

**CHALLENGES FACING TEACHERS IN UTILIZING
INSTRUCTIONAL RESOURCES WHEN TEACHING
MATHEMATICS IN PUBLIC SECONDARY SCHOOLS IN
NAIROBI COUNTY, KENYA**

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DECLARATION

I confirm that this research thesis is my original work and has not been presented in any other university for certification. The thesis has been complemented by referenced works duly acknowledged. Where text, data, graphics, pictures or tables have been borrowed from other works including the internet, the sources are specifically accredited through referencing in accordance with anti-plagiarism regulations.

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DEDICATION

To The Almighty God who gave me the physical and mental strength to accomplish the work as required. To my loving parents Mr. & Mrs. S.G.Nguyo with a lot of respect and appreciation for basically sacrificing their lives to ensure that I got a head start and a strong academic foundation.

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LIST OF ABBREVIATIONS AND ACRONYMS

| | | |
|---------------|---|---|
| ASEI | – | Activity, Student centred, Experiment, Improvise |
| COS | – | Classroom Observation Schedule |
| ICT | – | Information Communication and Technology |
| INSET | – | In-Service Training |
| JICA | – | Japan International Cooperation Agency |
| KCSE | – | Kenya Certificate of Secondary Education |
| KIE | – | Kenya Institute of Education |
| KLB | – | Kenya Literature Bureau |
| MoEST | – | Ministry of Education Science and Technology |
| MTQ | – | Mathematics Teachers' Questionnaire |
| PDSI | – | Plan Do See and Improve |
| SMASSE | – | Strengthening of Mathematics and Sciences in Secondary Education |
| SPSS | – | Statistical Package for Social Sciences |
| TIMSS | – | Trends in International Mathematics and Science Study |
| UNESCO | – | United Nations Educational, Scientific and Cultural Organization |

ABSTRACT

It has been observed that mathematics teachers rarely utilize a wide variety of instructional media as expected from their pre-service and in-service training (Oirere, 2008). There was need to establish the challenges these teachers faced in utilizing instructional resources. This study sought to find; i) the challenges facing mathematics teachers in utilizing instructional resources in teaching the subject in Nairobi County ii) the status of in-service training of mathematics teachers in Nairobi County iii) possible solutions to the challenges facing mathematics teachers in utilizing instructional resources and iv) suggestions for further research. Descriptive survey research design was adopted. The target population was 80 public secondary schools in the County. The population was sampled using stratified sampling techniques to include all categories of schools in the study and then proportionately sampled to give a sample size of 10 public secondary schools. The categories of schools included both girls and boys day and boarding schools as well as County/National schools. Five mathematics teachers were selected from each school yielding a total of 50 respondents. Data was collected using Mathematics Teachers' Questionnaire (MTQ). Classroom Observation Schedule (COS) was also used to investigate the types of instructional resources used and the frequency of their use. Two observations were done in every school in the sample. Form three classes were chosen because they are known to be well adjusted to their school systems. The validity and reliability of the instruments were enhanced by a pilot study. Data collected was analyzed using Statistical Package for Social Sciences (SPSS) and then presented in the form of frequency tables and percentages. The significant challenges facing teachers in utilizing instructional resources in teaching mathematics included; inadequate instructional resources, inadequate teacher professional development, heavy work load and large class sizes. The study further found out that most of the teachers interviewed were qualified and had been trained on the use of instructional resources in teaching but follow-up mechanisms like in-service training were inadequate. The results of the study would be of benefit to mathematics curriculum developers, mathematics teachers, higher institutions of learning, secondary school students and teacher trainers. Based on the findings, the study recommended that mathematics teachers should be in-serviced regularly on the use of practical approaches to teaching mathematics and follow up mechanisms on implementation of aspects taught to be put in place. A similar study was recommended in both public and private secondary and primary schools in other Counties.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

This study focused on utilization of instructional resources in the teaching of mathematics. Instructional resources are defined as all materials designed to support the instruction of a subject or course including but not limited to textbooks, library books, newspapers, magazines, printed materials, charts, recordings, videotapes, pictures, exhibits, slides, transparencies, online resources, speakers and other personnel resources and all technology based materials. The power of instructional media in enhancing learning may best be captured in the Chinese saying: “If we hear, we forget; if we see, we remember and if we do, we understand” (Muvango, 2013). What bridges the gap between theory and practice is instructional media.

Mathematics teachers have to use instructional media to provide students with a situation near to reality. The abstract mathematical concepts are made concrete when students see and do some activities using real objects like models. Studies indicate that people learn 25 to 30 per cent more when visual aids are used in teaching because they hold attention, motivate to take an action, increase permanence of learning, make the job of teaching easier and create interest (Muvango, 2013). The availability and utilization of instructional resources for the teaching of any subject in the school curriculum, mathematics included, is very crucial. However, not all schools

are able to provide all the materials needed for instruction and teachers have to develop teaching materials from the local environment through improvisation.

