learning Method. *International Journal of Research in Education and Science*, 1(1), 45-50.
- Avendaño, C. B. & Belanio, S. L. (2016). *The Effectiveness using Code-Switching in Teaching Math in a Bilingual Classroom*. Polytechnic University: Philippines Bataan.
- Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative and Mixed methods approaches (3rd ed)*. London, UK: SAGE Publications.
- Crotty, M. (1998). *The Foundations of Social Research*. London, UK: Sage Publications.
- Crowther, D. & Lancaster, G. (2008). Research Methods: A Concise Introduction to Research in Management and Business Consultancy. *Educational Researcher*, 18 (7), 4-10.
- Cummins, J. (2000). Educational Implications of Mother Tongue Maintenance in Minority Language Group. *Canadian Modern Language Review*, 38, 503-516.
- Curriculum Development Centre (2013). *Education Curriculum Framework 2013*. Lusaka, Zambia: CDC.
- Ernest, P. (1994). *An Introduction to Research Methodology and Paradigms*. Exeter, UK: RSU, University of Exeter.
- Feilzer, M. Y. (2010). Doing Mixed Methods Research Pragmatically: Implications for the Rediscovery of Pragmatism as a Research Paradigm. *Journal of Mixed Methods Research*, 4, 6 – 16.

- Ferguson, G. (2003). Classroom Code-switching in Post-colonial Contexts: Functions, Attitudes and Policies. *AILA Review*, 16, 38-51.
- Fraenkel, J. R & Wallen, N. E. (2007). *How to Design and Evaluate Research in Education* (7th ed.). New York: McGrawHill.
- Gall, M. D., Gall, J. P. & Borg, W. R. (2007). *Educational research: An Introduction* (8th ed). New York, NY: Pearson.
- Garegae, K. G. (2007). On Code-Switching and the English Language Proficiency: The Case of Mathematics Learning. *International Journal of learning*, 14(3),233-237.
- Gay, L. R., Mills, G. E. & Airasian, P. (2006). *Educational Research: Competence for Analysis and Applications*. New York, NY: Pearson Education Inc.
- Gilbert, S. (1989). *Principles of Educational and Psychological Measurement Evaluation* (3rd edition). London, UK: Wardsworth.
- Gordon, R. (2014). Language of Education Planning in Zambia. *Linguistic Portfolios*, 3(6), 48-57.
- Gotosa, K., Rwodzi, M. & Mhlanga, G. (2013). Language in Education: A Critical Review of Current Proposals for Official Mother Tongue Use in Zimbabwean Classrooms. *International Journal of Humanities and Social Science*, 3 (14), 88-94.
- Gwee, B. S. (2005). *Teacher Code-switching in a Multilingual Classroom*. Singapore: National Institute of Education.
- Hakalo, C. (2014). *Factors Contributing to Girls' Poor Performance in Mathematics in Light of Correctional measures taken at Sesheke Secondary School, Sesheke District, Western Province, Zambian*. Unpublished Masters Dissertation. Lusaka, Zambia: University of Zambia.

- Howie, S. J. (2003). Language and other background factors affecting secondary pupils' performance in Mathematics in South Africa. *African Journal of Research in Mathematics, Science and Technology Education*, 7, 1-20.
- Jabor, M. K., Machtmes, K., Kungu, K., Buntat, Y. B. & Nordin, M. S. (2011), "The Influence of Age and Gender on the Students' Achievement in Mathematics", *IPEDR*, vol.5. pp.304-308.
- Jegede, O. (2011). Code-Switching and Its Implications for Teaching Mathematics in Primary Schools in Ile-Ife, Nigeria. *Journal of Education and Practice*, 2(10), 41-54.
- Jimerson, S. R., Pletcher, S. M. W., Graydon, K., Schnurr, B.L., Nickerson, A. B. & Kundert, D. K. (2006). Beyond Grade Retention and Social Promotion: Promoting the Social and Academic competence of Students, *Psychology in the Schools*, 43(1), 85-98
- John-Steiner, V. (2007). Vygotsky on thinking and speaking. In Daniels, H. Wertsch, J. & Cole, M. (Eds.), *The Cambridge companion to Vygotsky*. New York, NY: Cambridge University Press.
- Kalumbi, D. (2005). *An Investigation into the Relationship between the Professional Qualification of Teachers and Mathematics Academic Performance of Grade Nine Pupils in Basic Schools: A Case Study of Kafue District Schools*. Unpublished Masters Dissertation. Lusaka, Zambia: University of Zambia.
- Kaphesi, E. (2003). The Influence of Language Policy in Education on Mathematics Classroom Discourse in Malawi: the teachers' perspective. *Teacher Development*, 7 (2), 265-285.
- Kavwaya, S. (2009). *Parents' and Teachers' Attitude towards the use of English as Medium of Instruction at Lower Basic Level in Livingstone and Namwala Districts of Southern Province*. Unpublished Masters Dissertation, Lusaka: University of Zambia.
- Kreiner, D. S. (2011). Language and Culture: Commonality, Variations and Mistaken assumption. In Keith, K.D. (Ed). *Cross-cultural Psychology: contemporary themes and perspectives*. Sussex: John Wiley & Sons.

- Lightfoot, C., Cole, M. & Cole, S. R. (2009). *The Development of Children (6th ed.)*. New York: Worth Publishers.
- Mahofa, E. (2014). *Code-Switching in the Learning of Mathematics Word Problems in Grade 10*. Unpublished Masters Dissertation. Cape Peninsula, South Africa: University of Technology.
- Martin, P. (2005). Safe Language Practices in Two Rural Schools in Malaysia: Tensions between Policy and Practice. In A. M. Lin and P. W. Martin (Eds.), *Decolonisation, Globalization: Language-in-Education Policy and Practice* (pp. 74-97), Clevedon, UK: Multilingual Matters.
- Mbewe, T. L. (2013). *Misconceptions and Errors in Algebra at Grade 11 Level: The Case of Two Selected Secondary Schools in Petauke District*. Unpublished Masters Dissertation. Lusaka, Zambia: University of Zambia.
- Md-Ali, R. Mohd-Yusof, F. & Veloo, A. (2014). Mathematics Teachers Discourse Practices in Teaching Lesson Content Using Non-native Language. *The European Journal of Social & Behavioural Sciences*, 1, 1367-1373.
- Ministry of Education (1977). *Educational Reform: Proposals and Recommendations*. Lusaka, Zambia: Government of the Republic of Zambia Printer.
- Ministry of Education. (1996). *Educating our Future - National Policy on Education*. Lusaka, Zambia: Zambia Education Publishing House.
- Moji, N. C. & Grayson, D. J. (1993). Physics Concepts in Mother Tongue. *SAARMSE Proceedings, First Annual Conference*, January 1993, Rhodes University, RSA.
- Molotja, T. W. (2008). *Code-switching as a Teaching and Learning Strategy in Mathematics Classes: A Case of Sekgose East Circuit Schools*. Unpublished Masters Thesis. Limpopo, RSA: University of Limpopo.

