# MASTERY OF BASIC MATHEMATICAL CONCEPTS AMONG SECONDARY SCHOOL TEACHERS AND STUDENTS IN MBEYA REGION, TANZANIA

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT FOR THE REQUIREMENTS OF THE DEGREE OF MASTER OF EDUCATION IN ADMINISTRATION PLANNING AND POLICY STUDIES OF THE OPEN UNIVERSITY OF TANZANIA**

**2018**

## CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the Open University of Tanzania a Dissertation entitled: ñMastery of Basic Mathematical Concepts Among Secondary School Teachers and Students in Mbeya Region, Tanzaniaò in fulfilment of the requirements for the award of Degree of Masters of Education in Administration Planning and Policy Studies of the Open University of Tanzania.

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(Supervisor)

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Date

## COPYRIGHT

## DECLARATION

I, Agrey Masebo, do hereby declare that this dissertation is my own original work and that it has not, and will not be presented for a similar or any other award to any other university.

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Signature

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Date

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## DEDICATION

I dedicate this work to my lovely parents, my father Mr. Israel Ambonisye Masebo and my mother Christina Mwotela together with my lovely wife Suzana Masebo, my beloved daughters, Dorlin A. Masebo and Eunice A. Masebo and my son Evan A. Masebo.

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## ACKNOWLEGEMENT

No study can be completed successfully without assistance of other people; likewise, this study is the product of many positive and constructive contributions of different people. In turn, I express my sincere gratitude to all those who assisted me in studying and writing this paper. First of all, I thank the almighty God who gave me the strength of attending and attaining Masters ôDegree program of the Open University of Tanzania and enabled staff members of The Open University of Tanzania for their contribution on successful completion of this program. I have nothing to pay but Iôm permanently indebted to them in my daily prayers.

Very special thanks go to Prof. Issa Mcholo Omari for agreeing to be my research supervisor and devoting most of his time, knowledge and skills working hand in hand with me throughout the entire study. May the almighty God strengthen the wisdom he endowed in him so that others continue to benefit from him. I am also obliged to give thanks to the Regional Administrative Secretary (RAS) of Mbeya Region, District Administrative Secretaries of Rungwe District, Kyela and Mbeya District for permitting me to collect data from the schools I planned.

More importantly, this work could end up in vein if the heads of schools, mathematics teachers and students from Kyela day Secondary School, Mbeya day Secondary school and Lwanga secondary school could not offer their maximum cooperation to provide the relevant data for this study. I really appreciate their contribution. Finally I thank Rev. Makuru Turyamuhaki who tirelessly read my draft and made various grammatical corrections whenever I called upon him.

## ABSTRACT

Mastery of mathematics concepts is indispensable in the process of learning mathematics and application in daily life. The teachersô and studentsô mastery of basic mathematical concepts becomes questionable if there are reports on the perpetuation of poor and pathetic mathematics performance in Tanzania. This study was conducted with the main objective of identifying the mastery of basic mathematical concepts of integers, algebra, fractions, and decimals among secondary school teachers and students in Mbeya region of Tanzania. The study employed quantitative research approach and evaluative research design. A special designed test for testing the mastery of basic mathematical concepts from the four topics namely fraction, integers, algebra and ratios was administered to both category of respondents. The test was moderated and tested for its validity and reliability by expert mathematics teachers. Twenty four (24) teachers and 120 students from the three secondary schools in Mbeya region participated in the study and the questionnaires were also used to collect data from teachers and students. The main findings of this study showed that:- teachers mastered well the basic concept contrary to their students who showed poor mastery of the basic mathematical concepts. Also the findings of this study indicated that teachers and students differed most in the mastery of algebraic concepts followed by integers. The results revealed further that, teachers perceived algebra as most difficult mathematical concepts to teach followed by integers. Lastly, it was found that students perceived integers as most difficult mathematical area to learn followed by algebraic concepts. This study then recommends that teachers still needed support in the pedagogical knowledge rather than in the content knowledge. Mathematics syllabus should emphasize mastery of mathematical concepts as part of the content to be learned as well as locating adequate time for coverage of topics.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| CIPP | Context, Input, Process and Product |
| MOEC | Ministry of Education and Culture |
| MoEVT | Ministry of Education and Vocational Training |
| PTR | Pupil Teacher Ratio |
| TIE | Tanzania Institute of Education |
| URT | United Republic of Tanzania |

# CHAPTER ONE

# INTRODUCTION AND BACKGROUND TO THE STUDY

## 1.1 Introduction

This chapter gives the overview of this study. It describes the background to the study that leads to understanding of the research problem and the statement of the problem which provides a summary of the research problem that was studied. The purpose, the objectives of the study as well as research questions were also included in this chapter to describe what exactly this study was dealing with.

The significance of this study explains why the study was worthy doing. In addition, the chapter included the delimitation of the study as well as limitations of the study just for the sake of showing the focus of the study as well as to describe possible factors that affected the study. The chapter ended by presenting the conceptual frame work which indicates the interconnection of independent and dependant variables of this study and how they relate to each other.

## 1.2 Background

Mastery of Mathematics concepts is indispensable in the process of learning mathematics and application in daily life. Mathematics concepts are the mathematical terms which are expressed in symbols, formula or word expression which bear the mathematical operational meaning. The mathematics communication is made possible by the mathematical language which is composed by the logical series of interconnected concepts and thus making the mathematical language unique.

The unique linguistic structure of mathematics makes the learning of mathematics similar to the learning of a foreign language. Thus, the level of understanding of mathematical language affects the level of communication of mathematical ideas (Mbugua, 2012). It is expected that secondary school pupils when learning mathematics should master different mathematical basic concepts in order to be able to manipulate mathematical ideas from real world problems to mathematical symbols leading to problem solving through algorithms.

For concepts to develop effectively, pupils need to perform their own physical actions until they are able to reason abstractly. Thus children must have the real and relevant variety of practical experiences if they are to internalize a concept. Thus concepts are constructed from a series of experiences. (Mbugua, 2011). On the other hand, mathematics teachers should be competent in the mastery of mathematical concepts in order to be effective in facilitating the learning of the abstract language of mathematics to secondary pupils. Indeed, the competence of mathematics teachers in mathematics is reflected on the way students are being trained.

The relationship between studentsô understanding of the language of mathematics and performance in mathematics was moderate but positive (Makungu, 2009). However it is reported that in Tanzania, teachersô lesson preparations and teaching methods led to studentsô lack of language of mathematics experience (Makungu, 2009). The driving force behind the need to study the mastery of mathematical concepts among school pupils and secondary school teachers in Tanzania was the perpetuation of poor performance in mathematics for more than ten consecutive years as indicated in Table 1.1.

**Table 1.1: Pass and Fail Rates in Mathematics for CSEE from 2007 to 2016**

| year | Pass (%) | Fail (%) |
|---|---|---|
| 2007 | 17.4 | 82.6 |
| 2008 | 24.3 | 75.6 |
| 2009 | 17.8 | 82.2 |
| 2010 | 20.9 | 79.1 |
| 2011 | 18.3 | 81.7 |
| 2012 | 11.3 | 88.7 |
| 2013 | 17.8 | 82.2 |
| 2014 | 19.6 | 80.4 |
| 2015 | 16.8 | 83.2 |
| 2016 | 18.1 | 81.9 |

**Source***:* National Examinations Council of Tanzania collected from examinations results reports from 2007 to 2016

Table 1.1 shows that performance in mathematics has been generally poor. Different reasons have been paused following this mathematics poor performance trend: Insufficient number of competent mathematics teachers, inadequate investment in mathematical research and most structure of research are somewhat biased toward field analysis (IMU: 2009). Other reasons for the poor performance in mathematics in Tanzania are poor delivery of instructions, lack of clear structured system of identifying and tracking exceptionally gifted mathematics students with the purpose of developing them to their maximum potential for the benefit of the country as well as themselves, shortage of Mathematics teaching and learning materials such as textbooks (Kitta,2004)

Another problem was the nature of the materials prepared for mathematics teaching and learning. The syllabus emphasised learners-centred teaching and learning (MOEC, 2005), while the curriculum materials used, particularly the textbooks, were not reflecting learner-centerednessô. They focus more on the content, with little

emphasis on the pedagogy. The government of Tanzania through the Ministry of Education and Vocational Training has taken different measures to alleviate the situation. It stresses the use of student centred methods of teaching and then paradigm shift from content based to competent based curriculum(Sigalla,2013),and constructions of many classrooms to reduce over clouding in different secondary schools where by 2016 there were a total of 34,823 classrooms in government schools URT (2016).

URT (2010) statistics shows that the number of teachersô colleges increased from 40 colleges in 2001 to 103 colleges in 2011 and from 2 university colleges in 1991 to 40 university colleges in 2011 which led to the increase of number of Teachersô enrolment in Teachersô colleges from 15561 in 2001 to 37698 in 2011.Initiation of science and maths camps for girls in some regions, In-service Training (INSET) programmes designed by 2010. In the financial year 2016-17, The Ministry of Education and Vocational Training trained all teachers including the private school teachers in the country on ótransformative Pedagogyô, mainly to enhance the quality of teaching learning in the classrooms and the year 2016 has been declared as the óTeacher Development Yearô on 2nd May 2016 coinciding with the Teachersô Day (URT, 2016).

URT (2010) defines qualified teachers for secondary schools as those with diploma and above with teaching certificates. The standard of PQTR (Pupil Qualified Teacher Ratio) for Secondary schools is 1:40 per subject. However, the PQTR was 1:51 in 2010 which indicated that there was still a serious shortage of qualified teachers in secondary schools. There were regional variations with Mara and

Kigoma having PQTR of 1:82 and 1:80 respectively while Pwani and Dar es Salaam had the PQTR of 1:31 and 1:36 respectively while Mbeya had PQTR 1:50.This implied there was uneven distribution of teachers in the regions and schools (URT 2010).

Apart from the well explained plans and strategies towards improvement of mathematics performance in Tanzania, no remarkable improvement has been registered in the area of mathematics up to date. The failure percentage had been maintained to the average of less than 25% for more than thirteen years. Student performance in mathematics has been left as the matter of trial and error instead of being the result of deliberate endeavour to plan and implement seriously strategy for improvement. There is a big gap between the policy interventions and classroom reality reading to stagnation of progress in mathematicsô performance. Kita (2004) points out a number of reasons for the gap between policy interventions and classroom realities. In terms of quality teaching, mathematics at ordinary secondary school is supposed to be taught by diploma and graduate teachers, the diploma being a minimum qualification (MOEC, 1995).

Diploma teachers are expected to teach forms one and form two, while graduate teachers were expected to teach forms three and form four classes. In practice, however, that was not the case as there were by then more diploma teachers than graduate teachers in schools. Diploma teachers were also teaching mathematics in form three and form four classes and in some schools there were no graduate teachers at all, (Kita, 2004).

Sichizya as cited in Kitta (2004) claims that basic mathematics program emphasized the understanding of a core of mathematics, active participation by learner, and the practical use of mathematics. Active participation by the learner implies the use of interactive methods in teaching ï learning process in the classroom situation in which learners participate fully in constructing their knowledge during the lesson. There is little evidence through research to support that, the mastery of mathematical concepts by both teachers and students is given the required attention in connection to constructivism view of learning among the schools in Mbeya region.

### 1.3 Statement of the Problem

Over ten consecutive years from 2007 to 2016 there have been the shocking perpetuation of poor performance in mathematics at ordinary secondary school level in Tanzania where by the average pass rate was less than 20%. Different reasons were being paused following this poor trend of mathematics performance in Tanzania including, shortage of teaching materials such as text books, lack of qualified teachers, studentsô negative attitudes towards mathematics, lack of pedagogical content knowledge among teachers and over clouded classes.

The Government of Tanzania has taken different measures to work on the mentioned reasons without any remarkable success. Some of the governmentôs initiatives includes, organizing teachers in-service seminars and workshops, expanding some universities and colleges to increase student teachers enrolments, employment of mathematics teachers annually and providing textbooks to schools (Sigallah, 2013). Despite the government of Tanzaniaôs efforts, still the problem of poor performance in mathematics in Tanzania has remained unsolved. Under such situation, one may

question, ñWhat is the major stumbling block for studentsô learning mathematics?ò and ñWhy this poor performance records occurs in mathematics only?ò Then the nature of mathematics has to be taken into consideration.

Mathematics is a logically organized conceptual system. Once a mathematical object has been accepted as a part of this system, it can also be considered as a textual reality and a component of the global structure. It may be handled as a whole to create new mathematical objects, widening the range of mathematical tools and, at the same time, introducing new restrictions in mathematical work and language (Godino, 1996). Misconceptions about mathematics may be attributed to inability to communicate using the appropriate terms, symbols, and structures. Although, language plays a significant role in learning and in success in mathematics, teachers still downplay its importance in helping learners acquire the prerequisite mathematical language skills (Mbugua 2012). Mathematics is a symbolic language in which problem-situations and the solutions found are expressed.

The systems of mathematical symbols have a communicative function and an instrumental role. One may question, ñCan mastery of basic mathematical concepts among secondary school teachers and students play any role in improving studentsô performance in mathematics?ò Teachers are expected to master basic mathematics concepts in order to be able to facilitate effectively the students learning. Mastery of concept by student depends largely on what their teachers emphasize during the teaching and learning process. For concepts to develop effectively, pupils need to perform their own physical actions until they are able to reason abstractly. Thus children must have the real and relevant variety of practical experiences if they are to

internalize a concept, since concepts are constructed from a series of experiences. (Mbugua, 2012)

There are lots to doubt as far as mastery of mathematics concepts by both teachers and students are concerned in Tanzania secondary schools. How can students master mathematics concepts while there are reports revealing that teachersô lesson preparations and teaching methods lead to studentsôlack of language of mathematics experience? (Makungu,2008).What stresses the doubt is the fact that, the unique linguistic structure of mathematics makes the learning of mathematics similar to learning of a foreign language. Thus the level of understanding of mathematical language affects the level of communication of mathematical ideas (Mbugua 2012).

There is no sufficient information about the mastery of basic mathematic concepts among teachers and secondary school pupils in Mbeya region. Whenever doubts are inevitable on the mastery of basic mathematics among mathematics secondary school teachers and students in Mbeya region, Tanzania, it becomes necessary for the research to be done in order to assess the mastery of basic mathematical concepts among secondary school teachers and students in Mbeya region, Tanzania.

### 1.4 The Purpose of the Study

The purpose of this study is to assess the mastery of basic mathematical concepts among secondary school teachers and students in Mbeya region, Tanzania.

### 1.5 Specific Objectives of the Study

More deeply the study was conducted with the vision of achieving the following

specific objectives

i. To compare teachers and their students in mastery of basic mathematical concepts.
ii. To assess the areas where teachers and students differ most in their mastery of mathematical concepts.
iii. To identify mathematical areas which teachers perceive as more difficult to teach.
iv. To identify mathematical areas which students perceive as being most difficult in learning.

## 1.6 Hypotheses of the Study

The following hypotheses guided this study.

**Hypothesis 1**

Teachers are better in mastery of basic mathematical concepts than secondary school students

**Hypothesis 2**

Teachers and students differ most in the mastery of algebra concepts followed by integers

**Hypothesis 3**

Teachers perceive integers and algebra as more difficult mathematical concepts to teach than concepts of fraction and ratios.

**Hypothesis 4**

Students perceive integers and algebra as more difficult mathematical concepts to learn than fraction and ratios.

## 1.7 Research Questions

During this research the following research questions were to be answered scientifically.

i. How do mathematics teachers and students differ in their mastery of mathematical concepts?
ii. In which area do mathematics teachers and students differ most in their mastery of mathematical concepts?
iii. Which mathematical area do teachers perceive as most difficult to teach?
iv. Which mathematical area do students perceive as most difficult to learn?

## 1.8 Significance of the Study

The researcher was optimistic that the situation in mathematics was not beyond despair even though it was pathetic. We still had the time to change what was happening in our schools and educate our children to compete in the then increasingly becoming flat world market. It is only through extensive study like this; we could explore and find out tentative ways of solving problems relating to poor performance in mathematics in Tanzania.

The study was important for the whole society. In particular the study would be very important for curriculum developers, educators, teachersô trainers, school administrators, policy makers, students themselves and parents who are always in need of better achievement in mathematics. The results of this study would help curriculum developers to design and print mathematics textbooks that would suit interactive aspect of learning mathematics that stress on the mastery of mathematics concepts.