(Mungai, 1992), argues that instructional media and materials are everywhere around us. These materials are found within the students' total continuum of experiences, from the concrete to the abstract, both outside and inside the classroom. These materials are said to provide means by which teachers teach and students learn. Books and other educational materials are the basic tools of educational development (Gacathi Report, 1976). Such materials must therefore be available to the learner in adequate quality and quantities and must also be available at the time they are required and at a cost a learner can afford.

Various researches done by Kariuki, (1988); Gacego,(1989); Eshiwani, (1982); Kathuri, (1986); Chepkurui, (2004); Angura,(2003) claim that resources are quite inadequate and are not properly utilized. Gacego (1989), in particular noted that in many schools, the resources did not seem to be organized in a way which made them easily accessible and this minimized their utilization. Schools should have well equipped and organized mathematics rooms that are easily accessible by teachers all the time. The situation in Nairobi County had not been well documented and this study sought to fill this knowledge gap.

Oirere (2008) in his evaluation of the effectiveness of SMASSE INSET in Gucha District Kenya found that there was partial utilization of resources and that there was a tendency of teachers not to improvise materials where conventional ones were present. He found the major challenges to the implementation of aspects taught in the INSETs as lack of sufficient time for lesson preparation by teachers, inadequate resources, lack of support by schools' administrations, large class sizes and pressure to cover syllabi. The problem of large classes and lack of support from school heads was also reported by Peter (2013) as a cause of falling standards in the teaching of English and Literature. The situation in the teaching of mathematics has not been adequately investigated which was the concern of this study.

For resources to be properly utilized, teachers need to have ample time to select and organize appropriate resources for each particular lesson. Where materials are lacking teachers need time to improvise and plan for suitable activities. Improvisation of materials is key to improving creativity in learning as well as linking mathematical concepts to the local learning environment. Improvisation of instructional resources is one of the major aspects taught in teachers' pre-service training and INSETs. Mathematics teachers are expected to use a variety of instructional media in all their lessons but from the reviewed research outcomes there seemed to be challenges facing teachers in utilizing instructional materials. Hence, there was need for this kind of study.

1.2 Statement of the Problem

Results from SMASSE baseline studies revealed that many mathematics teachers displayed poor mastery of content, lacked basic practical skills and innovativeness, and used poor teaching methods. This was manifested in the theoretical teacher-centred approach to teaching. There were general complaints about lack of teaching and learning materials and available resources were hardly used (Oirere, 2008). The challenges in utilization of available resources were not investigated which was the main concern of this study.

Inadequacy of instructional resources has been cited as one of the major causes of poor teaching techniques (Wasiche, 2006). Too much theoretical teaching of mathematics makes the subject to look too abstract and difficult to students. Other studies done both in mathematics and other subjects in various regions in Kenya also found out that instructional resources were quite inadequate in many schools. The problem of inadequacy of teaching and learning resources affects the number of activities that a teacher can plan for a lesson thus limiting teachers in their efforts to vary their teaching techniques. However, Mathematics teachers have to be more creative and use locally available materials in instruction.

Instructional resources are an inseparable element of the teaching/learning process. Nyaberi (1995) in his study on factors contributing to poor performance in KCSE in Egetuki zone, Kisii District, had one of the

explanations as lack of school facilities such as libraries and well equipped laboratories. MOEST (2003) noted that there was a critical shortage of textbooks, equipments and physical facilities in most public schools in Kenya. Further, there existed inter and intra Provincial resource variations in availability contributing directly to poor performance in National examinations. Wasiche (2006) observed that no teacher used the ASEI/PDSI approaches that were advocated by SMASSE during their teaching. These are mainly student centred approaches where students are engaged in practical activities that lead to discovery of ideas. The teachers either ignored the teaching aspects emphasized by the INSETs or they faced challenges in implementation which was another concern of this study.

It was in view of these findings that the researcher felt that there could be specific challenges affecting the utilization of instructional resources as a teaching technique and which had not been well identified at least in the Kenyan context in general and Nairobi County in particular. The essence of this research was therefore to establish these key challenges.

1.3 Purpose of the Study

The main purpose of this study was to establish the challenges teachers faced in utilizing instructional resources in teaching mathematics in public secondary schools in Nairobi County, Kenya.

1.4 Objectives of the Study

The objectives of this study were to:

- 1) Find the challenges teachers face in utilizing instructional resources in teaching mathematics in public secondary schools in Nairobi County.
- 2) Investigate on in-service training status of mathematics teachers in public secondary schools in Nairobi County.
- 3) Recommend possible solutions to the challenges facing teachers in utilizing instructional resources in teaching mathematics in public secondary schools in Nairobi County.
- 4) Establish the extent of utilization of instructional resources in teaching mathematics in secondary schools in Nairobi County.