- Moschkovich, J. (2004), Using Two Languages When Learning Mathematics. [Online] Available:<http://math.arizona.edu/~cemela/spanish/content/workingpapers/UsingTwoLanguages.pdf> (March 20, 2008)
- Mwape, J. & Musonda, A. (2014). A Investigate in the Teaching and Learning of Mathematics at Senior Secondary School Level in Solwezi District. *Journal of Mathematics*, 1 (6), 1-25.
- Myers-Scotton, C. (1993). Common and uncommon ground: Social and structural factors in Code-Switching. *Language in Society*, 22(4), 475-503.
- Myers-Scotton, C. (1995). *Social Motivations for Code-Switching: Evidence from Africa*. Oxford, UK: Oxford University Press.
- Myers-Scotton, C. (1998). *Codes and Consequences: Choosing Linguistic Varieties*. Oxford, UK: Oxford University Press.
- Myers-Scotton, C. (2001). The Matrix Language Frame Model: Development and Responses. In R. Jacobson (Ed.), *Code-Switching Worldwide II* (pp.23-56). Berlin, Germany: Mouton de Gruyter.
- Myers-Scotton, C. (2006). How Code-Switching as an Option Empowers Bilinguals. In J.A. Aertselaer, M. Pütz & J.A. Fishman (Eds.) *Along the routes to Power* (pp. 73-86). Berlin, Germany: Mouton de Gruyter.
- Nakawa, N. (2011). Investigation on Students' Learning Process and their Challenges From Grade 5 Lessons of Number Bricks in the Central Province in Zambia. *Journal of JASME Research in Mathematics Education*, 17(1), 9- 15.
- Nakawa, N. (2012). Growth and Challenges Two Basic Schools Teachers under the Practice of lesson Development Based on Substantial Learning Environment (SLE) in the Republic of Zambia. *Journal of JASME Research in Mathematics Education*, 18 (2), 13-21.

- Neo, N. & Heng, B. (2012). Reporting Qualitative Data Quantitatively: Code-Switching in Mathematics Classrooms. *US-China Education Review A*, 7, 639-649
- Nkolola-Wakumelo, M. (2013). A critical analysis of Zambia's language-in-education policy: Challenges and lessons learned. In McIlwraith, H. (Ed.), *Multilingual Education in Africa: Lessons from the Juba Language-in-Education Conference* (pp.127-146) London, UK: British Council.
- Noren, E. (2007). Bilingual students' mother tongue: A resource for teaching and learning mathematics. *Nordic studies in Mathematics Education*, 13(4), 29-50.
- Ntahontuye, J.B. (2010). *Effect on Formative Evaluation on Academic Performance in Mathematics: A Case of Upper Basic Schools in Lusaka District*. Masters Dissertation. Lusaka: University of Zambia.
- Nyambura, N.G. (2015). *Code-switching as a Communication Strategy in Secondary Schools: A Case Study of St. Francis Girls' High School, Mang'u*. Unpublished Master's Dissertation, Nairobi, Kenya: University of Nairobi.
- Ochwo, P. (2013). *Pupils, Teachers, and School Factors that Influence Student Achievement on the Primary Leaving Examination in Uganda: Measure Development and Multilevel Modelling*. Unpublished doctoral dissertation. Ohio, USA: Kent State University.
- Payawal-Gabriel, J. & Reyes-Otero, M. (2006). Comprehensible Input Strategies and Pedagogical Moves using Filipino/English as Medium of Instruction in Secondary Mathematics. *Education Quarterly*, 83- 97.
- Planas, N. & Setati, M. (2009). Bilingual Students using their Languages in the Learning of Mathematics. *Mathematics Education Research Journal*, 21(3), 36-59.
- Ralenala, M.F. (2004). *Reading Behaviour of First-Year Physics Students at the University of the North*. Unpublished doctoral thesis. Johannesburg, RSA: Rand Afrikaans University.

- Salami, L. O. (2008). It Is Still Double Take: Mother Tongue Education and Bilingual Classroom Practice in Nigeria. *Journal of Language, Identity and Education*, 6(4), 1-23.
- Salehmohamed, A. & Rowland, T. (2014). Whole-Class Interactions and Code-Switching in Secondary Mathematics Teaching in Mauritius. *Mathematics Education Research Journal*, 26(3), 555-577.
- Santrock, J. W. (2011). *Educational Psychology*, 5th ed. Boston, MA: McGraw-Hill.
- Sari-Hamzah-Refnaldi, D. A. W. (2013). The Use of Code-Switching Uttered by Math and Natural Science Teachers and Students' Perception toward it. *Journal of English Language Teaching*, 1 (3), 32-40.
- Senyatsi K. K.(2012). *An Analysis of Code-Switching as a Learning and Teaching Strategy in Selected Multilingual Schools of Limpopo Province*. Unpublished Masters Dissertation. Limpopo, RSA: University of Limpopo.
- Setati, M. and Adler, J. (2001). Between Languages and Discourses: Code-Switching Practices in Primary Classrooms in South Africa. [Online] Available: <http://www.mai.liu.se/~chber/workshop/Setati&Adler.pdf> (March 19, 2008)
- Setati, M., Adler, J., Reed, Y., & Bapoo, A. (2002). Incomplete Journeys; Code-Switching and Other Language Practices in Mathematics, Science and English Language Classrooms in South Africa. *Language and Education*, 16(2), 128-149.
- Setyaningrum, W. (2015). *Learning Mathematics in English for Indonesian Students: An Investigate into Code-Switching Practices, Obstacles and Attitudes*. PhD thesis. Dundee, Indonesia: University of Dundee.
- Shin, S. J. (2005). *Developing in Two Languages: Korean Children in America*. Clevedon, UK: Multilingual Matters.
- Simasiku, L. Kasanda C. & Smit, T. (2015). Can Code-Switching Enhance Learners' Academic Achievement? *Journal of English Language Teaching*, 8(2), 70-77.

- Simon, D. L. (2001). Towards a New Understanding of Code-Switching in the Foreign Language Classroom. In R. Jacobson (Ed.) *Code-Switching Worldwide II*, pp. 311–342. Berlin, Germany: Mouton de Gruyter.
- Tammaso, M. L. D., Mendolia, S., & Contini, D. (2016). The Gender Gap in Mathematics Achievement: Evidence from Italian Data. *IZA Discussion Papers, No.10053*, 1-23.
- Thompson, B. (2006). *Foundation of Behavioural Statistics: An-Insight-Based Approach*. New York, NY: The Guilford Press.
- Turuk, M. C. (2008). The Relevance and Implications of Vygotsky’s Socio-Cultural Theory in the Second Language Classroom. *ARECLS, 5*, 244-262.
- United Nations (2010). *World Data on Education (7th ed.)*. International Bureau of Education. <http://www.ibe.unesco.org>.
- Viriri, E. & Viriri, M. (2013). The Prevalence of Code-Switching in Secondary Schools Where English is the Official Medium of Instruction: A Case Study of Buhera South District. *International Journal of Academic Research in Progressive Education and Development, 2*(1), 227-234.
- Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press.
- Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Mental Processes*. Cambridge, MA: MIT Press.
- Webb, L. & Webb, P. (2008). Introducing Discussion into Multilingual Mathematics Classrooms: An issue of Code-Switching. *Pythagoras, 67*, 26-32.
- Wertsch, J. V. (1985). *Vygotsky and the Formation of Mind*. Cambridge, MA: Harvard University Press.
- Yamat, H., Maarof, N., Maasum, T. N. T. M., Zakaria, E. and Zainuddin, E. (2011). Teacher’s Code-Switching as a Scaffolding in Teaching Content Area Subjects. *World Applied Sciences Journal, 15*, 18-22.