For teachers, the result of this study was expected to lay down the strong foundation on which they would be able to plan and organise instruction for effective teaching and learning mathematics bearing in mind that mathematics is a unique language and cannot be studied in the same way as other subjects. It is worthwhile to bear in mind that learners need guidance of their teachers on what to study, what to master and how to achieve it.

It is through this study teachers would realise that, if in any way, the teaching of mathematics concepts is neglected then mathematics will constantly be perceived a difficulty subject among secondary schoolsô pupils in Tanzania. Teacher colleges and trainers would also realize the importance of putting special emphasis on training student teachers how to teach students mathematics concepts and discussion of mathematics through conceptual reasoning and lastly students will realise the need for them to master mathematical concepts thereafter make considerable efforts to improve their performance in mathematics.

### 1.9 Delimitations of the Study

Although this research was conducted in Mbeya region, basically it had a national outlook. This study was centred in Mbeya region because the region has 304 registered secondary schools which were enough to get the data for this study and the perpetuation of studentsô poor performance in mathematics affected the schools.The study focused on the study of the mastery of basic mathematics concepts by teachers and secondary school pupils among ordinary level secondary schools in Mbeya region.

### 1.10 Limitations of the Study

Limitations are those conditions beyond the control of the researcher that may place restrictions on the interpretations and conclusions of the study and their applications to other situations.(Omari, 2011) The major limitations that occurred was during data collections from mathematics teachers. It was difficult to persuade teachers to administer a test within two hours while knowing the truth that the test is for the comparison between teachers and students on mastery of basic mathematical concepts. To avoid, negligence, paying no value to the researcherôs work among teachers, deception was used inevitably. Instead of just doing the test for the sake of testing the mastery of basic mathematical concepts, teachers were told to provide solutions to the given test which will be used to study their different approaches to solve these questions. After the test the teachers were dehoaxed as suggested in Ommari (2011) that, when deception is used, provide opportunity for debriefing or dehoaxing.

### 1.11 Conceptual Framework

Several factors play roles in the mastery of mathematical concepts by both mathematics teachers and secondary school students. The CIPP (context, Input, process and Product) evaluation model which was developed by Stufflebeam (2003) was adopted and modified in order to provide a systematic way of looking at many different aspect of the curriculum development process relating to the mastery of mathematical concepts. The conceptual framework in the figure 1 illustrates the complex, dynamic and interactive relationships among these factors. This conceptual framework is used to ground this study.

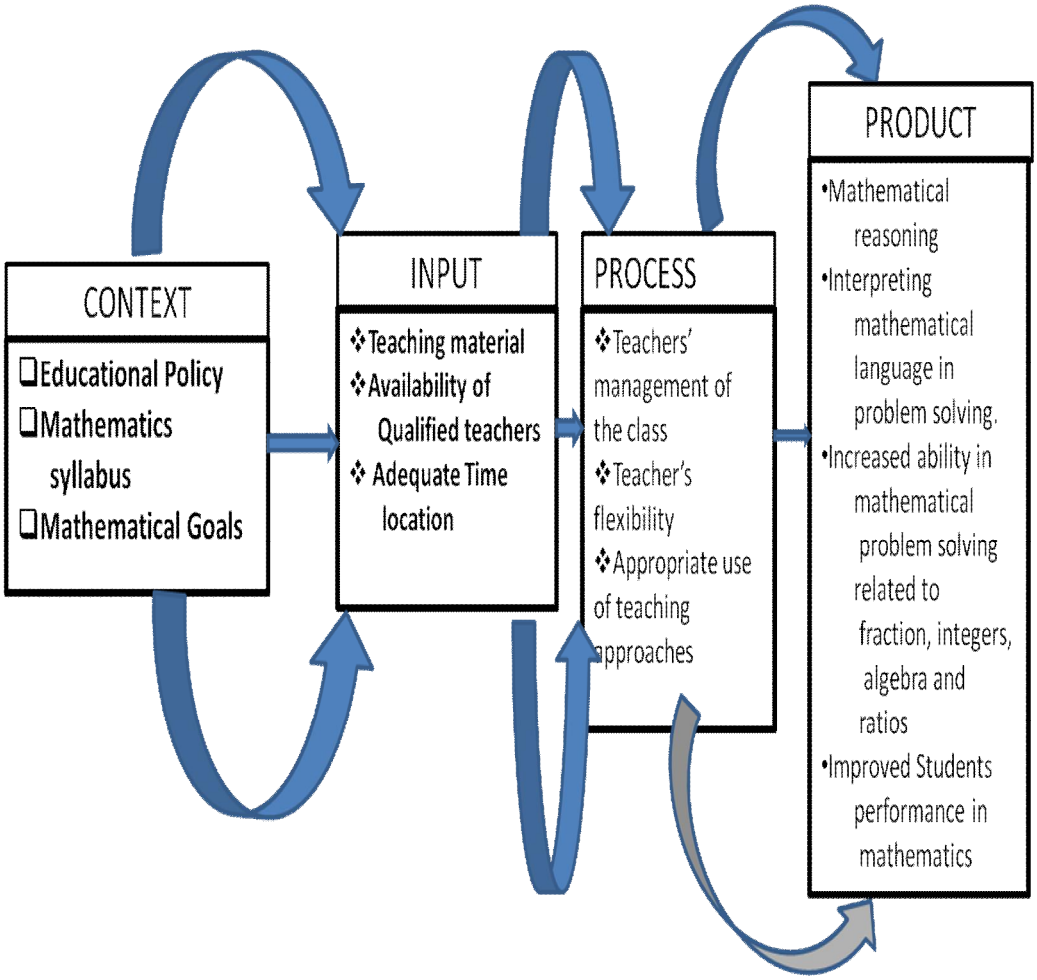


**Figure1.1: The Conceptual Framework for the Study**

**Source***:* Adopted and modified by the researcher from Stufflebeam (2003)

Specifically, the context evaluation component of the Context, Input, Process, and Product evaluation model for this framework poses the education policy, mathematics syllabus, and the national goal for teaching mathematics as the crucial information to be in hand in order to achieve this study. However the presence of teaching materials, the availability of quality and competent mathematics teachers in secondary school and their adequacy, and the adequacy of time for learning as necessary input for mastering mathematical concepts.

The syllabus determines the contents required to be covered for a given class of a school and it guides the time and suggests the approaches. The planned time for the study in both school time and home time is a necessary resource for the mastery of mathematical concepts. Not only the training but also teacherôs qualification is required for better facilitation of the mastery of mathematical concepts by both teachers and students.

The process evaluation component of the framework prescribes the teaching of concepts in algebra, integers, ratio and fractions that best address the identified mastery needs. It is the process that enables the teacher and the teaching environment that tend to prepare and select appropriate teaching approaches to suite studentsô level of mastery of mathematical concepts. Finally, the product evaluation component of the framework measures, interprets, and judges project outcomes and interprets their merit, worth, significance, and probity. For this study, good the studentsô ability to interpret correctly the conceptual question and to apply relevant concepts in solving the questions, and use mathematical concepts in reasoning when working mathematical problems will be regarded as evidence for the product of all the other three prior steps from contextual to process. Generally performance in mathematical concepts will imply the mastery of mathematical concepts.

# CHAPTER TWO

# REVIEW OF LITERATURE

## 2.1 Introduction to the Chapter

While Bordens and Abbott (2002) describe a literature review as the process of locating, obtaining, reading and evaluating the research literature in the researcherôs area of interest Kombo and Tromp (2006:62) define the term óliteratureô as the analysis of the textbooks or manuscripts. Although many people rightly associate literature with novels and poetry, in research the term is more specific. In terms of a literature review, ñthe literatureò means the works the researcher consulted to understand and investigate the research problem.

This chapter is divided into two main parts: theoretical literature review and empirical literature review. With reference to Raymund (2001:54), while theoretical literature provides scientific definitions of the major concepts describing the phenomenon being studied, empirical literature describes what has been done to solve or address the logical, illogical or contradicting relationship in the phenomenon.

## 2.2 Learning Mathematical Concepts

Constructivism is the learning theory that explains how people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When learners encounter something new, they reconcile it with previous knowledge and experience. They may change what they believe, or they may discard the new information as irrelevant. To be active creators of their knowledge however, they must be able to ask questions, explore and assess

what they know.

In the classroom, the constructivist view of learning means encouraging students to use active techniques such as experiments and real-world problem solving using authentic data if possible, and to create knowledge and reflect on their understanding. This theory states that learning is an active process of creating meaning from different experiences. In other words, students will learn best by trying to make sense of something on their own with the teacher as a guide to help them along the way (Bednar, Cunnigham, Duffy, Perry, 1995). In a constructivist classroom, learning is constructed. This means students are not blank slates upon which knowledge is etched. They come to learning situations with already formulated knowledge, ideas, and understandings. This previous knowledge is the raw material for the new knowledge they will create.

Also in this class student is active: Which means the student is the person who creates new understanding for him/herself. The teacher coaches, moderates, suggest, but gives the students room to experiment, ask questions, try things that don't work. Learning activities require the students' full participation. An important part of the learning process is that students reflect on, and talk about, their activities. Students also help set their own goals and means of assessment. More important to remember in relation to the constructivist class is that the student is always reflective thus it is suggested that teachers should create opportunities for students to question and reflect on their own learning processes, either privately or in group discussions. The teacher should also create activities that lead the student to reflect on his or her prior knowledge and experiences.

The constructivist classroom relies heavily on collaboration among students because students learn about learning not only from themselves, but also from their peers. When students together review and reflect on their learning processes, they can pick up strategies and methods from one another. Inquiry or problem based approach, whereby the main activity in a constructivist classroom is solving problems. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. Students have knowledge that they may later see as incorrect or insufficient to explain new experiences. As students explore a topic or problem, they draw conclusions, and, as exploration continues, they revisit those conclusions and modify them to support new knowledge (Bednar, Cunnigham, Duffy, Perry, 1995).

Agreeing with this view of knowledge, learning must be placed in a rich context, reflective of real world context, for this constructive process to happen and transfer to environments beyond the school or training classroom. Learning through cognitive apprenticeship, mirroring the collaboration of real world problem solving, and using the tools available in problem solving situations, are the keys to active learning. How effectual or instrumental the learnerôs knowledge structure is in facilitating thinking in the content field is the measure of learning (Bednar, Cunnigham, Duffy, Perry, 1995).

### 2.1.1 Evolution of Constructivism Theory of Learning

Behaviourism, cognitivism, and constructivism are the three broad learning theories most often utilized in the creation of instructional environments. or the past century these learning theories have driven educational pedagogy. In the early part of the

20th century, behaviourism dominated educational theories and research. The founders of Behaviourism are Physiologists Ivan Pavlov & John B. Watson Behaviourists held that the scientific study of psychology must restrict itself to the study of observable behaviours. Behaviourists viewed learning as a process of stimulating learners to behave differently. It was when learners demonstrated new behaviours that learning could assume to have occurred. The limitation of behaviourism is that it did nothing to address what happened inside learners' minds.

In response to this limitation, cognitive psychology emerged in the 1950s with its founder Jean Piaget (1896-1980) and Lev Vygotsky (1896-1934). Cognitivists were concerned not so much with behavioural responses, but rather with how people learned. The theory related to how humans absorb stimuli, convert those stimuli into thoughts, and store them for future use. The mental processes involved in learning were, and continue to be, the focus of most cognitivist research. Constructivism takes the cognitivist focus on the mind one step further. According to constructivists, knowledge is something each person "constructs," based on personal experiences. Reality is different for each person. Education, therefore, is never a matter of teaching one objective "truth," it is a matter of helping people arrive at their own personal constructions of reality.

> *In contrast to both behaviourism and early cognitivism, constructivism is not an objectivist theory in which "truth" is viewed as external to the learner, and the mind acts to process input from reality. The challenge posed by constructivism is that it presents a new view of how reality is perceived, and implies entirely new roles for teachers and students alike*.

Basically, constructivist approaches in teaching and learning environments have originated from several Psychologists and educators such as Jerome Bruner, Jean

Piaget, and Lev Vygotsky, etc. Those scholars emphasized two major different strands of the constructivist perspectives, social constructivism, and cognitive constructivism. Even though, there is some debate between these two aspects of thought, they have some perspectives in common about the constructivist-learning environment. Mastery of mathematical concepts stems on constructive learning process where learners need to be active in participating in conceptual learning and there after creating their own mathematical conceptsô meanings.

### 2.2.1. Comparison between Teachers and Students on Mastery of the Basic Mathematical Concepts

Mastery approach exposes almost all children to the same curriculum content at the same pace, allowing them all full access to the curriculum by focusing on developing deep understanding and secure fluency with facts and procedures, and providing differentiation by offering rapid support and intervention to address each individual pupilôs needs (Kastberg, 2002). Kastberg (2002), lists down principles on which the mastery approach is based which are:- Make use of mathematical representation, help children to make sense of concepts and achieve fluency through carefully structured question, exercises and problems that use conceptual and procedural variation to provide óintelligent practiceô, which develops conceptual understanding and procedural fluency in parallel, blends whole class discussion and precise questioning with intelligent practice and where necessary, individual support.

Kastberg, (2002) proposed that, the evidence for the mastery of mathematical concepts which are conception, representation, connection and application. I adopted and used the same evidence in studying the mastery of basic mathematics among

teachers and students while holding the following: -

i. A conception is a communicated feelings and ideas about a concept.

ii. A representation is a symbol the student uses to communicate the concept.

iii. A connection is a relationship between representations.

iv. Application is a use of the concept to solve a problem.

The question of comparing teacherôs mastery of mathematics concepts and studentôs mastery of the concepts may sound less important, for one may assume generally that it is very obvious that mathematics teachers would be at greater advantage of appearing the best in mastery since they have undergone different mathematical experiences including their training. In research, such assumptions are not accepted unless proved through research study since there are other situations where students may interact with the knowledge which is not known by their teachers.

#### 2.2.1.1 Teachers' Training in Tanzania

Teacher trainees in Tanzania most commonly have followed seven years of compulsory primary education. A Diploma holder who can teach in both primary and secondary schools needs six years of secondary school and attain at least two principle passes during his or her advanced certificate of secondary school examination. The admission requirement for student teachers are summarised in Table 2.1.

The diploma course minimum entry qualification is two principals in the Advanced Certificate of Secondary Education Examination. At University level, however, the

cut off points for education programmes have remained pretty low, especially in the sciences, going as low as 4 points out of a maximum of 15 points. Thus teaching is attracting the poor performers academically to join the courses.

**Table 2.1 Minimum Admission Requirement for the Teacher's Education for Diploma and Degree Courses in Tanzania**

| Courses | Requirements | Minimum Qualification | Point | Maximum Point |
|---|---|---|---|---|
| Diploma in Education | ACSEE | two principals passes | 2 | 15 |
| Degree in Education | ACSEE | two principal passes | 4 | 15 |

**Source**: The Education and Training Policy (1995)

Those who have a B.Ed can teach in both ordinary level secondary schools, advance secondary education as well as in teacher training colleges. Following liberalization policies in 1994, a number of private education institutions and colleges have been established in the country at all levels of the education system. Teacher training is now offered in some 34 government and 43 non-government colleges (URT, 2009).

The government of Tanzania has taken different measures to improve the enrolment of students into the teaching training institution. One of such a measure taken by the government was to transform one of the biggest schools and educational colleges to become education universities offering degrees instead of advanced level secondary school certificates and teacherôs diploma. Such conversion was made vivid to Mkwawa high schools, which was made an affiliate college of the University of Dar es Salaam and recruits about 3000 students in teaching profession in total. Changôombe teachers college was the second, which recruits about 2000 degree

candidates instead of diploma, which was offered before. These were considered short term measures which intended to increase the number of teachers within a short period (Sigalla, 2013).

Further, the government put in place long-term plans for ascertaining enough numbers of teachers in the end. In this vein, the government has to create a university in the capital city Dodoma, which is meant to recruit about 45,000 students of which 16,000, is in school of education. The attempt made by the government provided a prediction to end the teachersô problem in Tanzania by the end of 2014/2015. By 2013 the ministry of education was recruiting about 25,000 teachers from both tertiary and universities (Sigalla, 2013).