1.5 Research Questions

This study aimed at answering the following questions:

- 1) What challenges do teachers face in utilizing instructional resources in teaching mathematics in public secondary schools in Nairobi County?
- 2) What is the status of in-service training of mathematics teachers in public secondary schools in Nairobi County?
- 3) What are the possible solutions to the challenges facing teachers in utilizing instructional resources in teaching mathematics in secondary schools in Nairobi County?

- 4) To what extent are instructional resources utilized in teaching mathematics in public secondary schools in Nairobi County?

1.6 Significance of the study

The following groups of people would benefit from the results of the study:

a) Mathematics Curriculum Developers

The findings of this study would enable the curriculum developers at the Kenya Institute of Education to develop and avail enough, quality and technologically advanced resources for proper teaching of mathematics.

b) Mathematics Teachers

The findings of this study would help mathematics teachers to develop classroom competence by helping them to use a wide variety of instructional materials in their lessons other than the conventional ones. It would also help them to understand the professional application of instructional resources. They would become more innovative and avoid relying fully on school administrations to purchase resources for them but instead realize that there is a wide range of instructional media in every environment. They would realize that most resources for teaching and learning mathematics could easily be improvised and that it was important to involve their learners in this.

c) Higher Institutions of Learning

The findings of this study would also be of importance to the field of mathematics education. It would add to the pool of knowledge and expand the field of mathematics education in higher institutions of learning as reference material.

d) Secondary school students

This study was also significant in showing the reality of mathematics to learners in secondary schools. Students would be able to understand the implication of mathematics in their daily activities which would impact on and change any negative attitude towards the subject. Use of resources would enhance this by making mathematics more concrete and real leading to better understanding of mathematical concepts.

e) Teacher Trainers and Student Teachers

Teacher trainers at various teacher training institutions would be made aware of the challenges in utilization of instructional resources so that they would incorporate them in training. The findings and recommendations provided by this study would provide insight on how to cope with the challenges. Student teachers (teacher trainees at any level) would also benefit a great deal from the findings in that they would be well equipped to overcome the challenges in utilization of instructional media.

1.7 Basic Assumptions of the Study

This study assumed that:

- 1) All secondary schools under investigation had common characteristics and were adhering to uniform mathematics curriculum.
- 2) All respondents would be cooperative and would provide reliable responses.

1.8 Scope and Limitations of the Study

1.8.1 Scope

This study was carried out in Nairobi County, Kenya. The County was mainly urban with 80 public secondary schools at the time of this study (Directorate of secondary and tertiary education, 2013). The choice of the County was determined by accessibility and familiarity of the locality to the researcher which made it easy to develop immediate rapport with the respondents hence making data collection easy. Best, (1993) argue that, since research requires careful thought, a number of practical factors including accessibility and cost factors become legitimate considerations.

1.8.2 Limitations

1) Financial and Time constraints

Private secondary and all Primary schools should have been studied for a more conclusive result but this was not possible due to financial and time constraints. This study limited itself only to public secondary schools in Nairobi County, Kenya.

2) Longitudinal effects

The time available to investigate the research problem was constrained by the due date of the study. More classroom observations would have provided more information but this was not possible because the research had to be done within a limited period. Further research needed to be done on the same problem but with adequate time.

1.9 Theoretical Framework

1.9.1 Dale's Cone of Experiences

One device for identifying, selecting and producing what educational media is appropriate for a specific learning task and the group of learner's is the cone of experience which was devised by Edgar Dale published in his book Audio-Visual Education in 1946. It is a visual analogy which is used as a guide by the teachers in choosing what, why and how instructional material they should use to provoke learning with the most satisfying results as shown in figure 1.1.