Yew, J. M. & Nathan, J. (2008). Language Effects on Mathematics Learning among Secondary School Students: A Study on Form One Students from Malacca. *International Journal of Academic Research*, 2(2), 6-16.

Yohannes, M. A. G. (2009). Implication of the Use of Mother Tongues versus English as Language of Instruction for Academic Achievement in Ethiopia. In Brock-Utne, Birgit and Skattum, Ingse. (eds.) *Languages and Education in Africa: A Comparative and Transdisciplinary Analysis*. Oxford, UK: Symposium Books. Pp. 189-199

APPENDICES

Appendix – A: Teacher’s English-Nyanja CS Mediated Instruction Guide

1.0 Cognitive functions

The teacher will use English-Nyanja CS mediated instruction in the teaching of Mathematics to:

- Explain and clarify mathematical concepts, principles, laws and methods.
- Interpret mathematical content.
- Check if pupils have understood the subject matter.
- Express mathematical content easily.
- Emphasise a point to strengthen understanding.
- Repeating what has already been explained.

2.0 Motivational functions

The teacher will use English-Nyanja CS mediated instruction in the teaching of Mathematics to:

- Tighten teacher-pupil interrelationships.
- Urge each pupil to participate in the classroom.
- Reduce pupils’ anxiety in learning Mathematics.
- Reinforce Mathematics material.
- Boost pupils’ morale and confidence in learning Mathematics.
- Provide praise, feedback and remarks about pupils’ performance in Mathematics.

3.0 Classroom management functions

The teacher will use English-Nyanja CS mediated instruction in the teaching of Mathematics to:

- Organise learning activities and lessons.
- Maintain discipline through already established school rules.

4.0 Samples of English-Nyanja Code-Switching in teaching Mathematics

4.1 Coordinates

4.1.1 Sitting plans

Kuti tinvesese ma coordinates tiyeni tiyangane pa sitting plan yama desks within this classroom. Aya ma-lines yama-desks we call them columns. These other lines of the same desks tiyaitana ati ma rows. Let us give ma letters kuma columns yama desks nama numbers kuma rows yama desks yamene aya. So we have ma columns A, B, C, D na E. Ma rows they are how many? 1, 2, 3, 4, 5, 6. To find the coordinates ya desk yabene John na Rebecca, tiyambilila kupeza column ya desk yabo – they are in column A. Then tipeza number ya row mwamene bankala – which is 3. So position ya desk ya John na Rebecca has the coordinates (A, 3). Iyi point ti yikamba ati A comma 3.

4.1.2 The XOY-Plane

This plane is made up of two number lines; Yamane ya joinana apa pa point pamene ti-itana ati pa origin. Iyi number line yamene isonta ku East we call it x-axis. This one which points kumwamba ku North ti-itana ati y-axis. Yonse ma number lines aya mwamene mwaonela start from 0 and yachita include positive ma positive numbers. But tingaitalimpise x-axis ku west to include ma negative numbers; na y-axis pansu ku South to include ma negative numbers. You can do at least four things on the XOY-Plane 1) tingachite plot point kusebenzesa ma coordinates (x, y) 2) tingachite read off or kupeza ma points yamene bachita kudala plot 3) tinga drawing'e line to join ma points 4) futi tingapeze distance ya line which joins two points.

4.1.2.1 Example: *Iyi question ikamba ati muchite plot ma points A (2, 2), B(10, 2), C(10, 5) and D (2, 5). Then ujoinize ma points aya with a straight line, kuyambila pa A, B, C nakusilizila pa D. (a) Ni shape bwanji yamene tichita form pa XOY-plane? (b) Pezani perimeter ya shape iyi. First tell me, perimeter nichani? (c) Find the area of the shape. Tikakamba area ti-meaning'a Malo.*

4.1.2.2 Positive and negative coordinates

If we extend the x-axis and the y-axis *ku-ikilako nama* negative numbers, *tipanga* XOY-plane *yonse ikulu*. Iyi x-axis na y-axis *yachita* divide XOY-plane *yatu* into four equal parts. *Tingapeze ma* negative coordinates *yama* points *mwamene* *tipezela ma* positive coordinates *yama* points; and we can plot on the XOY-plane in the same way we plot the positive ones. (a) Given the coordinates of the points A, B, C and D *pa* XOY-plane, x-coordinate *ya* A *ni* 4 and y-coordinate *ni* 2. So point *yatu ni* A(4, 2). The x-coordinate of B is 3 and the y-coordinate is -3. Therefore, B(3, -3). *Kuchita sochabe*, we get C(-4, -5) and D(-2, 3). (b) Plot the points P(-3, 4), Q(3, -4), R(-5, -2) and S(0, -5) on the XOY-plane. *Kuti tichite* plot point P, *tipenda ma* steps 3 *kuchokela* *pa* origin *pa* 0 *kuyenda ku* left until you reach *pa* -3, then *ma* steps *yali* 4 *kuyenda kumwamba*. To plot point Q *uyenda* 3 steps *ku* right *kuchokela* *pa* 0 *kufika* *pa* 3, then 4 steps *kuyenda pansi*. In the same way, *mungapeze ma* positions *ya* R *na* S.

4.2 Angles

An angle is an amount of turning. *Ti-meaning'a* *ati* angle *nikuseguka kwama* straight lines *yabili yamene yachita* join *pa* point *pamozi*. When the lines are closed up, *siyanaseguke*, the angle formed is 0° . So line *imozi ingaseguke* 1° , 5° , 15° , 20° up to 360° *kuchokela ku* line *inangu*. An example is that of a wall clock, *nkoloko yakuchiumba: pamene ka* hand *kama* minutes *ka-moving'a* *kuchokela kuli kama* hours, it makes different angles. If they are both pointing at 12, *nishi* angle *yaseguka ni* 0° . If the short hand points at 12 and the longer points at 3, *nishi* angle *yaseguka ni* 90° ; at 6 *nishi yaseguka* 180° ; at 9 it makes 270° ; and *kubwelela futi pa* 12 it makes 360° , complete revolution or *kuzunguluka*.

4.2.1 Kinds of angles

Muzibako ma types *bwanji yama* angles? Acute angle *iseguka bwanji*? Right angle *iliyonse ilina ka-square pa* corner *pamene pajoinana ma* lines *yabili* and it is always equal to 90° . *Ti-itana bwanji* angle *yamene ichita* open between 90° and 180° ? Straight line *iliyonse ilina* how many

degrees? Reflex angle opens *pakati paiti naiti* angle? Straight line *ikaseguka nakuzunguluka* so that it goes back where it started from, *nishi yapanga* angle *bwanji*?

4.2.2 Naming angles

The symbol of angle is \angle . *Tingachite* name angle using the symbol \angle and *ma* capital letters *yatatu monga so* $\angle ABC$, letter *yapakati ilangiza point* where an angle is formed. *Ma* letters *yali mumbali yalangiza posilila ma* lines. We can also name angles *nakuikamo ka* small letter *mukati mwa* angle, *monga so* $\angle x$.