Apart from these Tanzania government endeavour, it was still being reported that schools in Tanzania have unqualified and under qualified teachers, most of whom had problems in pedagogical content knowledge, while teachers who were qualified often had problems in teaching due to the poor teaching preparations they received in college (Kitta, 2004). Gencturk (2012) specified seven categories of a knowledge base for teaching: knowledge of content; knowledge of curriculum; pedagogical content knowledge; knowledge of pedagogy; knowledge of learners and learning; knowledge of contexts of schooling; and knowledge of educational philosophies, goals, and objectives

More recently it has been reported that there is a reduced moral competence of new teachers: It has been noted that most new teachers lack competence in morality, which include acting as parents to children as opposed to peers (Sigalla, 2013). Most

long serving teachers indicate that new teachers are supposed to be nurtured just as they nurture the students. They look similar in most of the behaviour except on the level of education.

The long serving teachers indicate that what differentiates the new teachers and the students is the level of education. In addition, it has been leant that differentiating the two is because one teaches and another listens (Sigalla, 2013). Kitta (2004) reveals out teachers' lack of qualification in teaching mathematics. He further reports that most of them have problems with the subject matter content knowledge and skills. Such a situation had a major implication on what we should observe in this study in regard to mastery of basic mathematical concepts in algebra, fraction, integers and ratios for neglecting the knowledge of teaching while studying the teaching would logically be meaningless.

#### 2.2.1.2 Teachers Training on How to Teach Basic Mathematical Concepts in Tanzania

In Tanzania it is also possible to become a mathematics teacher without going to university. Generally Tanzanian mathematics teachers have a Bachelor of science (B.Sc.) or a Bachelor of education (B.Ed.) degree. If someone is not a university graduate or decides not to go to a university, it is possible to become a diploma teacher in a teacher college and it takes from one to two years, depending on the current need for teachers and other political factors (Eskola, 2009).

It has been quite possible to study the mathematics teacherôs training using at diploma level using mathematics pedagogy syllabus for diploma in secondary

education of the united republic of Tanzania which provides the guidelines and standard for training mathematics teachers in Tanzania at ordinary diploma level. Due to liberalization policy, mathematics education at university level is not easy to study due to the fact that universities are having their own standard of training teachers with each university having its own course outlines per each semester and eventually for course duration.

Mathematics pedagogy syllabus for diploma in secondary education stresses that teacherôs trainees should be able to explain the meaning of mathematics and explain the historical development of mathematics as well as describing the application of mathematics in daily life within a 3 hours lesson of the training in the training, (MOEVT, 2009). One may question on whether this time could be sufficient to train a mathematics teacher in order to make him adopt the meaning of mathematics, feel empathy with it and be able to be affected by the meaning of the concept of mathematics. Logically the time allocated and the stress given by the syllabus answers insufficiently the questions about the quality of training and paused more puzzles than answers on whether mathematics teachers were competent enough to facilitate the mastery of basic mathematical concepts in algebra, fraction, integers and ratios.

One of the objectives of mathematics pedagogy as the subject states that ñBy the end of the course, the student teacher should be able to guide students to understand the meaning of different mathematics concepts interpret them and solve mathematical problems applying them with real life experiences,ò(MOEVT, 2009). A mathematics teacher can only teach the mastery of mathematical concepts depending on whether

the teacher is competent in the subject to the extent of understanding deeply the broad concept of mathematics and whether the mastery of concept is part of his belief about learning mathematics.

Some definition of mathematics that may influence the mathematics teacher have been given here:- Mathematics is the study of numbers, shapes and space using reason and usually a special system of symbols and rules for organizing them (Cambridge Advanced Learners Dictionary 2008 ).Mathematics is a logically organized conceptual system. Once a mathematical object has been accepted as a part of this system, it can also be considered as a textual reality and a component of the global structure. It may be handled as a whole to create new mathematical objects, widening the range of mathematical tools and, at the same time, introducing new restrictions in mathematical work and language (Godino, 1996).

Gordino (1996) expands the meaning of mathematics as he defines mathematics as a symbolic language in which problem-situations and the solutions found are expressed. The systems of mathematical symbols have a communicative function and an instrumental role. Such precise meanings of the concept of mathematics need to be internalised by a mathematics teacher. Mathematics gives strategies for thinking. Those strategies are, for example, classification, organization, reasoning and problem solving skills. In general mathematics develops thinking and creativity.

Among other things these are also the formal objectives of mathematics teaching, distinguished from the material objectives (Maiga, 2009). Indeed the belief of a teacher on mathematics as concept has a great deal to affect the teaching in a

classroom situation. Gencturk (2012) reports that ñthree aspects of instructional practices;- lesson designs, mathematical quality of lessons, and teachersô task choices were related to their beliefsò. He further reports that ñteachers favouring standards-based view of mathematics tended to take more initiatives to make changes in their practices; however, without strong mathematical knowledge, these changes were superficialò. This suggests in contrast the competent teacher who values mathematical concepts, will never skip the conceptual knowledge teaching in alignment with mathematical facts and procedures to improve studentsô learning (Booth, 2011)

The competent mathematics teacher is expected to master pedagogical skills as well as the subject content. The mastery of both pedagogical skills and mathematics content plays a great role as a roadmap of how and what students should learn. Gencturk (2012) reports that, ñThe gains in teachersô mathematical knowledge predicted changes in the quality of their lesson design, mathematical agenda, and classroom climateò. He further reports that ñteachers with strong mathematical knowledge focused on making sense of the concepts behind the mathematics being taught. They showed the meaning behind a procedure and explained steps in the procedure.

On the other hand, teachers with limited mathematical knowledge taught the procedure without teaching the underlying meaning. Furthermore, teachers with limited mathematical knowledge seemed to spend a considerable amount of time on activities unrelated to mathematicsò. Therefore a teacher should know all necessary mathematical skills such as, procedural skills (algorithms), conceptual skills,

problem solving skills. Booth (2011), provides the operational definition of procedural knowledge as how to do something and conceptual knowledge as the knowledge that allows one to understand why the procedure is appropriate for the task. Teachers must focus their teaching on concepts and how this can be done in the way that develops studentsô conceptual knowledge without sacrificing attention to required procedural skills, (Booth, 2011).

#### 2.2.1.3 The Teaching of Mathematical Concepts

My experiences as both a mathematics student and as a mathematics teacher remind me that teachers never teach the definition of mathematics. I have rarely met with a secondary mathematics teacher asking the pupils a conceptual question ñWhat is mathematicsò? Avoiding this question or neglecting it cannot be strange since the ordinary secondary school mathematics syllabus of Tanzania does not urge them to discuss the meaning of mathematics (TIE 2005). In connection to my experience, Mbugua (2012) found that ñout of 18 observed lessons, the teachers never got concerned with the definition of mathematical terms in of the lesson. In one case, a teacher was teaching about ósimultaneous equationô but the teacher started with solving simultaneous equations by elimination. In this case, mathematical terms involved are equations, simultaneous and eliminations, which should have been defined by the teacher before proceeding to solve problems.

Mathematics has its own system of symbols, which have their own grammar, for articulating mathematical concepts and so does not require long written answers. Secondary school mathematics does include the skill of converting word problems into mathematical expressions and this requires distilling the relevant information

from word questions that are rarely more than two or three sentences long. All textbooks modelled grammatical structures used in mathematics (e.g. use of ómore thanô and óless thanô) and the use of mathematical vocabulary (e.g. asking students to identify óline segmentsô and óraysô on a diagrams). Several books asked students to write out numbers in words in the topic integers as part of teaching about place values (Barrett *et al.*, 2014)

Misconceptions in mathematics may be attributed to inability to communicate using the appropriate terms, symbols, and structures. Although, language plays a significant role in learning and in success in mathematics, teachers still downplay its importance in helping learners acquire the prerequisite mathematical language skills (Mbugua, 2012).

#### 2.2.1.4 Time Allocated for theTeaching Mathematical Concepts

Teaching the mastery of mathematics concepts requires adequate time. Sufficient time should be allocated for mathematics instructions so as to give teachers enough time to handle concepts (Grouws and Cebulla (2000) in Mbugua 2012). However it is inevitable to argue the adequacy of time allocated for teaching mathematical concepts in Tanzania secondary schools since there are also reports on the over clouded classes, inadequate number of mathematics teachers leading to teaching overloaded teachers (Sigalla, 2013).

The mathematics syllabus provides only a list of topics to be covered in secondary school curriculum. It is mathematics textbooks that add flesh to the syllabus, determine sequence of teaching and provide exercises for masterly of concepts

(Mbugua, 2012). Topics are built in a manner that builds understanding of concepts, structure, problem solving and computation. They also provide the exercises through which learners can attain mastery of concepts (Kosgei, 2004 in Mbugua 2011). The use of the available mathematics textbooks in secondary schools will also depend on how the teacher values the conceptual knowledge. It is also wealth while to question the proper clarification of mathematical concepts by mathematics textbooks authors used in Tanzania.

One could expect to see the extensive use of mathematics dictionary as the crucial tool for elaboration of mathematical operational definition and meaning of some mathematical concepts bearing in mind that mathematical language is a unique language, but this has been rarely mentioned to be among the teaching reference or aid in the mathematics syllabus. This makes the argument to be inconclusive with the real situation of Tanzania, and is required to be answered by this study.

Teaching for conceptual understanding is a typical activity- based approach. This requires adequate time. Kitta (2013) reports that ñdespite the fact that teachers appreciated the importance of activity-based teaching for ensuring student participation, some showed concern about it. For them, using an activity-based approach takes more time than other methods. Their concern was brought about by the class size, lack of appropriate teaching material and pressure to finish the syllabusò.

### 2.2.1 The Nature of Mathematics Tests and Examinations Given to Students

Another factor that may necessitate the teaching of the mastery of mathematical

concepts is the nature of mathematics examination. If the examinations given to secondary school pupils consist some items that require them to explain and apply the conceptual knowledge as required in the blooms of taxonomy, definitely teachers would never skip the teaching of mathematical concepts.

The nature of examinations and tests that were being administered contributed to a significant role in studentsô learning styles, and decelerate studentsô understanding of the language of mathematics (Makungu, 2008). Apart from all the mentioned factors that may act as a driving force for a mathematics teacher to stress the mastery of mathematical concepts, it was still inevitable to question teacherôs mastery of mathematical concept due to the fact that they could not teach concept beyond their knowledge.

The need to question about teacherôs mastery of basic mathematical concepts is intensified by Kitta (2004) who reports that ña number of students could not respond to teachers' questions ï not because they did not have an idea of how to answer, but because they did not know how to communicate their ideas to the teacher. If the same question was asked in Kiswahili, students were able to answer it, but also in Kiswahili (Kitta, 2004). It was therefore more appealing to investigate through this study, teacherôs mastery of mathematical concepts and the way it influenced their teaching in classroom situation particularly basing in algebra, fraction, integers and ratios.

**2.2.1.6 Student Mastery of the Mathematical Concepts**

Mathematics is a major subject in secondary schools and it is useful in producing

members of the society who are numerate and logical in thought, the subject is also useful in learning other subjects, hence teaching and learning of the subject has to be improved (Mbugua, 2012). According to my experience as a mathematics teacher, algebra, fractions, integers and ratios are very crucial contents of mathematics that constitute some basic concepts that are widely applied in manipulation of other complex areas of mathematics. They are basic concepts because these four concepts are not used only as the corner stone of mathematics but are the foundations on which all other areas of mathematics are laid.

Think of the possibility of deriving any formula without the mastery of concepts of algebra, fraction and integers. Furthermore, think of the possibility of teaching coordinate geometry or probability without having the concepts of algebra and fractions! It may sound very abstract, if one can talk of an angle measuring $-270^0$ as used in trigonometric ratio without the mastery of the concepts of integers.

A fraction (from Latin fractus, "broken") represents a part of a whole or, more generally, any number of equal parts. When spoken in everyday English, a fraction describes how many parts of a certain size are there, for example, one-half, eight-fifths, three-quarters. Also fraction is a number that represents part of a whole. It is consisted of a numerator and a denominator. The numerator represents the number of equal parts and the denominator represents the total amount of parts that make up a whole. For example 2/5, the numerator is 2 and the denominator is 5. Fractions cause difficulty to most people because they involve relations between quantities. What is 1/2? One half of what? (Ndalichako, 2013).

Fractions play a central role in mathematics learning. They are theoretically important because they build a foundation which helps the pupils to successfully learn topics related to percentage, ratios and decimal numbers. Fractions require a deeper under-standing of computational procedures than that typically required with whole numbers. In Tanzania, the topic of fractions is an integral part of primary school mathematics syllabus which is introduced as early as pupils start grade I, yet it is one of the most difficult areas for pupils to master and was among the most poorly performed topics in the mathematics primary school leaving examination done in 2012 (Ndalichako, 2013).Ndalichako (2013) stresses further that, studentsô difficulties in learning fractions emanate from the fact that most teachers devote too much time to teaching the procedures of manipulating fractions and too little time to teaching their conceptual meaning

Algebra is a system of mathematics where by letters are used to represent the unknown number in a mathematical expression. In algebra, letters are treated as numbers in the way that they can be added, subtracted, multiplied or divide (TIE, 2002). Example, a teacher wants to add 3 oranges to unknown number of oranges which are in a bag and then gets the total number of oranges is ten. Such statement may be expressed algebraically by letting x stand for the unknown number of oranges in the bag. Then symbolically the expression may be $x + 3 = 10$.

Teachers, mathematics educators, and mathematicians consider algebra to be one of the most important areas of school mathematics. Despite the importance placed on algebra in school mathematics curricula, many students find it abstract and difficult to comprehend (Witzel, Mercer, & Miller, 2003). They cannot understand simple

algebraic concepts such as variables, expressions and equivalence. Failure to understand algebraic concepts it becomes difficult for a student to generate the derivation of general mathematical formula such as $a^2 + b^2 - c^2$ which is used for Pythagoras theorem and $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ which is a general formula for quadratic equation.

An integer is a whole number that can be positive, negative, or zero. Example of integers = { ..., -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, ... } and is worthwhile studying examples of:-

i. Negative integers = { ..., -5, -4, -3, -2, -1 }
ii. Positive integers = { 1, 2, 3, 4, 5, ... }
iii. Non-negative integers = { 0, 1, 2, 3, 4, 5, ... } *(includes zero,) (TIE,2012)*

Mastery of the concepts of integers is very crucial in the development of mathematics and in general. In the computation, integers appears in many mathematical areas such as in vector where we describe the opposite direction by negative (-), we also use integers to indicate opposite direction in trigonometric ratios, logarithms and many other complex mathematical areas. In Tanzania education curriculum, the concepts of integers are introduced in grade 6 of primary school and are also included in the form one mathematics syllabus (TIE,2012).

Khalid and Badarudin (2013) reports that secondary school students in Brunei Darussalam tend to get confused with the signs and operations on integers although teachers had attempted to explain about it several times. They further report that

students got mixed-up with operation and signs when there are subtraction and negative signs in a problem.

A ratio compares two values. It shows you that when you have this much of something, you will need to have that much of something else. You see ratios used in cooking and when working with model toys. The recipe for hummingbird food, for instance, calls for 4 parts of water for every part of sugar. What this ratio tells you is that however much sugar you put in, you need to put in 4 times as much water. If you use 1 cup of sugar, you need 4 cups of water. If you use 1 tablespoon of sugar, you need 4 tablespoons of water (Mahlabela, 2012).

Mahlabela (2012) in his case study of grade 9 learners from a rural KwaZulu-Natal school, reports that learner scripts and interviews reflect superficial or no understanding of ratio and those learners did not portray the correct conceptualisation of ratio. Students and teachers need to master these concepts in order to be able to apply them in a mathematical field for both expressing and solving mathematical problems.

Zakaria *et al*., (2010) reveals ñthat there is a significant relationship between conceptual knowledge and mathematics achievement in both courses of studyò. This finding is also supported by Mbugua (2012) who reports that ñachievement in mathematics is highly correlated to studentsô understanding of mathematical languageò Thus mathematical language contributes as a communication media towards achievement in the mathematics. Mathematical concepts are accommodated and assimilated through a series of experiences, which can be achieved through

mathematical languages. Mistakes students make when solving mathematics problems is partly due to studentôs lack of understanding of mathematical language (Mbugua,2012).