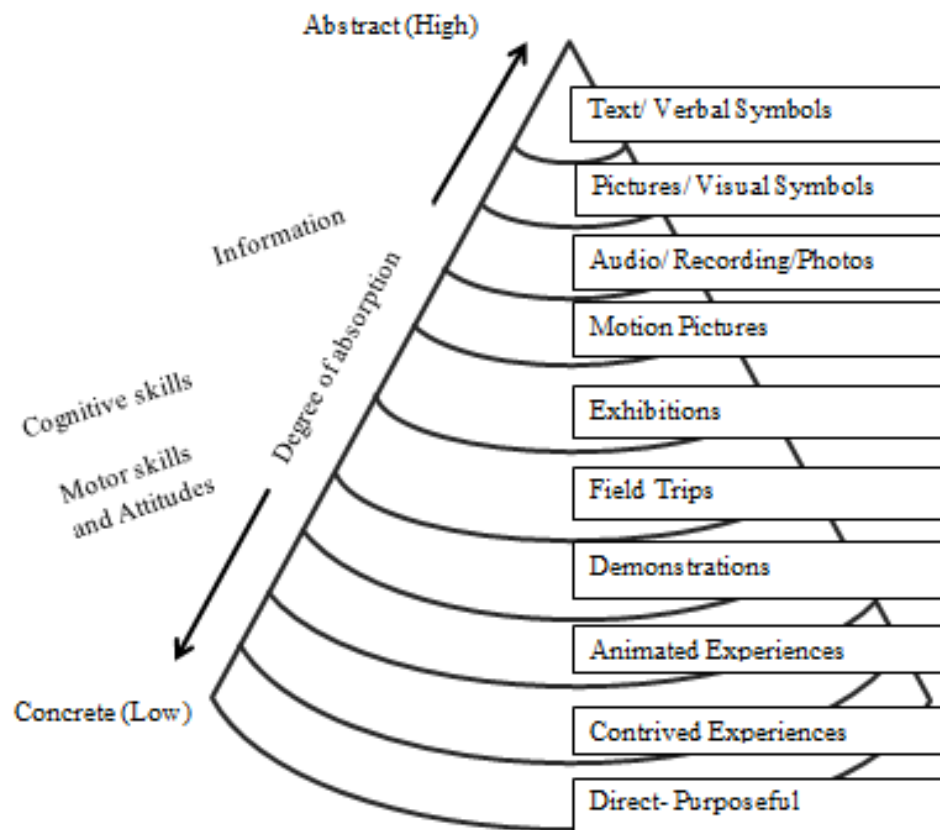


Figure 1.1 Dale's cone of experiences

Source: . <http://headtech2a5.wordpress.com>

From figure 1.1, the cone of experiences is presented in its inverted form such that the base is broader than its apex. It is made up of seven bands which are arranged in an increasing degree of abstraction as one moves from the base to the apex as follows; Direct purposeful learning experiences, Contrived experiences, Animated experiences, Demonstration, Field trips, Exhibitions, Motion Pictures, Audio/recordings/photos, Pictures/Visual symbols and Text/verbal Symbols.

Although the experiences are arranged in bands, they are fluid, crisscrossing one another and they become more simulating.

Further, the cone of experience suggests that learning is more impressive if one proceeds from concrete to abstract, or from specific to general, because more senses are involved as the relationships are built in more pronounced manner. Direct and actual learning is the basis for conceptualization and abstraction (Monica, 2010)

1.10 Conceptual Framework

A conceptual framework is a model of presentation where a researcher explores and represents the relationships among the studied variables (Orodho, 2004). This study adopted the diagrammatical framework, as shown below.