4.2.3 Related angles

Complementary angles – *Ma* angle *yaliyonse yabili mukayachita* add *yakakupasani* 90° . If angles x and y are complementary angles, *nanga* angle y *izankala zingati ngati* angle x *ni* 65° .
Supplementary angles – Any two angles which add up to 180° . *Ngati imozi ni* 150° *nishi inangu ni* 30° .
Angles on a straight line – A straight line is always equal to 180° , so *ngati ma* angle $\angle a, \angle b, \angle c$ and $\angle d$ *yali pa* straight line, we can add them up to get 180° . For example $\angle a + \angle b + \angle c + \angle d = 180^\circ$. *Ma* vertically opposite angles *yamankala* equal all the time. Example *niyama* angles *yamene yaseguka pakati pa* scissors, *kumwamba na pansi*, and *ku right na ku left*.
Angles at a point *yachita* add up to 360° . *Ngati pa point pali ma* angles *yali* four, $45^\circ, 150^\circ, 60^\circ$ and 105° *yafunika kukupasa* 360° . For example, $45^\circ + 150^\circ + 60^\circ + 105^\circ = 360^\circ$.

4.2.4 Angles associated with parallel line

Corresponding angles are always equal. *Aya ma* angles *yachita* form *ku side kumoz*i *kwa transversal* on different parallel line *pa position pa* same. Alternate angles are always equal. *Aya ma* angles *yachita* form *kuma sides kosi*yana *kwa transversal* on different parallel line *pa position pa* same. *Ma* interior angles on the same side of the transversal add up to 180° . *Aya ma* angles *yachita* form *ku side kumoz*i *kwa transversal* but on different parallel lines *pa position posiyana*.

4.2.5 Angle properties of a triangle

The sum of angles in a triangle is 180° . *Ti-meaning'a ati ma* angles yatatu yali mukati mwa triangle yafunika kukupasani 180° mukayachita add. If you are given two interior angles, ungapeze imozi yamene sibanatipase. Add the given two and then *muchite* subtract *muli* 180° . The exterior angle of a triangle is equal to the sum of the two opposite interior angles. *Ti-meaning'a ati ma* angles aya yali uku ku opposite side mukati mwa triangle mufunika kuya adding'a kuti mupeze iyi yakunja.

4.3 Functions

4.3.1 Relations

A relation is an association of elements in set A with those in set B. *Ti-meaning'a ati* relation nikuyendelana kwa ma elements yamu set A nayamuli set B. A relation is based on a rule. Iyi rule ilengesa ma elements ya set A yayendelane or yasayendelane nama elements ya set B. For example if $S = \{1, 2, 3, 4\}$ and $T = \{2, 4, 6, 8\}$, define (a) Relation from S to T (b) Relation from T to S. Question *ikamba ati ma* elements yama sets aya yayendelana na rule yabwanji? (a) From S to T: 1 is half of 2, 2 is half of 4, 3 is half of 6 and 4 is half of 8. Relation from S to T *inkala ati* "is half of". (b) From T to S: 2 is twice 1, 4 is twice 2, 6 is twice 3, and 8 is twice 4. So relation from T to S *inkala ati* "is twice".

4.3.1.1 Types of relations

Kuli ma types yali four yama relations: One to one – *Muli iyi* relation element *imozi mu* set A *iyendelana na* element *imozi mu* set B. One to many – In this relation one element in set A matches with many elements in set B. Many to one - *Ma* elements *yambili mu* set A *yaendelana nama* elements *yang'ono mu* set B. Many to many – Many elements in set A matches with many elements in set B.

4.3.2 Mappings

Mapping ti-itana futi ati function; mapping ni instruction yamu Mathematics for example take any number muchite multiply by 2 and muchite add 5 kuti mupeze answer. If the number you take is 2, multiply it na 2 and muchite add 5 as follows: $(2 \times 2) + 5 = 9$.

4.3.2.1 Notation

Notation *imeaning'a mwamene tilangizila ati iyi ni mapping*. For example in the instruction “take any number, multiply it by 2 and then add 5”, let that number be x , then *tilangiza* mapping or function so: $f(x) = 2x + 5$ or $f: x \rightarrow 2x + 5$. Always remember for a function there is only one image to the object. *Ti-meaning'a ati* one element in set A *ifunka ku-matching'a na* element imozi mu set B *kuti tinkale na* function.

4.3.2.2 Types of functions

One to one – Under this function on element in set A has only one image in set B. *Ti-meaning'a ati iliyonse* element in set A *iyendelana chabe na* element imozi mu set B. Many to one – Under this function, set A has *ma* elements *yambili kuchila* set B, and then each element in set A has only one image in set B. Note: These types of functions just like relations *tingayalangize na kuyaziba pama* arrow diagrams.

Appendix – B: Mathematics Lesson Plan

Teacher:

Class:

Subject:

Attendance – Boys: Girls:

Topic:

Date:

Lesson:

Duration:

Teaching/learning Aids:

Reference(s):

Objectives (PSBAT):

Introduction (Duration):

Lesson development (Duration):

Step/ Duration	Content	Methodology	
		Teacher activity	Pupil activity

Conclusion (Duration):

Follow-up assessment (Duration):

Lesson Evaluation:

Appendix – C: Mathematics Pre-test

Pupil level characteristics

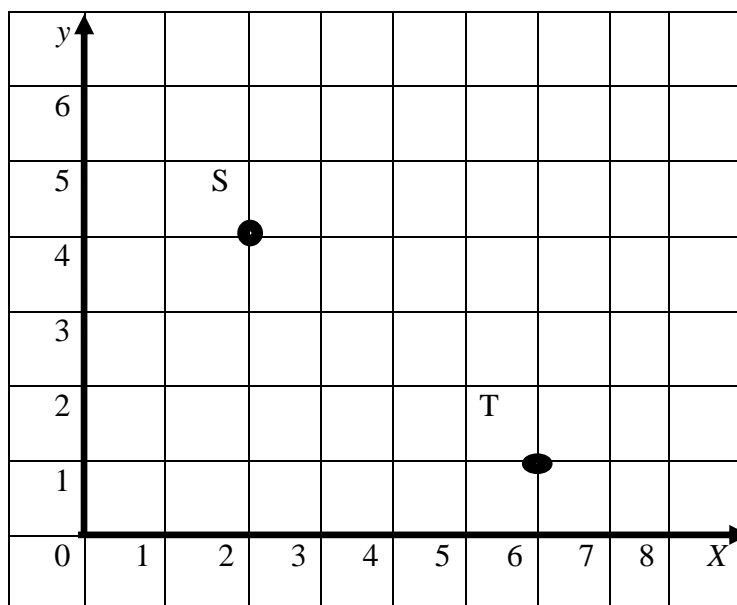
1. Gender: Boy Girl
2. Age
3. Class Attendance
4. Number of times repeated Grade Eight