For concepts to develop effectively, pupils need to perform their own physical actions until they are able to reason abstractly. Thus children must have the real and relevant variety of practical experiences if they are to internalize a concept. Thus concepts are constructed from a series of experiences. Piaget's stages of intellectual development are useful guides to the teaching in which he emphasizes concrete operational materials that facilitate learners internalize concepts presented to them. Understanding is important and desirable since it generally promotes retention of the concept (Mbugua,2012).

The constructivist view emphasizes the practice of mathematics and there construction of mathematical knowledge. Teachers holding a constructivist view of mathematics/ perceive the subject as a language developed by humans to describe their observations of the world. The teachers see mathematics as continually growing, changing and being revised, as solutions to new problems are explored by the learners with the teachers as facilitators.

### 2.2.2 Mathematical Areas Where Teachers and Students Differ Most

Teachers training and content pedagogical skills is expected to put teachers at the advantage of scoring higher than their students in the comparison of the mastery of mathematical concepts, but under some situation this is not always the case, for it depends on the kind of training, presence of the guidelines that emphasise the

learning and teaching of the mathematical concepts in the mathematics curriculum. When no clear guidelines are used, teachers and students are likely to differ in some areas of mastery of mathematical concepts depending on their own interests.

The first mathematics topic a form one secondary school pupil in Tanzania need to encounter is numbers (TIE, 2009).The basic mathematics syllabus for secondary schools include Integers as a subtopic within numbers and provide guidelines on the discussion of integers as concepts and its operations (TIE, 2012).Fractions, algebra and ratio, profit and loss are also located in the basic mathematics syllabus to be covered in form one (TIE, 2012). At least every topic consists of a number of interconnected concepts which are the building stones towards understanding mathematics.

Mastery of mathematical concepts is different from merely defining the terms used in a given mathematics subtopic and then quickly jumping into mathematical procedural knowledge teaching. Mastery learning is unique compared to the traditional method. Under the mastery teaching model, a unit of material is taught, and students' understanding is evaluated before they are able to move on to the next unit. Mastery learning shows students that the focus is not on their grade, but on what they learn. And that alone seems to be a very valuable contribution to the field of education (Mazarin, 2012).

The main objectives of teaching basic mathematics in Tanzania secondary schools are: (1). To promote the development and application of mathematical skills in interpreting the world and solving practical problems in daily life. (2) To provide

pupils with mathematical tools and logical thinking which they can apply in understanding other subjects. (3) To develop a foundation of mathematical knowledge, techniques and skills for studying mathematics and related subjects at higher levels of education (MOEVT, 2009). The main objectives of teaching mathematics in Tanzania seems to hold the following definition of mathematics as defined by Godino (1996). ñMathematics is a logically organized conceptual system.

Once a mathematical object has been accepted as a part of this system, it can also be considered as a textual reality and a component of the global structureò. It may be handled as a whole to create new mathematical objects, widening the range of mathematical tools and, at the same time, introducing new restrictions in mathematical work and language. Also ñmathematics is a symbolic language in which problem-situations and the solutions found are expressedò. The systems of mathematical symbols have a communicative function and an instrumental role.

According to Kotsopoulos (2007), students must continually and actively negotiate among the mathematical meaning of a word, its everyday language meaning, and its new meaning as well as its alternative meaning within the mathematical registers. It is worthwhile noting the key facts about Tanzania secondary schoolsô learning environment from recent studies that may reveal the situation of mastery of mathematical concepts.

About mathematics textbooks available in schools in Tanzania, Barret*et al.*, (2014) found that, mathematics teachers were generally the least critical of textbooks. They valued books for ñmatching the syllabusò, providing clear explanations, being

accessible to students and providing a good source of exercises. The most common reason for disliking a book was that the order of content did not match with the syllabus. Books were also criticized for being shallow or unintelligible. Very few schools (2/18) had practical materials for mathematics and around one quarter (4/18) had teachersô guides.

Barret *et al*., (2014) reports more that, 11 out of 21 schools had a class set of mathematics textbooks and one book was shared between six or fewer students and four schools had a class set of more than one textbook. How textbooks were used depended more on the teacher than the textbook and most teachers used textbooks in a range of ways. They were less likely to use them to support inquiry-based project work or to set extra questions for óquickô students, consistent with findings from our review of mathematics textbooks (chapter 3), which found books offered little or no resource for activity based learning or extension work for more able students. Under such situations, the question about the area in which mathematics teachers and students differ most in their mastery of mathematical concepts among algebra, fraction, integers and ratios is inevitable since the teaching and learning of mathematics is hampered by a number of challenges as discussed above.

### 2.2.3 Areas Which Mathematics Teachers Perceive as Most Difficult to Teach

When there are different reports that reveal the studentsô perception that mathematics is among the difficult subjects, (Kihwele, 2014), it is logical to argue which areas makes mathematics most difficult? Indeed when there is lack of conceptual understanding of mathematical areas it may be inevitable to develop misconception among students caused by teachersô difficulty helping students to clarify logical

connections of concepts.

Recent study done by Clement (2015) revealed that teachers had slight agreements in their judgments on pie chart and histogram and there were no agreements on the other four items (frequency distribution, bar charts, simple probability and measures of central tendency) during the study that involved six items in statistics/probability that were given to the mathematic teachers in the sample to categorize. Even though the study was done in Nigeria, statistics and probability is also among the topics required to be taught at oô level secondary school in Tanzania.

In Nigeria**,** Adegun (2013) reveals that eight out of a total of 15 teachers administered with a mean of 0.53 perceived construction and loci as the most difficult topic to teach while fraction, decimal, number bases and percentage as the least difficult. Out of 180 students administered 140 students with a mean of 0.78 perceived construction and loci as the most difficult topic to learn. Indices, logarithms, fraction, decimal, number bases and percentage with a frequency count of 14 and mean value of 0.08 was viewed by the students as the least difficult to learn.

Even though the review reveals the related results to the one to be studied, there is a strong need to justify through this study whether topics such as fraction, integers, algebra and ratio are easy to teach their concepts or not in Mbeya secondary schools. Strangely, Clement (2015) reports that, there is no significant difference in the perceived levels of difficulty of mathematics topics by mathematics teachers and

students in Nigeria. This is still inconclusive as far as mastery of mathematical concepts is concern, there is need to investigate the difference as far as mastery of mathematical basic concepts from the four areas namely algebra, fraction, integers and ratios.

### 2.4 Synthesis and Research Gap

Both theoretical and empirical literatures have addressed the need for the mastery of mathematical concepts as the corner stone for development of proficiency in mathematics. Mastery learning shows students that the focus is not on their grade, but on what they learn, and that alone, seems to be a very valuable contribution to the field of education (Mazarin, 2012). The review has expressed a number of facts in relation to the prevailing situation on the mastery of mathematical concepts by both teachers and students in Tanzania and outside Tanzania but it has left the basic research questions unanswered.

i. How do mathematics teachers and students differ in their mastery of mathematical concepts?
ii. In which area do mathematics teachers and students differ most in their mastery of mathematical concepts?
iii. Which mathematical area do teachers perceive as most difficult to teach?
iv. Which mathematical area do students perceive as most difficult to learn?

These were the questions that prompted this study to be carried out in order to find out the tentative answers to fill in this gap by assessing the mastery of basic mathematical concepts among teachers and secondary school pupils in Mbeya region in four areas namely algebra, fraction, integers and ratios.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

Research methodology typically refers to the techniques that are used to conduct research. This includes data collection instruments such as questionnaires, interviews or observations as well as sampling procedures and statistical techniques for organizing and interpreting unstructured data (Bryman, 2008). This chapter spells out the approach to the research. It seeks to establish sound reasoning in linking the steps employed to answer the research questions and to achieve the objectives of the research. Sampling methods, data analysis are discussed. Issues of confidentiality and the validity and reliability of the study are stated. Thus, the chapter is divided into the following sections: Research design, approach, study area, population sample and sampling procedures. Others included are data collection methods, validity and reliability and data analysis plan.

## 3.2 Research Approach

The research approach to the study is informed by a review of the forms of data whether qualitative or quantitative data. Sullivan (2001) indicates that another step of refining the research problem is to decide whether qualitative or quantitative data or both are appropriate for the research. The author explains that qualitative data is the data collected in form of words, pictures, descriptions or narratives. Quantitative data involves numbers, charts and measures of things.

Neuman (2006) take a semantic view to the distinction between the two; thus, they define qualitative research approach as a set of techniques employed to describe,

decode, translate or generate meaning from a phenomenon. They argue that it is a fundamental approach to exploratory research and includes individual and group interviews, participant observation, videotaping, case studies, etc. quantitative approach involves quantifying data or assigning measures to them to statistically test them for any relationship to increase understanding of a topic. Neuman (2006) confirms that research based on qualitative data is unstructured, primarily exploratory, and aimed at breaking fresh grounds and giving insights while quantitative data research employ techniques that quantify data and subjecting them to statistical analysis.

Omari (2011)Puts it more clear that in triangulation method, the researcher collects both quantitative and qualitative data, at the same time and on the same phenomenon, and compares the results, and check if the results validate each other or are in contradiction. Sullivan (2001) argued that the choice between the two approaches depends on these factors:

i. The researcherôs disposition to human social behaviour.
ii. When knowledge of the subject area is unclear.
iii. When there is theoretical understanding of the phenomenon.

This study adopted a quantitative data approach to answer the research questions which by nature presuppose quantitative data analysis.

### 3.3 Study Area

This study was conducted in Mbeya region. Mbeya region is one of Tanzania's 31 administrative regions. It is located in the country's southwest. The regional capital is

the city of Mbeya. The region is located in the south west corner of the southern highlands of Tanzania. The region lies between latitudes 70 and 90, south of Equator, and between longitudes 320 and 350 east of Greenwich. Mbeya region lies at an altitude of 375 above sea level with high peaks of 2981metres above sea level at Rungwe higher attitudes. Prior to 2016, it covered an area of 62,420 square kilometers.

In 2016, Songwe region was created from the western part of Mbeya region, including the districts of Ileje, Mbozi and Momba. Mbeya region is now bordered to the northwest by Tabora region, to the northeast by Singida region, to the east by Iringa region, to the south by Zambia and Malawi, and to the west by Songwe region. After the 2016 reorganization, Mbeya now comprises seven districts: Busokelo, Chunya, Kyela, Mbarali, Mbeya city, Mbeya rural, and Rungwe. The schools that were involved were Kyela day secondary school, Mbeya day secondary school and Lwangwa secondary school which are located in the three different districts in Mbeya region which are Kyela, Mbeya city and Busokelo district council respectively. Non-probability sampling was used to select these schools since the factor used was the possibility of availability of enough mathematics teachers and unrestricted learning environment that can present the representative of the real situation of most Tanzanians secondary schools.

### 3.4 Research Design

Omari (2011) clarifies research design as distinct plan on how a research problem will be attacked. Research design is the conceptual structure within which a research is conducted. It is the logical sequence in which the study is to be carried out, and it

constitutes the blueprint for the collection, measuring and analysis of data (Kothari, 1990). In this study, the researcher employed an evaluation research design to assess the mastery of basic mathematical concepts among teachers and secondary school pupils in Mbeya region. The study was evaluative in nature because it aimed at ascertaining if the objectives of teaching mathematics are well attained in Tanzania. Omari (2011) clarifies that, the purpose of evaluation research design is to ascertain if the objectives of a given innovation or education were archived.

### 3.5. Population, Sample, and Sampling Techniques

#### 3.5.1 Target Population

Omari(2011) Defines a population as the totality of any group of units which have one or more characteristics in common that are of interest to the research. Before the researcher discusses the sampling method, the researcher takes an indication from Sullivan (2001) by examining the populations for which sample will be taken for the study. He proposes that to select a good sample, clear definition of the population is vital for unambiguous and accurate findings. A target population is a precisely specified group of cases from which a researcher studies a sample and to which the results from the sample are generalized (Neuman, 2006).

The attribute of good sampling is the ratio. It is the proportion of the population in the sample (Neuman, 2006). This brings to the fore the appropriateness of the sample size for a given population. He also observes further that larger samples, other things being equal, generate high accuracy, and are needed when the population is significantly heterogeneous or when there is the need to simultaneously analyze many data variables. In contrast, smaller samples are sufficient when less

accuracy is acceptable, when there is homogeneity in the population or when only a few variables are analysed at a time.

The term population refers to a large group of people, institution, or anything that has one or more characteristics in common on which a study focuses. It consists of all cases of individuals or elements that fit a certain specification (Kothari, 2004). The population of this study comprised of O-level secondary school students and mathematics teachers in Mbeya region. The study focused on form three students from the three chosen schools in Mbeya region.

### 3.5.2 Sample Size

A sample is a smaller group of subjects drawn from the population in which a researcher is interested for purposes of drawing conclusions about the universe or population Kothari, (2004) adds that the results from the sample can be used to make generalizations about the entire population as long as it is truly representative of the population.

A sample of this research involved 144 respondents categorized into two groups; of which students who accounted for 40 respondents from each school of three schools making the total of students 120. Twenty four (24) mathematics teachers from 10 secondary schools were involved in the study completing the total number of respondents 144. These twenty four teachers were to be included in this study due to the fact that the study required studying their teaching and their mastery of mathematical basic concepts and also due to their indispensable role of teaching gave them the position of determining how to enhance secondary school pupilsô

mastery of basic mathematical concepts. Students were involved in the study due to the fact that are the victims of poor performance in mathematics.

### 3.5.3 Sampling Procedures

Sampling procedures employed in this study included purposive sampling and simple random sampling. Purposive sampling involves the selection of those participants who portrayed the desired characteristics or elements and hence the potential of yielding the right information. According to Fraenkel and Wallen (2000), purposive sampling is an occasion based on previous knowledge of a population and specific purpose of the research investigators for use in personal judgments to select a sample.

In this study, the purposive sampling technique was employed to select form three class for the study, mathematics teachers in the sampled secondary schools as well as four mathematics topics that will be used in the study. Mathematics teachers were selected due to their positions as moderators and facilitators of the learning process in mathematics. They were expected to provide adequate information on their own ability about the mastery of mathematical basic concepts as well as secondary school pupilsô mastery of mathematical basic concepts in algebra, integers, fractions and ratios and the way they affect their operations in solving different mathematical problems.

The four topics namely integers, fractions, ratios and algebra were purposely sampled due to their concepts wide application in other area of mathematics even in the perceived most difficult topics. For students, stratified sampling was used to get

form three class to be used in the study. The choice of this class is due to the fact that form one and form two students were still having problem with the English language for they had just changed the language of instruction from Kiswahili used in primary schools to English used in secondary schools.

Form three students were so much experienced with the selected mathematical area under the study and they had just been located to either science of social science classes. Form four students were left because they had opted either as science students or social science students, since science students normally are willing to study mathematics but it could not be a good representative sample while social science students are in most cases having the negative attitude towards mathematics.

**Table 3.1: Students Sample**

| School | Boys | Girls | Total |
|---|---|---|---|
| Mbeya day secondary school | 20 | 20 | 40 |
| Kyela day secondary school | 20 | 20 | 40 |
| Lwangwa secondary school | 20 | 20 | 40 |
| **Total** | 60 | 60 | 120 |

**Source**: Field Data, 2018

So the best sample for the study was left to be the form three students they were assumed to possess adequate English language proficiency to express the mastery of basic mathematical concepts in the four topics chosen according to their level. But also stratified random sampling was used to get 40 students from each school of all the three secondary schools. To avoid biasness, pieces of paper labelled: **yes** and no were placed in a box.

### 3.6 Sources of Data

Data collection is the pocess of obtaining evidence for a research problem in a systematic way. This study used primary data from the test as a major source of data and questionnaire.

#### 3.6.1 Primary Sources of Data

These are original sources from which the researcher directly collects information that had not previously been collected. Primary data refers to first-hand information collected through questionnaires, interviews and observations, (Kothari, 2004). The study collected primary data from students and mathematics teachers through tests and questionnaire.

#### 3.6.2 Secondary Sources of Data

These are sources which contain data which have been collected and compiled for other purposes such as readily available and already compiled documents and reports. (Kothari, 2004) Secondary data were collected through different published materials and library sources. This study did not employ any secondary data.