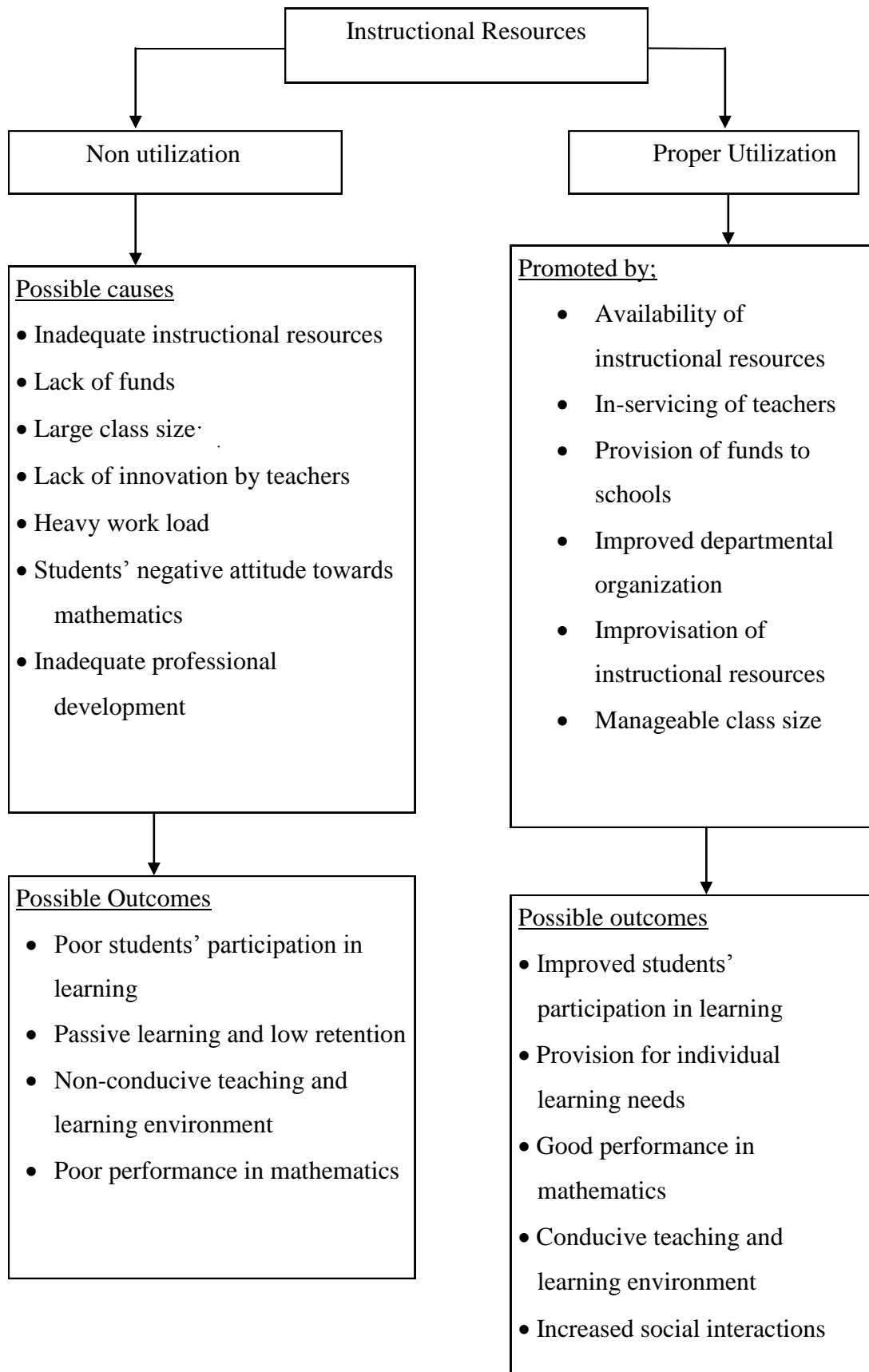


Figure 1.2 Conceptual Framework

Figure 1.2 provided an overview of the relationship between the variables to be tested and instructional resources. The independent variables in this study were instructional resources, while utilization and challenges in the use of instructional resources in teaching mathematics served as the dependent variables. As can be seen from the figure, there are consequences when mathematics teachers use or fail to use instructional resources in teaching.

Utilization of instructional resources results to general improvement in teaching and learning of mathematics. However, most public secondary schools in Kenya lacked physical facilities and equipments including textbooks and other media resources as noted by Wasiche, (2006). Non-availability of instructional materials is a challenge to mathematics teaching because the abstract concepts in the subject have to be concretized and made real to learners. The use of a variety of instructional media enhances positive attitude to mathematics because students are engaged in active learning.

1.11 Operational Definition of terms

Achievement – The result that comes when the teaching action attains its desired goals.

Active learning–Students participation in mathematics lessons or activities students do other than merely passively listening to an instructor’s lecture.

Attitude – Having inclined interest and emotion towards mathematics.

Challenge – Difficulty in using a variety of instructional resources in every lesson.

Content knowledge – Being familiar with basic concepts and applications of all content covered in secondary mathematics program.

Improvise– Provide or make instructional resources in time of need from locally available but relevant materials for teaching and learning mathematics

Instructional resources – Materials used by mathematics teachers when teaching.

Learning – Understanding mathematical concepts and ability to apply them in different situations.

Performance – The ability of students to score good grades in mathematics examinations.

Problem – A mathematical situation for which the learner does not have an immediate answer or an obvious mathematical operation or method for determining it.

Problem solving– The attempt to find a solution to a mathematical problem.

Resource – Any object improvised or commercially produced that establishes a condition which enables learners to acquire knowledge, skills and attitudes.

Teaching – Passing knowledge of new mathematical concepts and skills of problem solving.

Utilization–Use of instructional materials

Audiovisual – That which can be heard and seen.

1.12 Organization of the Study

This thesis was presented in five different chapters. Chapter one highlighted the background of the study, statement of the problem, research objectives and questions, significance of the study, scope and limitations of the study, assumptions of the study, theoretical and conceptual framework of the study and operational definition of terms. Chapter two presents relevant literature on mathematics teaching and its challenges, types of instructional resources used in teaching and learning mathematics and benefits of their proper utilization. Chapter three presents information on research design, location of the study, target population, sampling techniques and sample size, research instruments, data collection procedure and data analytical techniques. Chapter four explores research findings, interpretation and discussions while Chapter five gives the summary, conclusions, recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents relevant literature on teaching mathematics and challenges faced. It discusses the use of instructional resources in teaching mathematics, highlights selected instructional resources and gives guidelines on their proper use. There are suggestions of improvised media which mathematics teachers can use in case of inadequacy of conventional materials. ICT integration in education is also discussed though it was in the process of implementation in most schools in the country at the time of the study. Possible interventions to the challenges faced in utilizing instructional resources in teaching mathematics are suggested at the end of the chapter.