Instructions

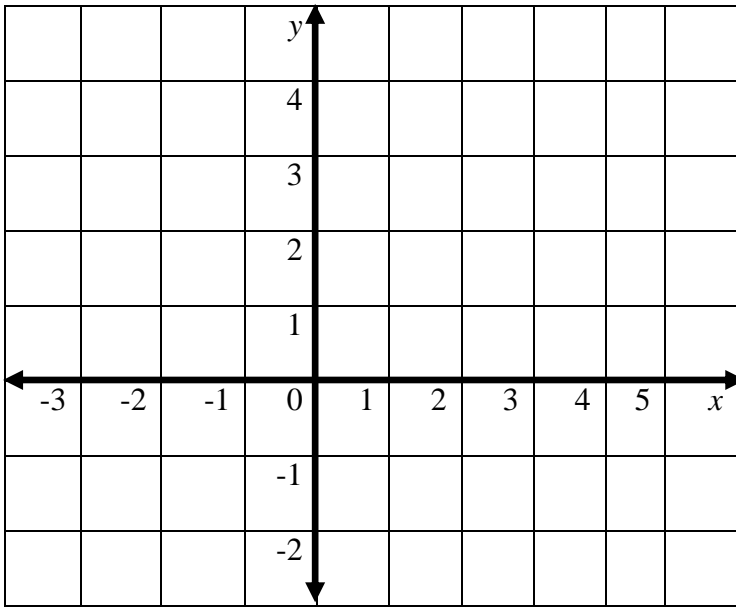
- a. The test will take 2 hours.
 - b. Answer **all** the questions on the spaces provided.
 - c. Show your working.
 - d. Omission of essential working will result in loss of marks.
-

SECTION A – COORDINATE SYSTEM [15 Marks]

- 1) What are the x -coordinate of the points $A(-8, 5)$ and $B(9, 6)$?
- 2) What are the y -coordinate of the points $M(0, 13)$ and $N(9, -3)$?
- 3) From the XOY – plane below, what are the coordinates of the points S and T?



4) Plot the points $P(5,5)$ and $Q(-1, 0)$ on the XOY – plane given below.

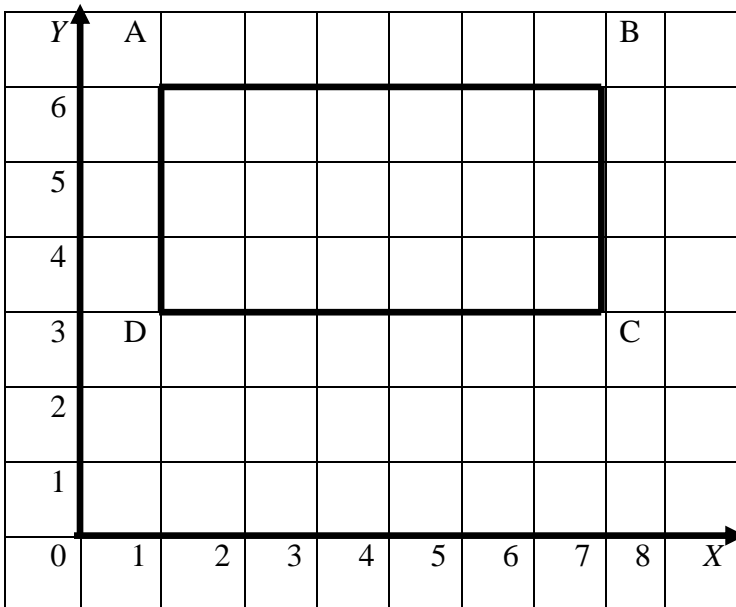


5) Draw the graph of the equation $y = -2$

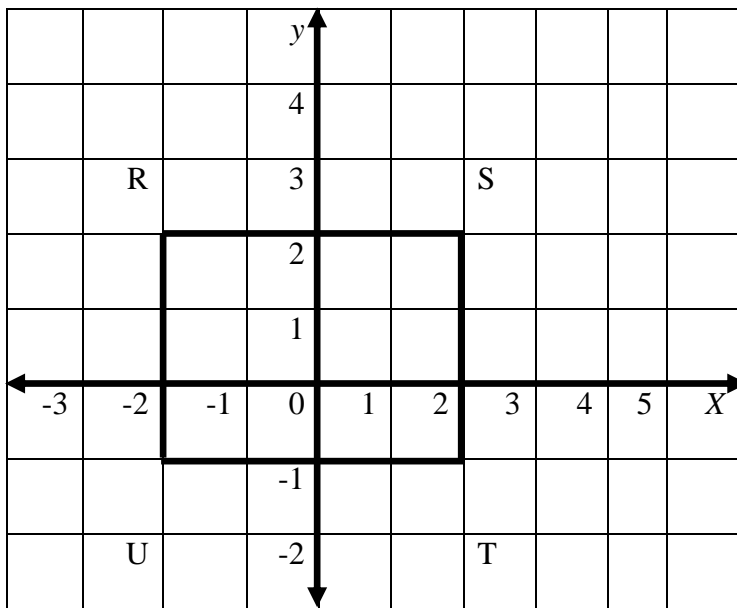
6) What is the x -coordinate of the point half-way between 8 and 11 along the x -axis?

7) Find the intersection point of the graphs $x = 5$ and $y = -4.5$

8) Calculate the perimeter of a rectangle ABCD on the XOY – plane below.



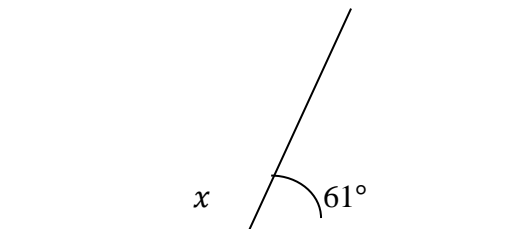
9) Find the area of a square RSTU on the XOY – plane below.



10) Draw the graph of $-2x + 3y = 6$.

SECTION B – ANGLES [15 MARKS]

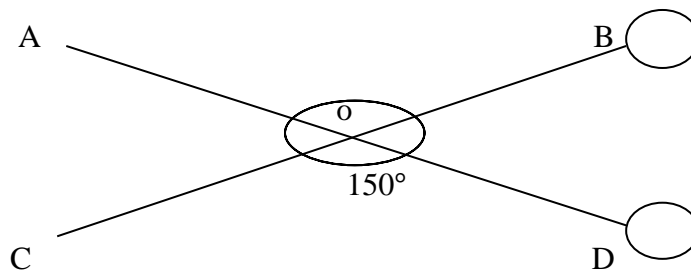
11) In the diagram below calculate the size of the angle marked x .



12) Angles a and b are complementary angles. What is b if $a = 24^\circ$

13) If angle $\angle AOB$ and $\angle COD$ are vertically opposite angles of a scissors, find $\angle AOB$ if

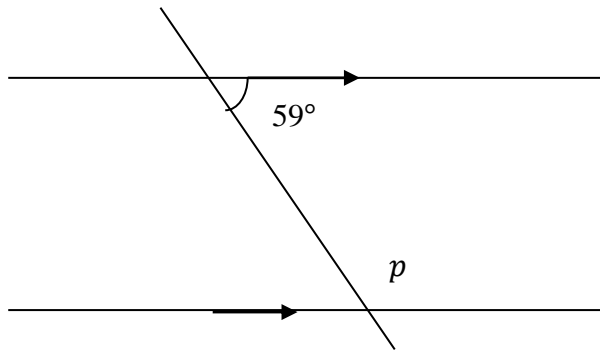
$\angle COD = 150^\circ$.