#### 3.7.0 Instruments for Data Collection

Basic mathematical concept test and questionnaires were used in collecting data. Three criteria were taken into account for an appropriate methodology to collect data on teachers and students mastery of mathematical concepts at ordinary level secondary schools in Mbeya Region:

i. The actual measurable procedure for the determination of both teachersô and secondary school pupilsô mastery of mathematical basic concepts should be

recorded in detail.

ii. Biases caused by the researcher, by the situation or by social desirability should be minimized.

Criterion 1 leads to the rejection of quantitative methods and of methods that are likely to reveal only verbalized self-expression about oneôs mastery of mathematical concepts, e.g. interviews. Experimental settings and artificial situations were refused due to criterion 2. The methodological framework that was developed according to the two criteria combines Test and questionnaires. Bearing in mind that mastery of mathematical concept is a mental construct, and is the personal privately held belief about the concept, I had to think of the best evidence to test for the mastery of mathematical concept.

First of all, teachers and students were given the mastery of mathematical concept test which required students to demonstrate conception of concepts, representation of concepts, and connection of concepts and application of specific mathematical concept as a measure of the mastery of the concepts. This method of data-collection has been developed in order to get the most precise information about the mastery of mathematical basic concept by keeping the situation of the study as natural as possible. Questionnaires were used to get data about perceived difficult mathematical areas by both teachers and students.

### 3.7.1 Mastery of Mathematical Concepts Test among Teachers and Students

This tool was employed as a comparison factor on mastery of mathematical concepts by teachers and students in the four area of mathematics namely algebra, integers,

fractions and ratios (See appendix A). The items for the test were taken from different previous form two secondary education examinations because the items were standardised and had been used national wise for this level. The marking was done by two selected competent mathematics teachers.

### 3.7.2 Validity and Reliability of a Test

**Validity of the Test:** The test was developed by the researcher by collecting items from the form two secondary education examinations covering all the four topics included in the study. The test was moderated by two mathematics experts from two schools so as to ensure its content and face validity. These experts were guided by a table of specification which helped them to relate to the objective of the study. Omari (2011) defines content validity as the appropriateness of the content of an instrument. To be in line with content validity, different items have been chosen in the test in each of the chosen four mathematic topics relating to different mathematical concepts for the sake of ensuring accurate assessment of the mastery of the concepts.

**Reliability of the Test:** Omari (2011) Defines reliability of a test as the consistency with which examinations measures what they intended to measure. The split half method was used to test the reliability of the test where by a Spearman Brown formula technique was employed to obtain a reliability coefficient r. The reliability coefficient greater than 0.5 implied the test is reliable. The pre- test for both validity and reliability were administered before collection of data so as to avoid the use of wrong tools in the study. The calculated Pearson product moment correlation was 0.63 indicating that the test was valid.

### 3.7.3 Questionnaires

The tool was employed to get the data relating to teachers perceived most mathematical area to teach concepts as well as determining studentsô perceived most difficult mathematics area to learn mathematical concepts. The preference of the use of multiple techniques was based on the belief that there is no single research tool that is adequate in itself in collecting valid and reliable data on a particular problem therefore triangulation approach became inevitable (Omari ,2011).

## 3.8 Data Analysis and Organization Plan

Data analysis is a process that implies editing, coding, classification and tabulation of collected data (Kothari, 2000). Triangulation was used in this study. Omari (2011) clarifies the concept of triangulation as studying the same phenomenon using more than one paradigm, method, design, approach, or instrument, techniques or measure, so as to increase depth of understanding in a given research episode or phenomenon. Triangulation was adopted in this study because one paradigm was not covering a phenomenon quite adequately (Omari, 2011).

### 3.8.1 Quantitative Data Analysis Procedures

Quantitative data analysis was used for the data obtained from structured test and questionnaire. The quantified data was tabulated and calculated in terms of mean score, standard deviation, frequencies, and percentages. They were computed using the excel computer program and SPSS computer program, version 15 of 2007. SPSS was used for computing t- test and Pearson product moment correlation. The final results were summarized and presented in tables.

### 3.9 Ethical Issues Considerations

Ethical procedures for conducting research were highly observed during the process of preparing for and conducting the field study. During the data collection process, informed consent of the respondents was considered, and respondents were assured beforehand of the confidentiality of the information they would provide and participants were left absolutely anonymous. Moreover, the researcher accordingly acknowledged all scholarly work and data consulted including books, journals, theses, and field data.

The national regulations guiding the research enterprise were followed accordingly as the research clearance letter from the Open university of Tanzania was taken to the regional administrative secretary of Mbeya region who released the research permit letter to the three district administrative secretary of Rungwe district, Kyela and Mbeya city. All the three district administrative secretaries issued me an introductions letter to the respective schools.

Deception was used when the researcher wanted mathematics teachers to administer a test for mastery of basic mathematical concepts. Instead of telling them the truth that they were to do the test for comparison with their students which would make teachers ignore the test or work it in a non-natural way, teachers were told that they were required to work out the solution of this test for the sake of investigating the different alternatives of solutions from teachers. After the test, teachers were given the intention of the test with apology. 14 mathematics teachers who were in the form two Busokelo district mock examination mathematics marking panel, were very happy and laughed loudly after being told the reality of the objective.

# CHAPTER FOUR

# ANALYSIS AND PRESENTATION OF RESULTS

## 4.1 Introduction

This chapter presents the findings collected from the sample involved in the study. Data collected from the mastery of basic mathematical concepts tests were presented as they were administered by teachers and secondary school students. The data obtained from questionnaires were also presented in tabular form for easy analysis and interpretations.

The main objective of this study was to assess the mastery of basic mathematical concepts by both teachers and secondary school students in Mbeya region. To be more focused, data presented were organised and analysed according to the objectives of this study which were;-

i. To compare teachers and their students in mastery of basic mathematical concepts.
ii. To assess the areas where teachers and students differ most in mastery of the basic mathematical concepts.
iii. To identify mathematical areas which teachers perceive as more difficult to teach,
iv. To identify mathematical areas which students perceive as being most difficult in learning.

Furthermore hypothesis testing has been employed to give more strong statistical evidence for the verification of the findings.

### 4.2 Teachers and Students' Mastery of Basic Mathematical Concepts

Both students and teachers were given the same test that was constructed specifically to test the mastery of the basic Mathematical concepts in fraction, integers, algebra and ratios. Each item was constructed in such a way that in solving it a respondent would present mental demonstration of the mastery of the Mathematical concepts through the observed conception, representation, connection and application of the concepts. 120 students and 24 teachers did the test and the results were summarized in table 4.1

**Table 4.1: Teachers and Students' Mean Performance in All Tests**

| Type of respondents | n | Total Scores | Mean score | Standard deviation |
|---|---|---|---|---|
| Students | 120 | 3140 | 26.2 | 18.7 |
| Teachers | 24 | 2189 | 91.2 | 3.74 |

**Source:** Research Finding, 2018

Table 4.1 indicates that students performed poorly in the mastery of Mathematical concepts test with a mean score of 26.2% with standard deviation of 18.7 which is quite different from the teachersô performance of the same test whereby, as indicated in the table, teachers mean score was 91.2% with standard deviation of 3.7 The result revealed that students have not mastered basic mathematical concepts in the four mathematical areas of fractions, integers, algebra and ratios. It was expected that studentsô mean performance would range from 65% to 100% for them to demonstrate good mastery of the basic mathematical concepts. On the other hand, the results indicated that teachers had the better mastery of the basic mathematical concepts than their students.

**Testing of Hypotheses:** Hypothesis one stated that, teachers are better in mastery of basic mathematical concepts than secondary school students. Using statistics from table 4.1, the computed p-value is greater than 0.05 which is 0.183 Indicating that teachers were better in mastery of basic mathematical concepts than secondary school students.

### 4.3 Teachers and Students Differ Most in the Mastery of Different Mathematical Concepts

From the mastery of basic mathematical test, items were organised with respect to the subject areas. To identify the respondentôs performance in each mathematical area, the scores were equally distributed to all the four mathematical areas in the study namely fractions, integers, algebra and ratios. Each of these mathematical areas was allocated 25% of the total score and had five items carrying 5marks each when completely done to demonstrate the mastery of the intended concepts. The results for both categories of respondents are presented in table 4.2.

**Table 4.2: Teachers' and Students Performance by Subject Area**

| **Subject Area** | **Students** | | | | **Teachers** | | |
|---|---|---|---|---|---|---|---|
| | n | Mean | Std | | n | Mean | Sd |
| Fraction | 120 | 8.2 | 7.3 | | 24 | 23.2 | 1.5 |
| Integers | 120 | 4.8 | 3.4 | | 24 | 21.0 | 2.5 |
| Algebra | 120 | 2.0 | 3.6 | | 24 | 22.0 | 3.2 |
| Ratio | 120 | 11.1 | 8.8 | | 24 | 23.2 | 1.5 |

**Source:** Research Finding, 2018

Table 4.2 shows that the subject area with the least studentsô mean score was algebra which had a mean score of 2.0 out of 25. Teachersô mean score for algebra

was 22 with standard deviation of 3.2. This indicates that teachers and students differed greatly in the mastery of algebraic concepts. The next poorly performed mathematical area by students was integers with a mean score of 4.8 out of 25 while teachers scored the mean score of 21. The difference between studentsô mean score and teacherôs mean score in integers is 16.2. Studentsô mastery of fractional concepts was reflected by the mean score of 8.2 with standard deviation of 7.3. This standard deviation indicates that studentsô scores were not so uniform in the sense that some students mastered at least some concepts and others had some misconceptions. Teachers in fraction got the mean score of 23.3 with standard deviation of 1.5.

**Table 4.3: The Performance of Students and Teachers in Fraction Items**

| Students | | | | | | | Teachers | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | 1 | 2 | 3 | 4 | 5 | TOTAL | **Item no** | 1 | 2 | 3 | 4 | 5 | TOTAL |
| **N** | 120 | 120 | 120 | 120 | 120 | 120 | **N** | 24 | 24 | 24 | 24 | 24 | 24 |
| **Total** | 247 | 82 | 214 | 244 | 200 | 987 | **Total** | 118 | 115 | 92 | 116 | 116 | 559 |
| **Mean** | 2.1 | 1.0 | 1.8 | 2.0 | 1.7 | 8.2 | **Mean** | 4.9 | 4.8 | 4 | 4.8 | 4.8 | 23.3 |
| **Sd** | 2.3 | 2.0 | 2.1 | 2.1 | 2.0 | 7.3 | **Sd** | 0 | 0.4 | 2.0 | 0.5 | 0.5 | 1.5 |

**Source:** Research Finding, 2018

Studentôs lack of mastery of fraction was so apparent since the performance on every item had a mean less than 2.2 out of the required total marks of 5. Most students failed to demonstrate any idea about the items which implied they had no conception on the intended concepts; they failed to express the word problem in the respective fraction and convert the repeating decimal into fraction which proved their lack of representation. Also most students failed to make connections of the concept of fraction and other mathematical concepts especially as they poorly performed item 2 that required connection between the fractions, the total number of

periods being regarded as a whole (one). Items 2, 3 and 5 were poorly done with average of 1, 1.8 and 1.7 respectively.

Item 2 was the most poorly done since it was a conceptual question that required a respondent to master the interconnection of the following concepts:- a fraction is a part of whole; and a whole thing in fraction is 1. The respondents were asked to write down the fraction left for the other subjects after 1/5 of the total periods per week having been given to English and 1/8 to mathematics. The response to the question was as indicated in figure 4.1.

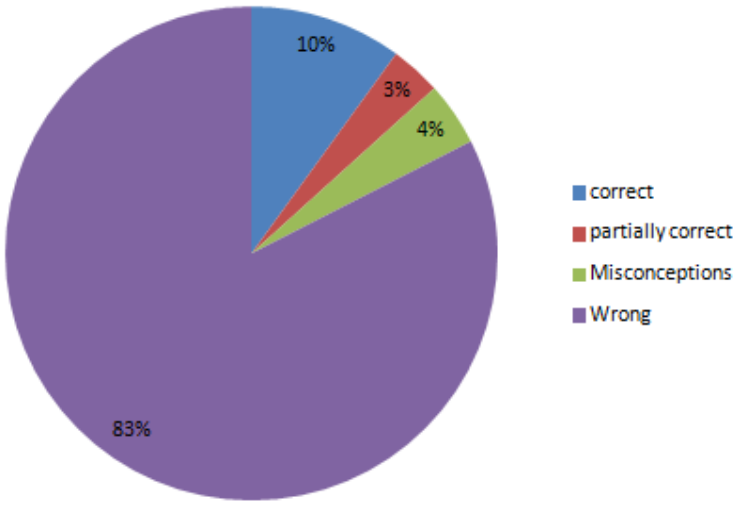


**Figure 4.1: Students' Misconceptions on Item Two of Fractions Test**

**Source:** Research Finding, 2018

Only 10% of the studentôs participants responded correctly while 3% tried to answer the question but they got stuck on the way so they failed to make clear the other logical procedures such as transformation of fractions with different denominators to the fractions with common denominators. 83% of the respondents did not know what to do to solve the question, indicating that they had no concepts of fraction at

all.

On the other hand, teachers on the same item got the mean mark of 4.8 out of 5 and about 97% responded well to the question and they clarified well their solution. Generally teachers demonstrated good mastery of mathematical concepts in fraction contrary to their students.

**Table 4.4**: **The Performance of Students and Teachers in Integers Items**

| **Students (N= 120)** | | | | | | | **Teachers (N = 24)** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item No | 6 | 7 | 8 | 9 | 10 | TOTAL | Item No | 6 | 7 | 8 | 9 | 10 | Total |
| Total | 178 | 0 | 24 | 77 | 298 | **577** | Total | 117 | 45 | 113 | 118 | 117 | 510 |
| Mean | 1.48 | 0 | 0.2 | 0.64 | 2.5 | **4.808** | Mean | 4.88 | 1.88 | 4.708 | 4.9 | 4.9 | 21 |
| Std | 2.05 | 0 | 0.79 | 1.30 | 2.1 | 3.351 | Std | 0.34 | 2.47 | 0.55 | 0.3 | 0.4 | 2.5 |

**Source:** Research Finding, 2018

Table 4.4 indicates the performance of students and teachers in integerôs items. It reveals that students failed to solve a conceptual question number 7 that required to be solved by identifying the maximum number of negative integers when six integers are multiplied to give a negative product. The item meant to test the mastery of the concept of multiplication of integers. The solution required to communicate the idea about how the respondents conceived multiplication, particularly the change of signs as pairs of negatives and negatives are multiplied.

All the student respondents failed to portray the conception and representation of the concept of multiplication of integers. The solution of item 8 required the respondents

to give the number of integers found in the range from -3 to 6 but most students failed to solve the item and scored the mean mark of 0.2 out of 5marks located to the question. On the other hand, teachers got a challenge on item 7 whereby they scored a mean mark of 1.88. However other items in integers were properly solved, demonstrating high mastery of integers.

**Table 4.5: The Performance of Students and Teachers in Algebra Items**

| | Students (No = 120) | | | | | | Teachers (No = 24) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item no** | 11 | 12 | 13 | 14 | 15 | **Total** | **Item No** | 11 | 12 | 13 | 14 | 15 | **Total** |
| **Total** | 61 | 19 | 59 | 82 | 15 | 238 | **Total** | 116 | 117 | 81 | 120 | 93 | 527 |
| **Mean** | 0.51 | 0.16 | 0.49 | 0.68 | 0.13 | 1.98 | **Mean** | 4.8 | 4.88 | 3.4 | 5 | 3.9 | 22 |
| **Sd** | 1.25 | 0.66 | 1.32 | 1.49 | 0.72 | 3.63 | **Sd** | 0.5 | 0.45 | 2.2 | 0 | 1.7 | 3.2 |

**Source:** Research Finding, 2018

The most poorly done concepts in the test by students were in algebra. The average performance of every item was less than 1 and the two most poorly done items were item 12 and 15. The solution of item 12 required a participant to demonstrate the mastery of the concept of algebra by representing an algebraic expression from the simple word problem that also demanded to apply algebra to solve how many examination papers were left after the unknown number of examination papers represented by the letter m had been done from the total of eleven examination papers.