2.2 Teaching Mathematics and possible challenges

Teaching generally, not only mathematics is a challenging affair and has its own pleasures and difficulties. Moreover, teaching secondary school mathematics can be difficult, discouraging, successful, exciting and delightful. First it is exciting because mathematics teachers work in a profession which is constantly expanding in both content and methodology. Second, mathematics teachers play a significant role in moulding and guiding the country's future scientists and citizens. Third, mathematics teachers teach one of the remarkable subjects in the school curriculum.

Teaching mathematics can be disappointing and difficult because of the following reasons: First, most mathematics teachers will have to teach another subject, (Mutunga et al., 1992). Having to prepare for other lessons may be challenging because a mathematics teacher needs enough time to prepare and plan well for effective teaching and learning activities. Second, the number of teaching lessons allocated for mathematics may not be enough for the teacher to involve the learners in many learning activities and at the same time cover the syllabus in time. Mathematics teachers need to accept the challenge and improve their teaching strategies in every way to make students learn. They need to understand both the mathematical content for teaching and students' mathematical thinking. It is essential that mathematical expertise of teachers be developed (National Research Council (NRC), 2001).

Many factors govern the methods of teaching of mathematics. Some of these are the teacher, topic to be covered, age and aptitude of the learners, the size of the class and the facilities available. The most common methods are the lecture, discussion, class activities, class experiments and project work (KLB, 2010). Each of these methods requires the use of one or more instructional resources. Lecture and discussion methods may only require reference from text books while class activities, class experiments and project work may require the use of more than one resource. It is the teachers' duty to choose and organize the appropriate materials for a class activity with regard to the objectives of the lesson. However, these appropriate materials may be lacking

in a school and this calls for improvisation of instructional materials from the local environment.

According to Afolabi et al. (2006), teaching can only be effective when adequate and relevant instructional materials are used. Many educators and researchers have reported the importance of instructional materials in teaching. Grant (1978) noted that teaching and learning cannot be effective without adequate and relevant use of instructional materials. Inadequacy of instructional resources can be a great challenge to the teaching and learning of mathematics. Schramm (1977) referred to instructional materials as basic channels of communication (of ideas and concepts) in the classroom for the purpose of bringing about effective teaching and learning. There was need to establish the availability of these materials in our schools and how effectively they were used.

Mathematics teachers have to use more practical strategies and concrete ways to help students grasp mathematical concepts, improve their proficiency and generalize knowledge in multiple contexts (Merlot Pedagogy, 2013). Practical work is important in teaching and learning mathematics. Proper understanding of concepts being taught requires that they be concretized through the use of suitable experimental/practical work, teaching aids and real life experiences. It is an established fact that we are more likely to remember/internalize what we do than what we see or hear. Practical work in mathematics ensures learners' participation and variation of stimuli. Apart from making theoretical and

abstract concepts real and concrete, it enhances learning by promoting curiosity and interest in addition to awakening manipulative skills. The cone below illustrates how the degree of retention increases with increased use of senses.