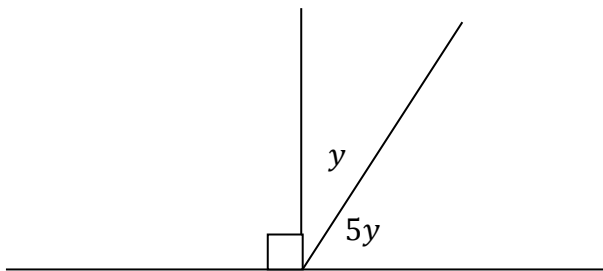
14) If 60° and 60° are two angles of a triangle, calculate the value of the third angle.

15) Express 270° as a fraction in its lowest terms.

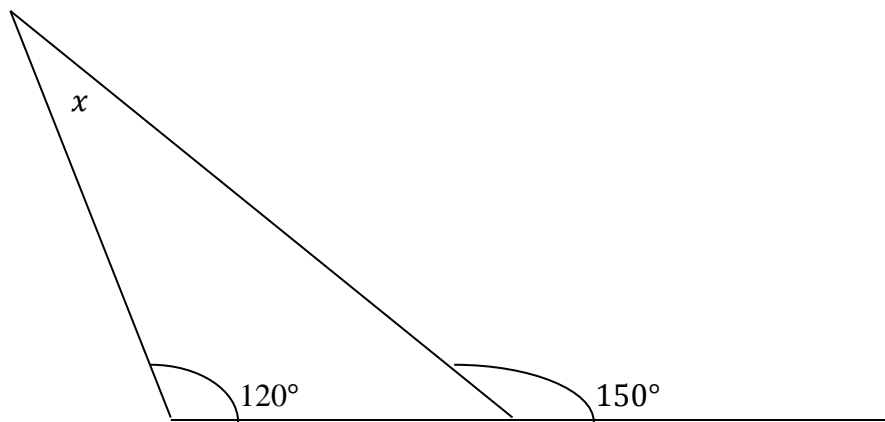
16) In the diagram below, find angle p .



17) In the diagram below, calculate the size marked angle y .

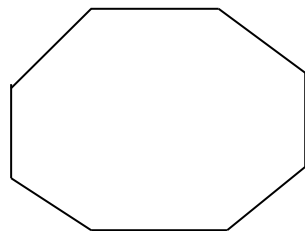


18) Find $\angle x$ in the diagram below.



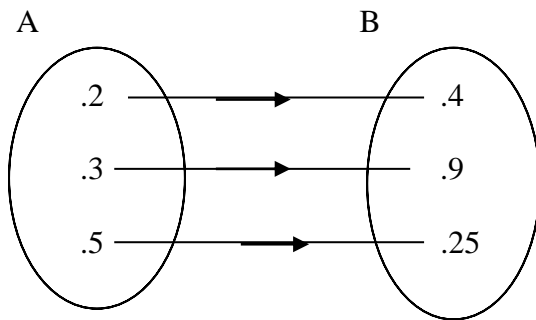
19) Calculate the size of interior angles of a regular Hexagon.

20) Find the sum of interior angles of a regular polygon below.

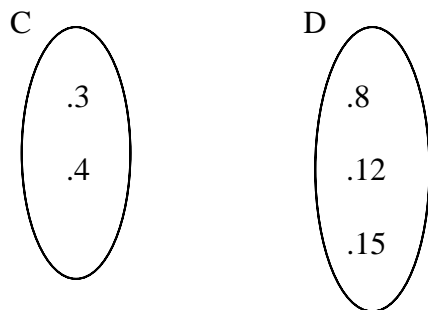


SECTION C - FUNCTIONS [15 MARKS]

21) Name the type of a relation given below.



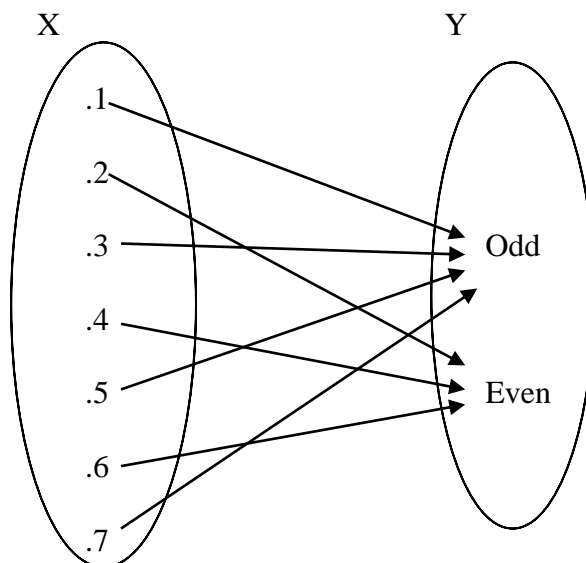
22) Use arrows to represent the relation “is a factor of” between set C and set D.



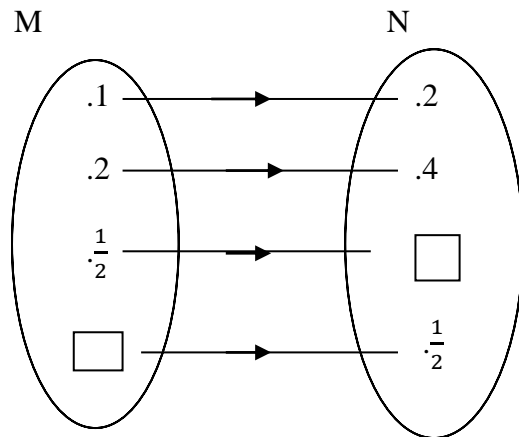
23) If $S = \{1, 2, 3, 4\}$ and $T = \{2, 4, 6, 8\}$ define a relation from S to T.

24) If $A = \{1, 2, 3, 4\}$ and $B = \{3, 6, 9, 12\}$. Draw a one-to-one arrow diagram between A and B representing a relation “times 3 is”.

25) Is the following arrow diagram representing a relation or a mapping?



26) Complete the arrow the arrow diagram between set M and set N which represents a relation “is half of”.



27) If $f(x) = 4x + 3$, find i. $f(0)$ ii. $f(-2)$

28) If $f(y) = 10 - 5y$, find the value of y for which $f(y) = 0$.

29) If $f(x) = ax - 3$, and $f(3) = 3$, find the value of a .

30) If $g(x) = ax^2 + 2x + 1$ and $g(2) = 9$. Find value of a .

Appendix – D: Mathematics Post-test

Pupil level characteristics

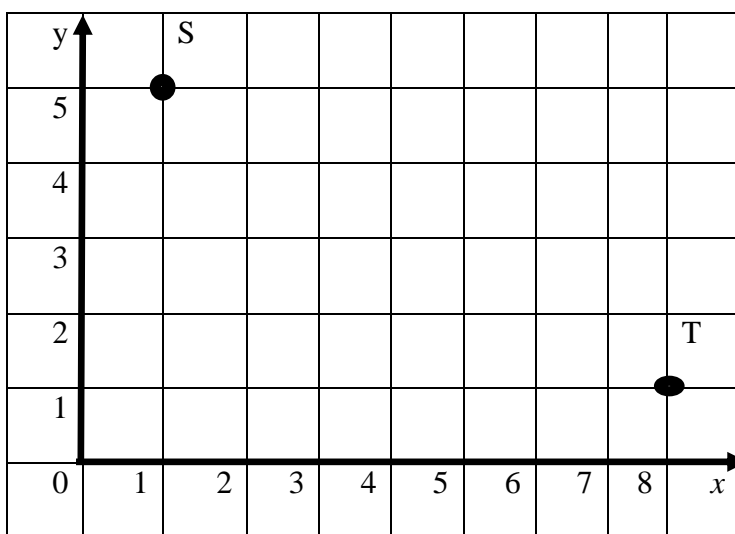
1. Gender: Boy Girl
2. Age
3. Class Attendance
4. Number of times repeated Grade Eight