The solution required realizing the presence of unknown number of examination papers having been done and that paper left. The results gave evidence of the lack of mastery of the concept of algebra. The answer to the item was examination papers left = 11- m. About 96% of all student respondents failed to apply the concept of

algebra in solving the equation. Likewise 88% of all student respondents failed to conceive, represent and apply algebraic concept created from geometrical figure in item 15. The item provided two dimensions of the lengths of opposite sides of a rectangle as ¼(q-6) meters and 48meters.

The solution required to equate the two sides and then solve for the value of q. But still the item could be well done by students who have mastered well concepts of algebra, fractions, and geometry by which the connection of the concepts of algebra to other areas and the application of algebra would prove the mastery of the concept by the respondents.

**Table 4.6: Students' Performance in Selected Algebra Items**

| Item No. | **Description of response** | **correct** | **Partially correct** | **Misconception** | **Wrong** | **Total** |
|---|---|---|---|---|---|---|
| | score | 5-4 | 3-2 | 1 | 0 | 5 |
| | Number of respondents | 1 | 4 | 6 | 109 | 120 |
| 12 | Percent | 0.83 | 3.34 | 5 | 90.8 | 100 % |
| | Number of respondents | 10 | 4 | 4 | 102 | 120 |
| 13 | Percent | 8.32 | 3.34 | 3.34 | 85.0 | 100 |
| | Number of respondents | 1 | 0 | 3 | 116 | 12o |
| 15 | Percent | 0.83 | 0 | 2.5 | 96.67 | 100 |

**Source:** Research Finding, 2018

Furthermore, from Table 4.6, 90.83% of the students had completely no concept on item 12, and 85% of all the student respondents had completely no concept on item 13, and 96.67% had completely no concept on item 15. Compared to students in mastery of algebra concepts, teachers mastered well the concepts since the mean score on every item was above 4 out of 5 except on item 13 and 15 which had the

mean score of 3.4 and 3.9 respectively. Minor misconceptions were found in the solutions from 3 teachers for items 13 and 15.

**Table 4.7: Performance on Every Item in Ratio Concepts**

| | Students (N = 120) | | | | | | Teachers (N = 24) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **16** | **17** | **18** | **19** | **20** | **Total** | **16** | **17** | **18** | **19** | **20** | **Total** |
| **Total** | 180 | 278 | 249 | 296 | 327 | 1330 | 120 | 120 | 120 | 120 | 120 | 600 |
| Mean | 1.5 | 2.3 | 2.1 | 2.5 | 2.7 | 11.1 | 5 | 5 | 5 | 5 | 5 | 25 |
| **Sd** | 2 | 2.2 | 2.1 | 2.2 | 2.2 | 8.8 | 0 | 0 | 0 | 0 | 0 | 0 |

**Source:** Research Finding, 2018

Table 4.7 indicates that, studentôs mean score for Ratio items was 11.1 out of 25 with the standard deviation of 8.8 indicating that there was variation in mastery of the concepts of ratio among students. Even though the performance in ratio was somehow better than in other concepts, actually the mastery of concepts by students was not good as compared to teachers. Teachers mean score on the same area was 24 with the standard deviation of zero.

Item 16 in ratio concepts, was poorly performed by most student respondents with a mean of 1.5 out of 5. The solution of this item required a respondent to conceive the concept of ratio in connection to geometrical concepts by considering the total degrees of angles of a triangle to be $180^o$, and then apply the concept of ratio to solve the measure of each angle of the triangle. The respondents had to find the size of the ratio by adding $5 + 7 + 8 = 20$ from the given ratio 5:7:8 then determine the measure of each angle by multiplying $5/20 \times 180^0 = 45^0$, $7/20 \times 180^o = 63^o$, and $8/20 \times 180^o = 72^o$. Then the largest angle is $72^o$.

On the other hand, teachers were very competent in this area. No misconceptions were identified in the solution in this area. Different alternatives on how to solve the question were observed which indicated high degree of mastery of the concept of ratio.

### 4.3.1 Testing of Hypothesis Two

Hypothesis two stated that, teachers and students differ most in the mastery of algebra concepts followed by integers. Using diagnostic assessment from table 4.2, it shows that the subject area with the least studentsô mean score was algebra which had a mean score of 2.0 out of 25. Teachersô mean score for algebra was 22 with standard deviation of 3.2. This indicates that teachers and students differed greatly in the mastery of algebraic concepts. Teachers and students difference in the mastery of algebra concepts followed by integers, the calculated p-value was greater than 0.05 which is 0.162 which indicates teachers and students differed most in the mastery of algebraic concepts followed by integers.

## 4.4 Most Difficult Mathematical Concepts to Teach as Perceived by Teachers

**Table 4.8: Most Perceived Difficult Mathematical Concepts to Teach**

| Mathematical area | Very simple | | simple | | Difficult | | Most difficult | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | Number | % |
| Fraction | 8 | 33.3 | 14 | 58.4 | 2 | 8.3 | 0 | 0 | 24 | 100 |
| Integers | 1 | 4.2 | 6 | 25.0 | 8 | 33.3 | 9 | 37.5 | 24 | 100 |
| Ratios | 18 | 75 | 6 | 25 | 0 | 0 | 0 | 0 | 24 | 100 |
| Algebra | 2 | 8.3 | 3 | 12.5 | 7 | 29.2 | 12 | 50.0 | 24 | 100 |

**Source:** Research Finding, 2018

Four selected mathematical area were listed to allow a respondent to rank all of them according to the perceived level of difficulty. From table 4.8, Algebra was highly

ranked by 79.2% of the respondents as difficult concepts to teach. Integers was ranked by a total of 70.8% as difficult mathematical concepts to teach followed by fraction which was ranked by 8.3 as difficult concepts to teach. No respondent ranked ratio as difficult concepts to teach.

### 4.4.1 Testing of Hypothesis Three

Hypotheses three stated that teachers perceive integers and algebra as more difficult mathematical concepts to teach than fraction and ratios. The test of this hypothesis was conducted using diagnostic assessment of the perceived most difficult mathematical concepts to teach. A list of four basic mathematical concepts was provided through questionnaires and teachers were asked to rank them according to the level of difficulty. The results indicate that teachers perceive algebra as more difficult mathematical concepts to teach followed by integers than fraction and ratios.

## 4.5 Perceived Most Difficult Mathematical Concepts to Learn

The study attempted a diagnostic assessment of the perceived most difficult mathematical concepts to learn. Four selected mathematical area were listed to allow respondents to rank all of them according to the perceived level of difficulty.

**Table 4.9 Students' Perceived Most Difficult Mathematical Concepts to Learn**

| Mathematical area | Very simple | | simple | | Difficult | | Most difficult | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | Number | % |
| Fraction | 16 | 13.3 | 59 | 49.2 | 28 | 23.3 | 17 | 14.2 | 120 | 100 |
| Integers | 18 | 15.0 | 21 | 17.5 | 35 | 29.2 | 46 | 38.3 | 120 | 100 |
| Ratios | 79 | 65.8 | 23 | 19.2 | 15 | 12.5 | 3 | 2.5 | 120 | 100 |
| Algebra | 22 | 18.3 | 26 | 21.7 | 63 | 52.5 | 9 | 7.5 | 120 | 100 |

**Source:** Research Finding, 2018

From the findings presented in table 4.9 it was revealed that 67.5% of student respondents ranked integers as difficult subject area to learn. Algebra was ranked by 60% of respondents as difficult mathematical concepts to learn, Fraction was ranked by 37.5% of the respondents as difficult mathematical concepts to learn, while ratios were ranked by only 15% of the respondents as difficult concepts to learn.

### 4.5.1 Testing of Hypothesis Four

Hypotheses four stated that, students perceive integers and algebra as more difficult mathematical concepts to learn. The test of this hypothesis was conducted using diagnostic assessment of the perceived most difficult mathematical concepts to learn from table 4.9. The results indicate that, students perceive integers as most difficult mathematical area to learn followed by algebra concepts.

# CHAPTER FIVE

# DISCUSSION OF THE RESULTS

## 5.1 Introduction to the Chapter

This chapter presents the discussion of the collected and analysed data. The chapter presents the researcherôs perspective based on what his study has revealed and tries to clarify why such findings were like that. In discussion, the supports of the findings from other research studies with similar findings are included to see its relevance. For clarity reasons, discussion is organised basing on specific objectives.

## 5.2 Findings from Each Specific Objective

### 5.2.1 Teachers and Students Mastery of the Basic Mathematical Concepts

Basing on the results of this study, it was revealed that, teachers are better in mastery of basic mathematical concepts than secondary school students. It has been found that, there is a big difference in mastery of basic mathematical concepts between teachers and students. It has been shown that teachers performed very well in the mastery of basic mathematical test with a mean of 91.2 and standard deviation of 3.7 and on the other hand, students performed poorly in the same test with a mean of 26.2 and standard deviation of 18.7.

Most students demonstrated misconception errors in their solution and ended up getting wrong answers in every areas of study which were fraction, integers, algebra and ratios. This finding is supported by Mbugua (2012) who found that students had considerable difficulties with mathematical skills and concepts and reveals further that misconceptions in mathematics may be attributed to inability to communicate

using appropriate terms, symbols, and structure. Further support to this finding is from the study done by Ndalichako (2013) who revealed that a considerable number of candidates could not perform correctly operations related to fractions. They tended to confuse fraction concepts with whole number concepts.

Khalid and Badarudin (2013) reports that secondary school students in Brunei Darussalam tend to get confused with the signs and operations on integers although teachers had attempted to explain about it several times. They further report that students got mixed-up with operation and signs when there are subtraction and negative signs in a problem. As well, Mahlabela (2012) in his case study of grade 9 learners from a rural KwaZulu-Natal school, reports that learner scripts and interviews reflect superficial or no understanding of ratio and those learners did not portray the correct conceptualization of ratio.

The reasons for the difference in mastery of basic mathematical concepts between teachers and students may be attributed to negligence by teachers to pay serious attention in teaching these basic concepts which are perceived simple by both students and teachers thus regarding them trivial. Ndalichako (2013) reveals that fractions require a deeper understanding of computational procedures than that typically required with whole numbers. In Tanzania, the topic of fractions is an integral part of primary school mathematics syllabus which is introduced as early as pupils start grade I, yet it is one of the most difficult areas for pupils to master (Ndalichako, 2013). Siebert and Gaskin, (2006) contended that children are bound to find fractions computations arbitrary, confusing and easy to mix up unless they receive assistance in understanding what fractions and fraction operations mean.

Kisakali and Kuznetsov (2015) reports that, two factors were identified to have a significant effect on the mathematics performance. These factors were lack of interest while studying mathematics and triviality and lack of practice by students. Also Adegun and Adegun,(2013) found that, both teachers and students identified their low level of commitment as the reason for the poor performance in mathematics. Both teachers and students accepted low level of commitment on the part of teachers /un-care attitude of students as the major reason for perceived levels of difficulty in mathematics. Teachers ranked poor knowledge of subject matter as the least important reason for perceiving a topic as difficult to teach while students saw wrongly deployment of teachers as the main reason for perceiving a topic difficult (Adegun and Adegun, 2013).

Another reason for the difference in mastery of basic mathematical concepts between teachers and students may be teachersô lack of adequate pedagogical knowledge. In fact the effective teacher has a role to facilitate the student mastery of mathematical concepts. It is expected that any concepts mastered by a teacher was to be facilitated well so that students also master the concepts at the same degree. If this does not happen, then one cannot hesitate to question teachersô pedagogical knowledge. Kitta (2004) reveals out teachers' lack of required qualification in teaching mathematics in Tanzania. He further reports that most of them have problems with the subject matter content knowledge and skills.

Any effective teacher with good pedagogical mathematical content knowledge keeps in mind that learners make mistakes for many reasons, including insufficient time or care. But errors also arise from consistent, alternative interpretations of mathematical

ideas that represent the learnerôs attempts to create meaning. Rather than dismiss such ideas as ñwrong thinkingò, effective teachers view them as a natural and often necessary stage in a learnerôs conceptual development. For example, young children often transfer the belief that dividing something always makes it smaller to their initial attempts to understand decimal fractions. Effective teachers take such misconceptions and use them as building blocks for developing deeper understandings.

### 5.2.2 Areas where Teachers and Students differ Most in their Mastery of Mathematical Concepts

To identify the respondentôs performance in each mathematical area, the scores were equally distributed to all the four mathematical area in the study namely fraction, integers, algebra and ratios. Each of these mathematical areas was allocated 25% of the total score and had five items carrying 5marks each when completely done to demonstrate the mastery of the intended concepts through conception, representation, connection and application of the concept.

The results indicates that teachers and students differ most in the mastery of concepts of algebra whereby teachers had a mean of 22 marks with standard deviation of 3.2 while students had a mean mark of 1.98 with standard deviation of 3.6. This is supported by Witzel, Mercer, and Miller, (2003) who reported that, despite the importance placed on algebra in school Mathematics curricula, many students found it abstract and difficult to comprehend. They further argued that, students cannot understand simple algebraic concepts such as variables, expressions and equivalence. The big difference in mastery of the basic concepts among teachers and students

was also found in integers where students performance was 4.8 mean mark with standard deviation 0f 3.4 followed by fractions with studentsô mean score of 8.2 and standard deviation of 7.3. Similar findings were reported by Khalid and Badarudin (2013). Teachersô mean score for integers was 21 out of 25 with standard deviation of 2.5 and they got the mean mark of 23.3 in fractions with standard deviation of 1.5. Even though the apparent difference in the mastery of basic mathematical concepts was still in ratio by students scoring the mean mark of 11.1 while teachers scored the mean mark 0f 23.2 0ut of 25 yet we conclude to say at least students demonstrated some degree of mastery of the concept of ratio.

The most remarkable poorly done area in the test by students was algebra and which revealed the big difference in the concept mastery. Algebra was analysed further, and the mean performance of every item was less than 1 and the most 2 poorly done items were item 12 and 15. Further findings of the study shows that 90.8% students had completely no concept on item 12, 85% of all the student respondent had completely no concept on item 13, and 96.7% had completely no concepts on item 15. But also it was found that studentôs lack of mastery of fraction was so apparent since the performance on every item had a mean less than 2.2 out of the required total marks of 5. Items 2, 3 and 5 were poorly done with average of 1, 1.8 and 1.7 respectively.

Only 10% of the studentôs participants responded correctly while 3.3% tried to answer the question but they got stack on the way so failed to make clear the other logical procedures. 82.5% of the respondents did not know what to do to solve the question, indicating that they had no concepts at all. On the other hand, teachers on

the same item got the mean mark of 4.8 out of 5 and about 97% responded well to the question and they clarified well their solution to demonstrate conception, representation, connection and application of algebra concepts. Generally teachers demonstrated good mastery of Mathematical concepts in fraction contrary to their students.

The reason for teachers and students differing most in the mastery of algebra might among other things be attributed to Tanzanian overloaded mathematics curriculum that could be disastrous to the development of Mathematical literacy. Kajoro (2015) argues that in spite of embracing the learner-centred approach to education at all levels of basic education, the Tanzanian classroom reality on all counts promotes the content-centred approach; for coverage of the curriculum/syllabus seems to background any attempt to put the learner at the centre of the teaching and learning process. A physical count of topics from the ordinary secondary school syllabus gave the total topics of 38 topics to be covered over four years (The united republic of Tanzania: Ministry of Education and Culture. 2005).

Even after providing for some topic overlaps, these are still too many topics considering that there are only about 6 Mathematics lessons per week. After one provides for school vacations and public holidays in a year, one can reasonably assume that on an average of one topic per week had to be covered at secondary school level. This is an extremely fast pace; it cannot allow for thorough mastery of the content on the part of all learners, especially for secondary school (Kajoro, 2014). It therefore forces teachers to accelerate the curriculum so that at the end of the day they are not accused of not having covered the syllabus.

Teachers lacking pedagogical content knowledge have been well reported by Kitta (2004). Even though the teaching national wise was in the paradigm shift from traditional teaching of content based to competence based approach, it seems teachers have not practically adopted the change. Chick and Baker (2005) puts it clear that, what was noticeable in the teachersô responses was the lack of conceptual support for teaching the procedure, such as modelling the algorithm. For some teachers, the careful articulation of a well-developed sequence of ideas seemed to reflect deep understanding of concepts and strategies for making those ideas meaningful for students. In other cases, the concepts were not well-linked, nor were concepts well-supported pedagogically.