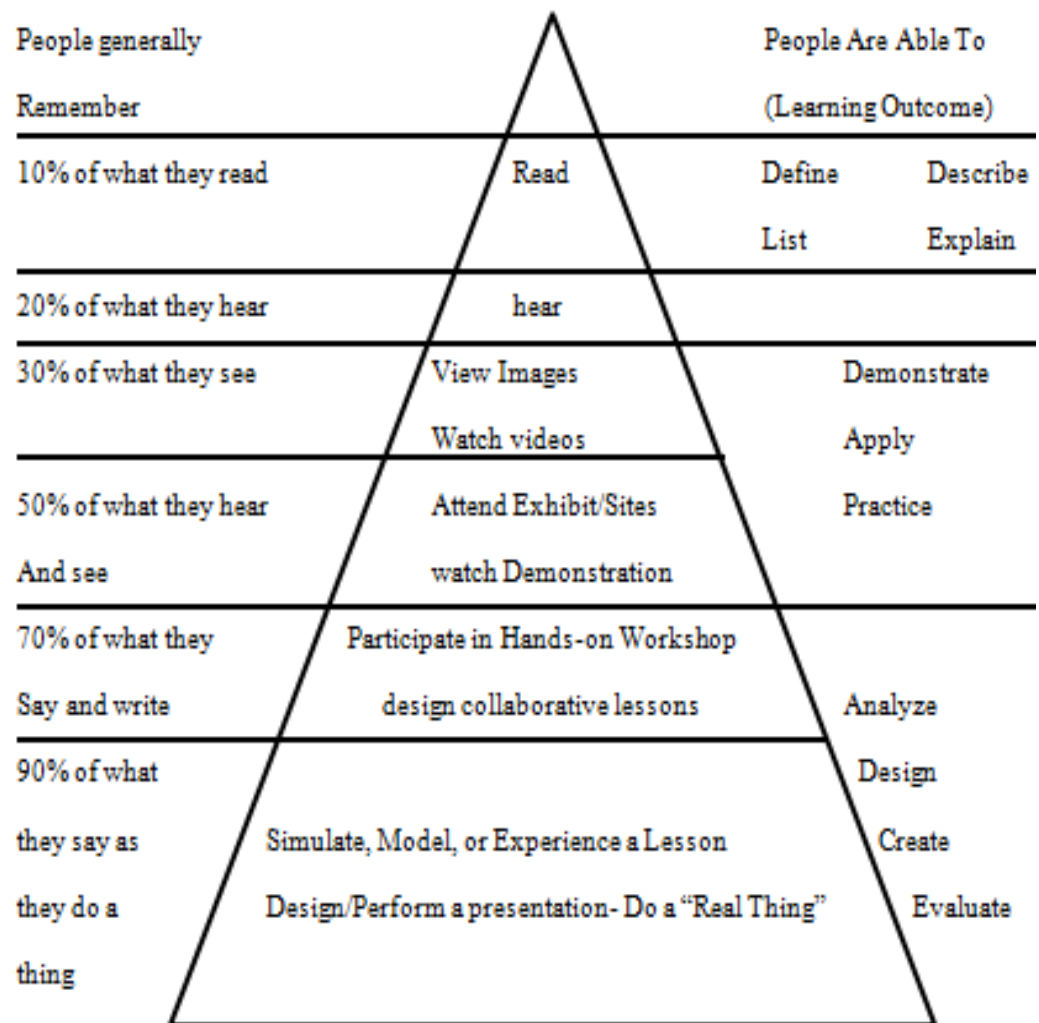


Figure 2.1 The cone of learning experiences

From the cone above, it is noted that there is little learning when learners read by themselves or listen to an instructor. The more the number of senses used by learners the higher the level of retention of what is taught. With today's students, lecturing does not hold their attention for very long even though it is a means of conveying information to them. Students need to be engaged and motivated by allowing them to do some activities through the use of more than

one instructional media. This will enhance the use of three senses; seeing, hearing and touching. When students are actively engaged, they are able to retain mathematical knowledge as well as participate in class.

2.3 Use of Instructional Resources in Teaching and Learning

Mathematics

Abimbade, (1997) found out that the use of instructional resources in teaching and learning makes students to learn more and retain better what they have been taught and that it also promotes and sustains students' interest. It also allows the learners to discover themselves and their abilities. Schramm (1977) notes that instructional materials enrich learners' knowledge and reinforce verbal instruction. This is because learning is more effective through seeing and touching than through hearing only.

Research report by Afolabi (2008) indicates that availability of instructional materials and ability of mathematics teachers to use them are vital determinants in the selection of the teaching methods to be used by mathematics teachers and consequently, mathematics achievements. The ability to use instructional materials in teaching mainly depends on training which has to be continuous in the profession. Professional development can be done through INSETs where teachers share experiences and are continuously exposed to new ideas that keep them abreast with developments in the teaching profession. In the recent past, there has been a major shift on how mathematics is taught. The changes have been inevitable due to the rapidly

changing world and growing technology. There is now the use of calculators and computers which are more efficient than mathematical tables. It is not well established whether mathematics teachers face any challenges in relation to the use of calculators and computers in teaching mathematics.

Oyeniran (2003) argues that students learn best if they are given the opportunity to see and make observations of what they are taught. He observes that a good instructional material serves as a substitute for real life objects in the classroom as against the use of exploratory method. Mathematics teachers have to construct models, along with their students, using local materials to represent the real objects to be studied. Construction of instructional materials also known as improvisation requires creativity which is likely to be a challenge to some teachers. It is time consuming and teachers with heavy workloads may end up not using improvised materials at all. The consequence of this is likely to be low attainments in mathematics. There was inadequate information on the use of improvised instructional materials in teaching mathematics and challenges faced in the Kenyan context.

The inevitability of instructional materials/ resources in mathematics learning outcomes are also emphasized by Adedayo (2000). In spite of this, many of these materials are lacking in our schools. Hassan (2000), in his study of evaluation of Mathematics teaching in Nigeria reported a 100% of his sample from Zamfara State in favour of inadequate resources and instructional

materials in the teaching of Mathematics. The situation in public secondary schools in Kenya also needed evaluation and documentation.

In order to create interest and motivation in students, teachers of mathematics will have to constantly consider the use of sensory aids in the teaching of mathematics. Sensory aids (also known as instructional media) commonly used in teaching and learning mathematics include printed materials like textbooks, audio-visuals, models, pictures, charts and diagrams, electronic calculators, video tapes and computer software. Improvised or locally available instructional media include students' shoes, schools' flag posts, wall clocks, coloured beads, playing cards, dice, marbles, beans and maize seeds, match sticks, school water tank, strings, stair case, classroom floors and walls, coins and currency notes among others. All these forms of instructional media are used to provide students with a situation near to reality.