Instructions

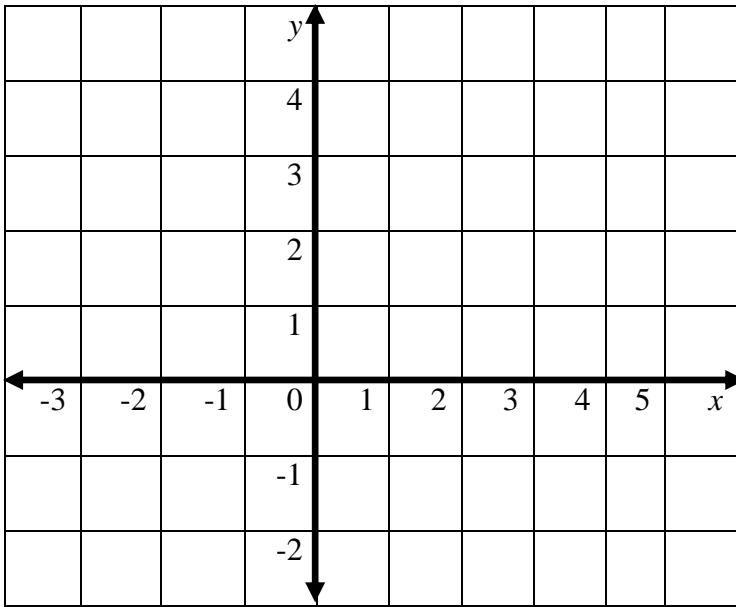
- a. The test will take 2 hours.
 - b. Answer **all** the questions on the spaces provided.
 - c. Show your working.
 - d. Omission of essential working will result in loss of marks.
-

SECTION A – COORDINATE SYSTEM [15 Marks]

- 1) What are the x -coordinate of the points $A(-2, 1)$ and $B(2, 3)$ 2)?
- 2) What are the y -coordinate of the points $M(0, 9)$ and $N(7, -4)$?
- 3) From the XOY – plane below, what are the coordinates of the points S and T?



4) Plot the points $P(5,3)$ and $Q(-2, 0)$ on the XOY – plane given below.

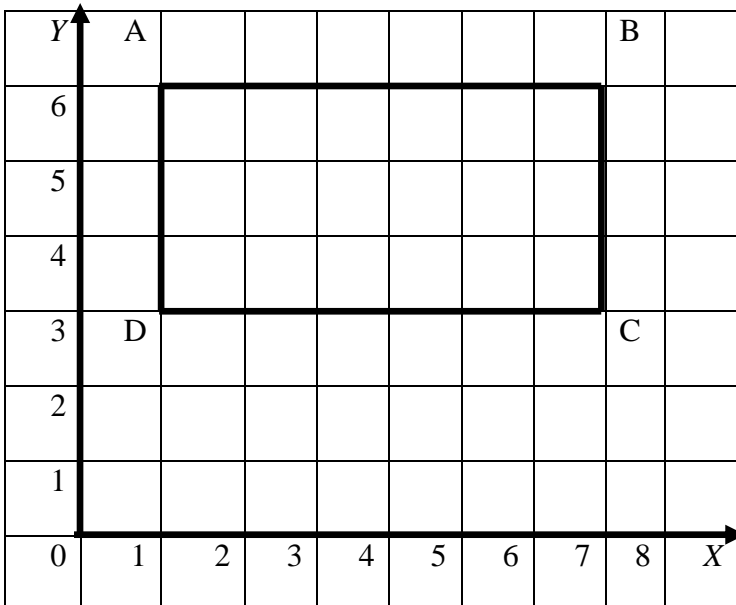


5) Draw the graph of the equation $y = -1$.

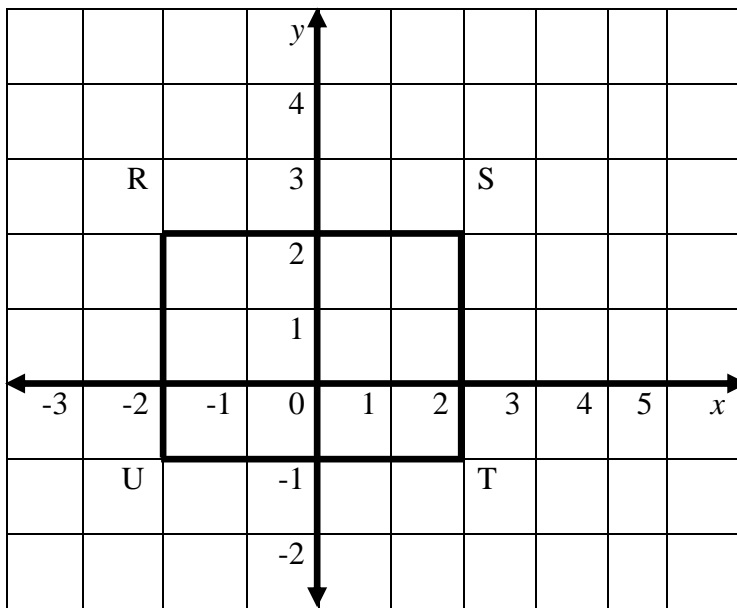
6) What is the xx -coordinate of the point half-way between 8 and 9 along the xx -axis?

7) Find the intersection point of the graphs $x = 7$ and $y = -4.5$.

8) Calculate the perimeter of a rectangle ABCD on the XOY – plane below.



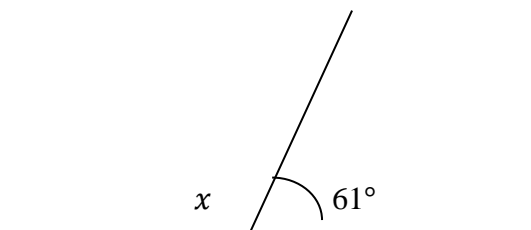
9) Find the area of a square RSTU on the XOY – plane below.



10) Draw the graph of $-2x + 3y = 6$

SECTION B – ANGLES [15 MARKS]

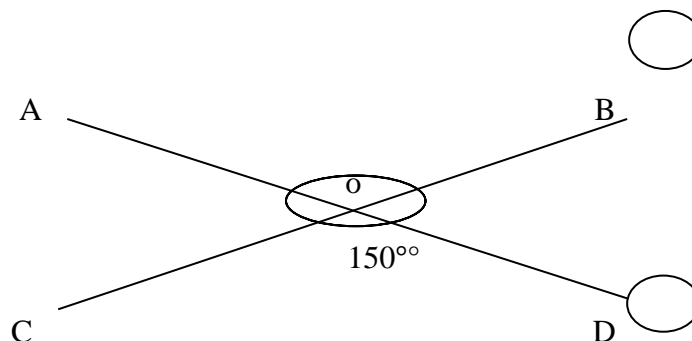
11) In the diagram below calculate the size of the angle marked x .



12) Angles a and b are complementary angles. What is b if $a = 13^\circ$?