Kitta (2004) found that teachers differed in terms of their proficiency in subject matter knowledge. The four teachers marked 'sufficient' were able to explain the concepts clearly and tried as much as possible to present the lessons logically. The four teachers marked 'satisfactory' could clarify few concepts clearly and the four teachers marked 'support needed' had problems in clarifying and defining the concepts. Another reason for the difference in mastery of mathematical concepts is the difference in English mathematical language proficiency among students and teachers. Kajoro (2014) reports that both teachers and students have not mastered English adequately to be able to learn in it, a good number of education stakeholders would still insist on learning all subjects in English.

### 5.2.3 Teachers' Perceived Most Difficult Subject Areas to Teach Concepts

Algebra was highly ranked by 79.2% of the respondents as difficult concepts to teach, The finding is supported by Witzel, Mercer, and Miller, (2003) who reported

that, despite the importance placed on algebra in school Mathematics curricula, many students found it abstract and difficult to comprehend. Integers were ranked by a total of 70.8% as difficult mathematical concepts to teach followed by fraction which was ranked by 8.3% of respondents as difficult concepts to teach. No respondent ranked ratios as difficult concepts to teach.

It sounded not strange that, the subjectôs area that teachers perceived most difficult to teach was not different from what was practically revealed by this study through the results of the mastery of basic mathematical concepts tests. This study revealed that algebra, integers, and fractions were the most three difficult mathematical area in teaching concepts. Strong support of the findings of this study was Ndalichako (2013) who reported that fractions cause difficulty to most people because they involve relations between quantities. Khalid and Badarudin (2013) also reported that students got mixed-up with operation and signs when there are subtraction and negative signs in a problem.

Probably what made teachers perceive  algebra and integers as the most difficulty mathematics concepts to teach, is due to the fact that they never try to question themselves what constitutes these subject areas. Booth (2011) identified a number of misconceptions in algebra, including that students believe that the equals sign is an indicator of operations to be performed, that negative signs represent only the subtraction operation, and do not modify terms that subtraction is commutative, and that variables cannot take on multiple values. Booth (2011) recommended helping students master both concepts and skills and maintained that preparation for algebra requires simultaneous development of conceptual understanding and computational

fluency, as well as cultivation of students' skill at solving problems.

There is a strong need to keep consistent recommendation that teachers focus on mastery of concepts in mathematics. Ndalichako (2013) reports that, studentsô difficulties in learning fractions emanate from the fact that most teachers devote too much time to teaching the procedures of manipulating fractions and too little time to teaching their conceptual meaning. In order to achieve this goal, teachers must first understand what conceptual and procedural knowledge are, how these forms of knowledge differ from each other, and the relations among the two types of knowledge (Booth, 2011). Booth (2011) Defines conceptual knowledge

> *"as recognizing and understanding the important principles or features of a domain as well as interrelations or connections between different pieces of knowledge in the domain and in contrast, the author defines, procedural knowledge as the ability to carry out a series of actions to solve a problem. In short, procedural knowledge can be operationally defined as how to do something, and conceptual knowledge as an understanding of what features in the task mean".*

### 5.2.4 Students' Perceived Most Difficult Subject Area to Learn

The study was conducted in order to identify studentsô perceived most difficult mathematical area to learn among the four concepts namely, fractions, integers, algebra and ratios. The findings revealed that 67.5% of student respondents ranked integers as difficult subject area to learn. The finding is supported by Khalid and Badarudin (2013) who reported that, secondary school students in Brunei Darussalam tended to get confused with the signs and operations on integers. Algebra was ranked by 60% of the respondents as difficult concepts to learn. This result is also reflected by the studentsô poor performance in the mastery of basic mathematical concepts test, they administered during this study. In this test, the

subject area with the least studentsô mean score was algebra with a mean score of 2.0 out of 25. The results were not strange, Witzel, Mercer, and Miller (2003), found that, despite the importance placed on algebra in school mathematics curricula, many students found it abstract and difficult to comprehend.

In real life, algebra merges into all other areas as a tool. Whenever life throws a mathematical problem at you, for example when you have to solve an equation or work out a geometrical problem, algebra is usually the best way to attack it. We actually need algebra, to solve most of our problems that involves calculations (Erdoĵan and ķengü, 2014). Studentsô poor mastery of algebraic concepts puts them in the disadvantage of development of problem solving skills not only in algebraic equations, but also in all mathematical areas requiring algebra prior knowledge such as functions, logarithms, probability, linear programming to mention few. In other words, students with strong conceptual knowledge about a topic are likely to continue to learn more because their prior knowledge makes it easier for them to process and use new information related to that topic (Booth, 2011).

In this study, fraction was ranked by 37.5% of the respondents as difficult mathematical concepts to learn. The results from the mastery of basic mathematical test the students administered during this study reveals that, students got the mean score of 8.2 out of 25 in fraction concepts, indicating poor mastery of the concepts of fractions. Siebert and Gaskin, (2006) contended that children are bound to find fractions computations arbitrary, confusing and easy to mix up unless they receive assistance in understanding what fractions and fraction operations mean. Ndalichako (2013) reveals that, fractions require a deeper understanding of computational

procedures than that typically required with whole numbers. To develop deeper understanding requires high degree of studentsô commitment towards learning the concepts.

Kisakali and Kuznetsov (2015) reported that, two factors were identified to have a significant effect on the mathematics performance. These factors were lack of interest while studying mathematics and triviality and lack of practice by students. Ndalichako (2013) argued that lack of proper knowledge of fractions could cause disastrous effect to studentsô progress in learning other areas of mathematics. It is therefore, very important for teachers to focus on teaching the mastery of concepts for the better student progress in learning mathematics.

# CHAPTER SIX

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Introduction

This chapter presents summary, conclusion, and recommendations with regards to the study that aimed at investigating the mastery of basic mathematical concepts by both teachers and secondary school students in Mbeya Region. This chapter is divided into three parts which include:- Summary, Conclusion, and Recommendations of the study.

## 6.2 Summary of the Study

The study was conducted for the purpose of investigating the mastery of basic mathematical concepts among teachers and students in Mbeya region. More specifically, the study intended to compare teachersô mastery of the basic mathematical concepts and their studentsô mastery of the concepts. Secondly, to assess the areas where teachers and students differ most in their mastery of mathematical concepts, and then, to identify mathematical areas which teachers perceive as more difficult in teaching their concepts and lastly, to identify mathematical areas which students perceive as most difficult in learning.

The literature reviewed had indicated the great need for the mastery of mathematical concepts being very important for the studentsô future mathematical progress. However the focus of the study was on four basic mathematical concepts, namely fractions, integers, algebra, and ratios. A sample of this research involved a total of 120 secondary school students and 24 mathematics teachers from 10 secondary schools.

The mastery of basic mathematical concepts test included algebra, integers, fractions, and ratios .The items for the test were derived from secondary school syllabus. The test was administered by both students and teachers in order to test their mastery in the basic mathematical concepts. Lastly the questionnaire was used to collect data relating to both teachersô and studentsô perceptions on the most difficult mathematical concepts to learn.

### 6.3 Summary of the Main Findings

The study revealed the following findings:-

i. Secondary school teachers are better in Mastery of basic mathematical concepts than secondary school students in Mbeya region, Tanzania.
ii. Secondary school teachers and students differed most in mastery of Algebraic concepts followed by integers.
iii. Secondary school teachers perceived Algebra as the more difficult mathematical concepts to teach followed by integers than fraction and ratios
iv. Students perceived integers as the more difficult mathematical concepts to learn followed by algebra than fraction and ratios.

Generally, the study indicates that, there was a great difference in mastery of mathematical concepts among teachers and students. While teachers showed high degree of mastery of mathematical concepts in fractions, integers, algebra and ratios with the mean score 91.2% students were found to be very poor in mastery of the basic mathematical concepts in the study scoring the mean score of 26.2%. Studentsô problems of misconceptions were very high in algebra where by their mean score was 2.0 % out of 25% of the required total scores for this area. Integers

was the next poorly done followed by fraction while ratios was at least at a moderate level of mastery.

The highly ranked most difficult mathematical areas to teach were algebra, and integers. The results in this section were reflected by the studentsô poor performance in the mastery of the basic mathematical concepts test, they administered during this study. On the other hand, the highly ranked most difficult mathematical areas to learn by students were integers, followed by algebra. These results were in agreement with the studentsô poor performance in the mastery of the basic mathematical concepts test, they administered during this study.

**6.5 Conclusions**

From the results, studentsô mastery of basic mathematical concepts in fractions, integers, algebra and rations is very poor. Lack of mastery of these mathematical concepts has disastrous effects on the studentsô learning of other mathematical areas. Mistakes students make when solving mathematics problems is partly due to studentôs lack of understanding of mathematical concepts. Misconceptions of these basic concepts are detrimental to students' performance on equation-solving tasks. Students who begin an equation-solving lesson with misconceptions learn less from a typical algebra lesson than students with more sound conceptual knowledge.

Achievement in mathematics could be improved by stressing the mastery of mathematical concepts. The mastery teaching approach should be emphasized in the teaching and learning processes in order to improve the achievement in mathematics. Teachers should be trained to take into consideration the importance of mathematical

language in their planning of the lessons so that their teaching should include definitions of mathematical language in lessons, set questions that would require definitions of mathematical terms, symbols or structure and award marks for the definitions.

### 6.4 Recommendations for Actions and Further Research

The researcher recommends the following after addressing the problem of studentsô poor mastery of basic mathematical concepts :-

i. Mathematics syllabus should emphasize mastery of mathematical concepts as part of the content to be learned as well as locating adequate time for coverage of topics. The researchers accepts what the very current literature recommends:- Kajoro (2015) recommends that overloaded mathematics curriculum can be disastrous to the development of mathematical literacy, and he further reasonable suggests that less loaded mathematics curriculum may allow mathematics learners to interact with mathematical activities that would make them mathematically literate, thus improving their performance and science subjects. There is also a strong need for the reorganization of mathematics textbooks to include clarification of mathematical concepts as contents to be taught.

ii. Mathematics teachers training programs need to be rechecked, so that the relevant mathematical pedagogical knowledge is imparted to them to the extent that they cannot allow studentsô accumulated misconceptions of mathematical concepts that cost the national mathematical development contrary to the national educational policy. The training of mathematics

teachers should to make teachers conversant with the concept and requirements of competent based curriculum, which is being implemented in schools.

iii. The government should revise its system that allows standard seven primary school pupils to sit for a mathematics examination of multiple-choice questions since this system has long ï term devastating effects to the national education system. The recommended system of primary school mathematics examination should require the candidates to do calculations to get answers.

Further studies need to be done in the following:-

i. To investigate how mathematics teachers respond to studentsô misconceptions in classrooms at both primary school and secondary schools in Tanzania.

ii. To assess the mastery of other elementally mathematical concepts among primary school teachers and pupils in Tanzania.

iii. Investigate how mathematics student teachers are trained to teach the mastery of mathematical concepts in Tanzania.

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# APPENDICES

## APPENDEX A: LIST OF CONCEPT TESTED

1. Algebra
2. Integers
3. Fractions
4. Ratios

**APPENDEX B: Mastery of Basic Mathematical Concept Tests**

**Instructions**

**TIME: 2:00 HRS**

**i.** This test consists of four parts, answer all questions from every part.

**ii.** Every part carry equal marks.

**PART A**

| QnN | QUESTION | SOLUTION/WORKING AREA |
|---|---|---|
| 1 | Arrange the following numbers from the largest to smallest. $\frac{2}{5}, \frac{5}{12}, \frac{3}{2}, \frac{7}{20},$ □□□ $\frac{3}{5}$ | |
| 2 | $\frac{1}{5}$ of the total number of periods per week of a class timetable is given to English and $\frac{1}{8}$ to mathematics. What fraction is left for the other subjects? | |
| 3 | Express $2.\dot{7}\dot{0}$ as fraction in the form of a/b where and b are integers and bÍ 0 | |
| 4 | What is the denominator when 5/6 is multiplied by 7/8 | |
| 5 | Add 2/5 to 7/8 and then subtract 5/6 from the result. | |

**PART B:**

| QN | QUESTION | SOLUTION/WORKING AREA |
|---|---|---|
| 6 | Arrange the following integers in the ascending order (From the smallest to the biggest integers) -4, -10, -1, -20, -13 | |
| 7 | If the product of 6 integers is negative, find the maximum number of integers in that product which are negative | |
| 8 | How many integers are there between the range -3 and 6 | |
| 9 | Simplify $14 - (-2 - (8 + 2) + 5)$ | |
| 10 | Use the number line to find the sum of -5 and -2 | |

**PART C:**

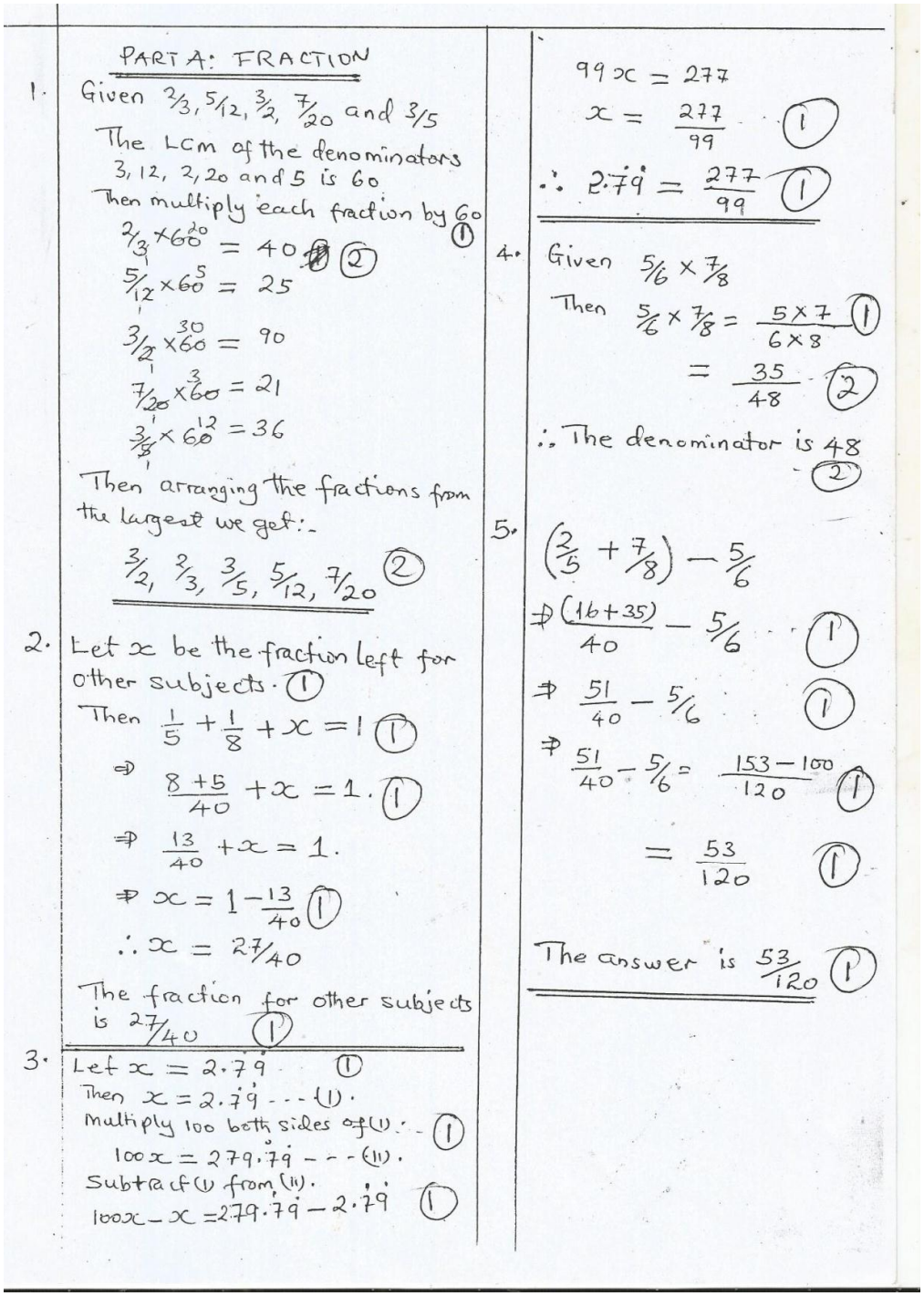
| QTN | QUESTION | WORKING AREA |
|---|---|---|
| 11 | A number is multiplied by 3 and 4 is added to the product. Write down an expression for the result | |
| 12 | A form two students has to do eleven examination papers. The student has already done m of them. How many examination papers have been left. | |
| 13 | Two numbers are such that the first number plus the second number is 7. The first number minus twice the second number is 1. Find the numbers | |
| 14 | Simplify 3a ï 3b ï 7a + 6c + 7a + 8b | |
| 15 | Mr. Jumbe has a rectangular farm of opposite sides ¼ (q -6)metres and 48metres. Find the value of q | |

**PART D:**

| QN | QUESTION | SOLUTION/WORKING AREA |
|---|---|---|
| 16 | If the angles of a triangle are in the ratio of 5:7:8. Find the largest angle of this triangle. | |
| 17 | George and Asha shared 35 mangoes in the ratio 2:3. How many mangoes did each get? | |
| 18 | A cake A contains some wheat flower and some sugar in the ratio of 3:5, while cake B contains some wheat flower and some sugar in the ratio of 3:4. From the two cakes which one contains greater ratio of the mixture? | |
| 19 | Three persons A, B and C divided Tshs. 480,000 among themselves in the ratio of 3:4:5 respectively. How much money did each get? | |
| 20 | An amount of Tsh. 1,430/= is divided in the ratio of 2:4:5. Find the difference between the largest and smallest amount of this money. | |

**Thank you for cooperation**

**APPENDIX C: Marking Scheme For The Mastery Of Basic Mathematical Concepts**



PART A: FRACTION

1. Given $\frac{2}{3}, \frac{5}{12}, \frac{3}{2}, \frac{7}{20}$ and $\frac{3}{5}$

The LCM of the denominators 3, 12, 2, 20 and 5 is 60

Then multiply each fraction by 60 (1)

$\frac{2}{3} \times 60^{20} = 40$ (2)

$\frac{5}{12} \times 60^{5} = 25$

$\frac{3}{2} \times 60^{30} = 90$

$\frac{7}{20} \times 60^{3} = 21$

$\frac{3}{5} \times 60^{12} = 36$

Then arranging the fractions from the largest we get:-

$\frac{3}{2}, \frac{2}{3}, \frac{3}{5}, \frac{5}{12}, \frac{7}{20}$ (2)

2. Let $x$ be the fraction left for other subjects. (1)

Then $\frac{1}{5} + \frac{1}{8} + x = 1$ (1)

$\Rightarrow \frac{8+5}{40} + x = 1.$ (1)

$\Rightarrow \frac{13}{40} + x = 1.$

$\Rightarrow x = 1 - \frac{13}{40}$ (1)

$\therefore x = \frac{27}{40}$

The fraction for other subjects is $\frac{27}{40}$ (1)

3. Let $x = 2.7\dot{9}$ (1)

Then $x = 2.7\dot{9}$ ---(i).

Multiply 100 both sides of (i). (1)

$100x = 279.\dot{7}\dot{9}$ ---(ii).

Subtract (i) from (ii).

$100x - x = 279.\dot{7}\dot{9} - 2.7\dot{9}$ (1)

$99x = 277$

$x = \frac{277}{99}$ (1)

$\therefore 2.7\dot{9} = \frac{277}{99}$ (1)

4. Given $\frac{5}{6} \times \frac{7}{8}$

Then $\frac{5}{6} \times \frac{7}{8} = \frac{5 \times 7}{6 \times 8}$ (1)

$= \frac{35}{48}$ (2)

$\therefore$ The denominator is 48 (2)

5. $\left(\frac{2}{5} + \frac{7}{8}\right) - \frac{5}{6}$

$\Rightarrow \frac{(16+35)}{40} - \frac{5}{6}$ (1)

$\Rightarrow \frac{51}{40} - \frac{5}{6}$ (1)

$\Rightarrow \frac{51}{40} - \frac{5}{6} = \frac{153-100}{120}$ (1)

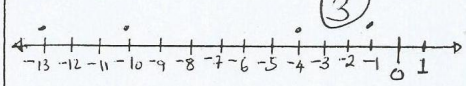
$= \frac{53}{120}$ (1)

The answer is $\frac{53}{120}$ (1)

PART B. INTEGERS

6. Given integers $-4, -10, -1, -20, -13$

Using a number line locate every given integer on it. (3)




Arranging the given integers from the smallest to the largest we get:-

$-20, -13, -10, -4, -1$ (2)

7. Given the product of any six integers is negative. To get the maximum number of negative integers we consider the pairs for the negative integers such that

$(-\times-)\times(-\times-)\times(-\times+ve) = -ve$ (2)

Another pair $(-\times-)\times(-\times+)\times(+\times+) = -ve$,

∴ The maximum number of negative integers is 5 (3)

8. Required to list integers between the range $-3$ and 6.

Then the integers are

$-2, -1, 0, 1, 2, 3, 4$ and 5 (4)

Then there are eight integers between $-3$ and 6. (1)

9. Given to simplify

$14-(-2-(8\div 2)+5)$

$\Rightarrow 14-(-2-4+5)$ (1)

$\Rightarrow 14-(-2+1)$ (1)

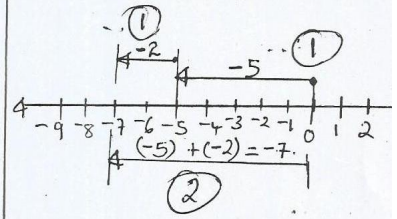
$\Rightarrow 14-(-1)$ (1)

$\Rightarrow 14+1$ (1)

$15$ (1)

10. To use a number line to find $(-5)+(-2)$

(1)




(1) (2)

∴ $(-5)+(-2) = -7$ (1)

## PART C: ALGEBRA

11. Let $x$ be the unknown number (2)

Then $3x + 4$ (2)

∴ The required expression is $3x + 4$ (2)

12. Let $x$ be the number of exam papers which have been left. (1)

Then $x + m = 11$ (1)

$x + 3 = 11$ Since $m = 3$ (1)

$x = 11 - 3$

∴ $x = 8$ (1)

8 exam papers have been left. (1)

13. ~~Two~~ Let $x$ be the first number (2)

$y$ be the second number

Then $x + y = 7 \cdots (i)$ (1)

$x - 2y = 1 \cdots (ii)$

By substitution

from (ii) $x = 1 + 2y$

Then (i) becomes

$1 + 2y + y = 7$

$3y = 7 - 1$

$3y = 6$

$y = 6/3 = 2$ (1)

Since $x = 1 + 2y$

$= 1 + 2 \times 2$

$= 5$ (1)

Then the two numbers are

Alternatively; Use elimination method.

$x + y = 7 \cdots (i)$ (1)

$x - 2y = 1 \cdots (ii)$ (1)

$-\begin{bmatrix} x + y = 7 \\ x - 2y = 1 \end{bmatrix}$ (1)

$y - (-2y) = 7 - 1$

$3y = 6$

$y = 2$

Then $x + 2 = 7$

$x = 7 - 2$

$x = 5$

∴ The numbers are 5 and 2. (1)

14. $3a - 5b - 7a + 6c + 7a + 8b$ (3b)

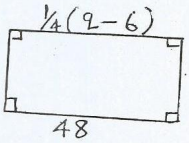
Grouping the like terms together.

$3a - 7a + 7a - 5b + 8b + 6c$ (2)

$= 3a + 3b + 6c$ (2)

$= 3(a + b + 2c)$ (1)

15.




(1)

$\frac{1}{4}(q - 6) = 48 \cdots$ (2)

$q - 6 = 192$ multiply 4 both si

$q = 192 + 6$ (1)

$= 198$

The value of $q$ is 198 (1)

## PART D: RATIOS.

16 Total angles for any given triangle is $180^\circ$ (1)

If angles are in the ratio 5: 7: 8
Then $5+7+8=20$ . . (1)

Therefore angles $\frac{5}{20} \times 180^\circ = 45^\circ$ (1)

$\frac{7}{20} \times 180^\circ = 63^\circ$ (1)

$\frac{8}{20} \times 180^\circ = 72^\circ$ (1)

The largest angle is $72^\circ$ (1)

17 The size of the ratio is $2+3=5$
The ratio is 2: 3 (1)

Then George's share is $\frac{2}{5} \times 35$ mangoes (1)
$= 14$ mangoes

Asha's share $= \frac{3}{5} \times 35$ mangoes (1)
$= 3 \times 7 = 21$ mangoes

George got 14 mangoes while Asha got 21 mangoes. (2)

18 The contents of cake A are in the ratio 3:5
And that of cake B are in the ratio 3:4.

Size of ratio of cake A $= 3+5$ (2)
$= 8$

Size of ratio of cake B $= 3+4$
$= 7$ (2)

∴ Cake A contains a greater ratio of the mixture than cake B. (1)

19. Given Tsh. 480,000 is dev to three persons A, B and C in the ratio 3: 4: 5.

The size of the ratio is:-
$3+4+5=12$ (2)

A got $\frac{3}{12} \times 480{,}000$ Tsh.
$= 120{,}000$ (1)
$=$ Tsh. 120,000/=

B got $\frac{4}{12} \times$ Tsh. 480,000
$=$ Tsh. 160,000/= (1)

C got $\frac{5}{12} \times$ Tsh. 480,000
$=$ Tsh. 200,000/= (1)

20. Given Tsh 1430 be devide in the ratio 2: 4: 5.

The size of the ratio is $2+4+$

The smallest $\frac{2}{11} \times 1430$
$= 260$
$=$ Tsh. 260

The largest $\frac{5}{11} \times 1430$
$=$ Tsh. 650

The difference is: $650-2$
$=$ Tsh. 390

∴ The difference between the smallest amount of money and the largest is Tsh. 390

**APENDIX D: Teacher's Questionnaire**

**Introduction:**

I am Agrey Masebo the student of The Open University Of Tanzania. I am doing research on Mastery of Mathematical Concepts by both teachers and secondary school students in Mbeya Region. Kindly I am requesting to get Maximum cooperation from you to fill this questionnaire with unbiased data. Every item is important for this study, **please answer all the items.** Your name is not needed so that the data you provide will never harm you and will be used for the sake of this research only and not other wise. If you have any doubt call: 0766481998.

| NO | Subject Concepts | Very simple | simple | Difficult | Most difficult |
|---|---|---|---|---|---|
| 1 | Fraction | | | | |
| 2 | Integers | | | | |
| 3 | Algebra | | | | |
| 4 | Ratios | | | | |

SEX: **Male ( ) Female ( )**

**LEVEL OF EDUCATION**

**DIPLOMA ( ) DEGREE ( ) MASTERS ( )**

SCHOOL CATEGORY: **Day ( ) Boarding** ( )

**Instructions**: Please fill In the following Table by putting a tick (ã ) beside the chosen mathematical area perceived according to the level of difficulty in teaching

**APPENDIX E: Students' Questionnaire**

**Introduction:**

I am Agrey Masebo the student of The Open University Of Tanzania. I am doing research on Mastery of Mathematical Concepts by both teachers and secondary school students in Mbeya Region. Kindly I am requesting to get Maximum cooperation from you to fill this questionnaire with unbiased data. Every item is important for this study, **please answer all the items.** Your name is not needed.

| Number | Subject Concepts | Very simple | simple | Difficult | Most difficult |
|---|---|---|---|---|---|
| 1 | Fraction | | | | |
| 2 | Integers | | | | |
| 3 | Algebra | | | | |
| 4 | Ratios | | | | |

SEX: Male ( ) Female ( )

**SCHOOL NAME** _____

**Instructions:** Please fill In the following table by putting a tick (ã ) beside the chosen mathematical area perceived according to the level of difficulty in teaching.

**Thank you for your cooperation's**

## APPENDIX F: Permission Letters

THE OPEN UNIVERSITY OF TANZANIA
*DIRECTORATE OF RESEARCH, PUBLICATIONS, AND POSTGRADUATE STUDIES*

P.O. Box 23409 Fax: 255-22-2668759
Dar es Salaam, Tanzania,
http://www.out.ac.tz

Tel: 255-22-2666752/2668445 ext.2101
Fax: 255-22-2668759,
E-mail: drpc@out.ac.tz

**31/08/2017**

Regional Education Officer,
P.O. Box 574,
Mbeya Region,
**MBEYA**.

**RE: RESEARCH CLEARANCE**

The Open University of Tanzania was established by an act of Parliament no. 17 of 1992. The act became operational on the 1st March 1993 by public notes No. 55 in the official Gazette. Act number 7 of 1992 has now been replaced by the Open University of Tanzania charter which is in line with the university act of 2005. The charter became operational on 1st January 2007. One of the mission objectives of the university is to generate and apply knowledge through research. For this reason staff and students undertake research activities from time to time.

To facilitate the research function, the vice chancellor of the Open University of Tanzania was empowered to issue a research clearance to both staff and students of the university on behalf of the government of Tanzania and the Tanzania Commission of Science and Technology.

The purpose of this letter is to introduce to you **Agrey Israel Masebo; Reg.No. HD/E/389/T.11** who is a **MED.APPS** student at the Open University of Tanzania. By this letter **Agrey I. Masebo** has been granted clearance to conduct research in the country. The title of his research is "**Mastery of Basic Mathematical Concepts among Teachers and Secondary School Students in Mbeya Region.**"

The period which this permission has been granted is from 1/09/2017 to 2/11/2017.

In case you need any further information, please contact:
The Deputy Vice Chancellor (Academic);
The Open University of Tanzania;
P.O. Box 23409;
Dar Es Salaam.
Tel: 022-2-2668820

We thank you in advance for your cooperation and facilitation of this research activity.
Yours sincerely,

Prof Hossea Rwegoshora
**For: VICE CHANCELLOR**
**THE OPEN UNIVERSITY OF TANZANIA**

**THE UNITED REPUBLIC OF TANZANIA**
**PRESIDEBT'S OFFICE**
**REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT**

**MBEYA REGION**
TELEGRAM: "REGCOM"
Telephone No: 025-2504045
Fax No.025-2504243
Email: ***ktm-mby@atman.co.tz***

REGIONAL COMMISSIONER'S OFFICE,
P.O. Box 754,
**MBEYA.**

In reply please quote:

Ref. No. DA.191/228/01/18

04th October, 2017

District Administrative Secretary,
P.O. Box 255,
**MBEYA.**

**REF. RESEARCH PERMIT**

Please refer to the above captioned subject.

May I introduce to you **Mr. Agrey Israel Masebo** from Open University of Tanzania

At the moment he is conducting research on **"Mastery of Basic Mathematical Concepts Among Teachers and Secondary School Students"**. A case study of **Mbeya Region** from **01th September to 2nd November, 2017.**

Please assist him accordingly.

M. J. Sepocho
For: **REGIONAL ADMINISTRATIVE SECRETARY,**
**MBEYA.**

**Copy:** Mr. Agrey Israel Masebo

,, Vice Chancellor,
The Open University of Tanzania
P.O. Box 23409,
**DAR ES SALAAM.**

**THE UNITED TEPUBLIC OF TANZANIA**
**PRESIDENT'S OFFICE**
**REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT**

MBEYA REGION
TELEGRAM: "ADMIN".
Telephone No: 502309.
Fax No. 025-2502567
In reply please quote:

DISTRICT COMMISSIONER OFFICE,
P.O. Box 255,
MBEYA.

**Ref No**. AB.120/369/01/G/315 18th October, 2017

City Director,
P.O. Box 149,
**MBEYA.**

District Executive Director,
P.O Box 599,
**MBEYA,**

**REF: RESEARCH PERMIT**

Please refer to the above captioned subject.

May I introduce to you **Mr. Agrey Israel Masebo** from Open University of Tanzania.

At the moment he is conducting research on "**Mastery of Basic Mathematical Concepts Among Teachers and Secondary School Students**" A case study of **Mbeya Region** from **01st September** to **2nd November, 2017**.

Please assist him accordingly.

/Amimu .J. Mwandelile
**For: DISTRICT ADMINISTRATIVE SECRETARY**
**MBEYA**

Copy: Mr. Agrey Israel Masebo.

" Vice Chancellor,
The Open University of Tanzania,
P.O. Box 23409,
**DAR ES SALAAM.**