13) If angle $\angle AOB$ and $\angle COD$ are vertically opposite angles of a scissors, find $\angle AOB$ if \angle

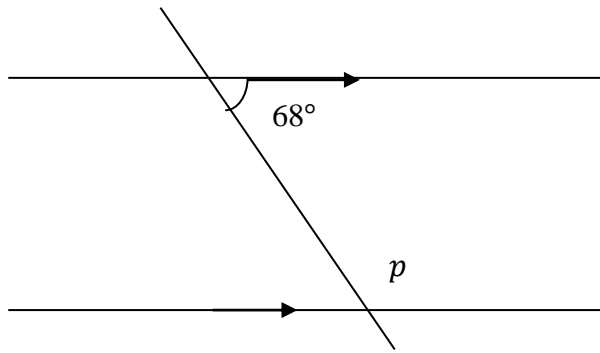
$COD = 150^\circ$.



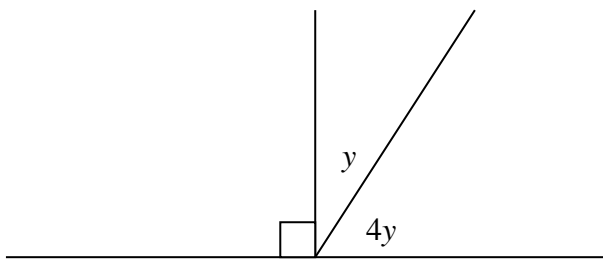
14) If 60° and 60° and 60° are two angles of triangle, calculate the value of the third angle.

15) Express 270° as a fraction in its lowest terms.

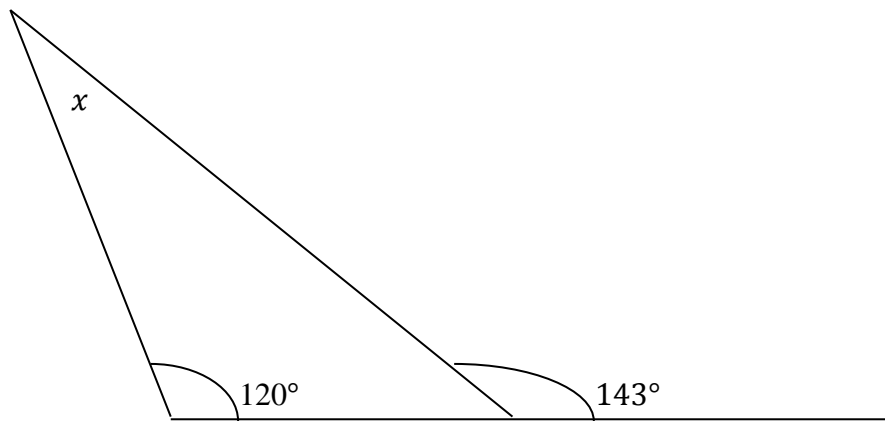
16) In the diagram below, find angle p .



17) In the diagram below, calculate the size marked angle y .

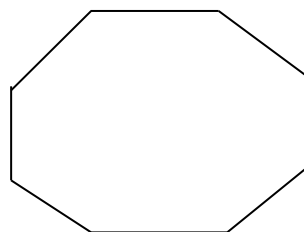


18) Find $\angle x$ in the diagram below.



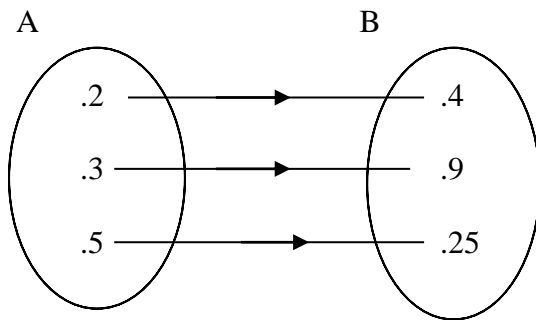
19) Calculate the size of interior angles of a regular pentagon.

20) Find the sum of interior angles of a regular polygon below.

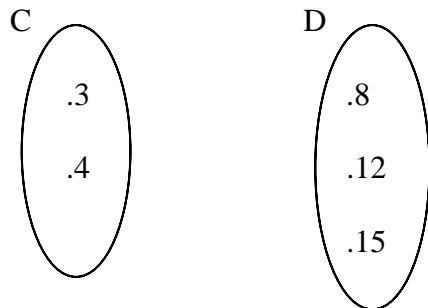


SECTION C - FUNCTIONS [15 MARKS]

21) Name the type of a relation given below.



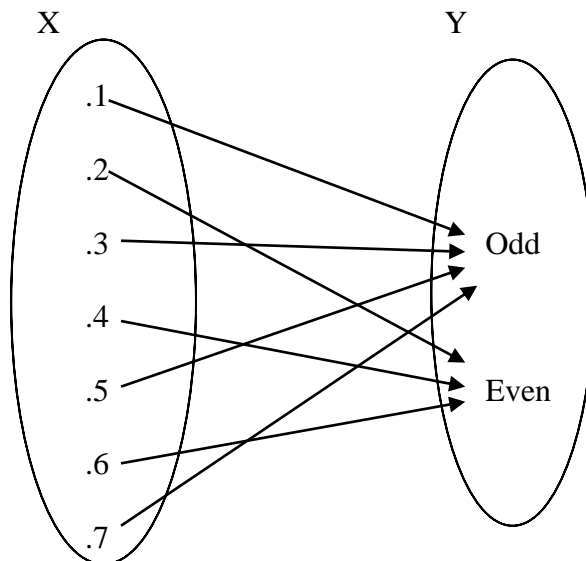
22) Use arrows to represent the relation “is a factor of” between set C and set D.



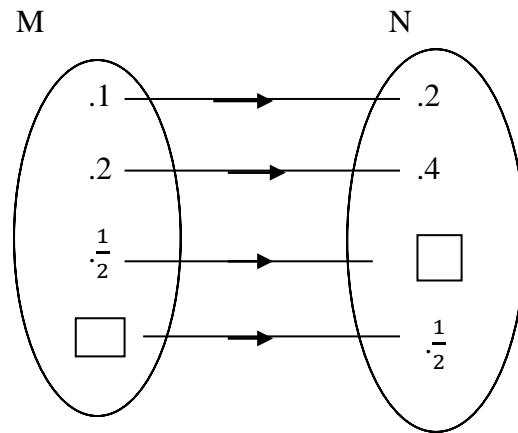
23) If $S = \{1, 2, 3, 4\}$ and $T = \{2, 4, 6, 8\}$ define a relation from S to T.

24) If $A = \{1, 2, 3, 4\}$ and $B = \{3, 6, 9, 12\}$. Draw a one-to-one arrow diagram between A and B representing a relation “times 3 is”.

25) Is the following arrow diagram representing a relation or a mapping?



26) Complete the arrow diagram between set M and set N which represents a relation “is half of”.



27) If $f(x) = 4x + 3$, find i. $f(0)$ ii. $f(-2)$

28) If $f(y) = 10 - 5y$, find the value of y for which $f(y) = 0$.

29) If $f(x) = ax - 3$, and $f(3) = 3$, find the value of a .

30) If $g(x) = ax^2 + 2x + 1$ and $g(2) = 9$. Find value of a .