For resources to enhance understanding of concepts, it is important for the teacher to consider some factors. The first factor is the appropriateness or suitability of the resources to accomplish the task. The second factor is the level of sophistication; whether it is at the correct level of understanding for the learners. The third factor is the cost element; whether it is cost effective and has the potential for the intended learning. The fourth factor is the availability of the resource; its availability when needed and learner's familiarity with it. The fifth factor is the technical quality; the quality of the material that is whether legible, visible and/or audible. The sixth factor is time;

that is, the activities should be planned to fit into a forty minutes lesson if not eighty minutes and that the resources should not take too long to prepare.

2.4 Selected Instructional Resources used in teaching mathematics

This study looked at selected instructional resources commonly used in teaching mathematics. These included textbooks, electronic calculators, geometrical equipments, models, pictures, charts and the chalkboard.

2.4.1. The Mathematics Textbook

Mathematics textbooks are books that are designed to present the basic principles or aspects of mathematics. They are used as the basis of instruction and can be considered as an entire course of study in print. Textbooks are highly organized, contain a summary (often simplified) of a specific body of knowledge and usually they contain learning activities or suggestions for further study (Miheo, 2004). Thus, their design which is meant to summarize a subject means that they do not encourage in-depth learning. Because of their highly structured nature, textbooks tend to encourage rote learning rather than creative inquiry. They are often not responsive to the needs and abilities of individual learners. Textbooks have also been criticized for the inclusion of racial, ethnic and sexual stereotypes at odds with our changing multiethnic and multicultural society (Miheo, 2004).

On the other hand, mathematics textbooks occupy an important place in the teaching and learning process in our schools. They are looked at as alternative sources of the mathematical knowledge that teachers communicate to the learners, and also as a medium for presentation and ordering (though subject to teachers' opinions) of the subject for purposes of teaching. Mathematics textbooks, however, need to be selected carefully and used with great skill if they are to assist teachers and learners to accomplish meaningful learning and achieve important objectives. No single mathematics textbook is sufficient for proper planning of successful lessons and indeed a variety of textbooks should be used. It is therefore important for the teacher to appreciate the role that books play in the teaching and learning process, and the misuse to which books can be put.

The mathematics textbook, together with the syllabus, is a major factor in determining what mathematics topics are taught but it is the duty of the mathematics teacher to determine how the topics are taught. The mathematics textbook has often dictated the scope, the sequence, and even the pace of the mathematics program. Its importance increases when a teacher's instruction is inadequate. However, the mathematics curriculum should not be determined by the textbook, rather, the textbook should be selected on the basis of curriculum decisions. According to Sidhu, (1982) the essence of mathematical teaching is helping the students to discover rules, formulae and understand concepts. It is not desirable that students learn anything from a book before the matter is taken up in the class. If they do so, the classroom heuristic, analytic

or inductive approach cannot be effective. The teacher is to see that the students not only discover, understand and formulate rules, but also remember and readily apply them whenever required. For this, the students have to be provided with a record of class-work and also a set of examples for practice. A good mathematics textbook saves the time for the teacher and the students since note taking during lesson time may prove to be time consuming.

Although some of the criticism leveled at textbooks can be traced to content or structural limitations, others are as a result of inappropriate or insensitive applications. Due to this, mathematics teachers have a special responsibility to understand the nature of their textbooks and to use them creatively and effectively. If a mathematics textbook is to serve its proper function, it must be a good text. According to Miheso, (2004), a good text has: quality topics that will attain the objectives of the course, correct mathematics, interesting and thought provoking language, enrichment aids to learning and attractive physical characteristics like the use of colour.

Mathematics teachers should avoid becoming textbook teachers because by doing this, the mathematics textbook becomes the mathematics curriculum. In some cases textbooks have come to replace the syllabus often resulting in the loss of focus on important learning objectives. The textbook should be seen as an instrument for organizing curricula and as a basic tool for teaching and learning. The content of the text should not become the total content of the course with rate and sequence rigidly prescribed. Confining the class content

to that of the text gives students a limited experience and increases the danger of poor attitude and little appreciation of the elegance of mathematics.

Textbooks should not replace the important responsibility of the teacher as far as scheming and planning of lessons are concerned (Miheso, 2004). The tendency of the textbook to emphasize some given rules and procedures, defeats the possibilities for discovery, independent thought and intellectual curiosity. Even where discovery questions are included, the answers usually appear on the next page and students find it easier to look ahead rather than to discover the concepts. Students' memorization of the language of the text and stated definitions and rules do not nourish skill in communication or the development of understanding. Students need experiences in stating generalizations in their own words even though these may lack precision. The constant use of textbooks kills interest by its monotonous formal treatment. Learning needs a variety of meaningful and interesting experiences which can be provided through the use of a variety of instructional resources.

It is a discouraging experience to see teachers using the same text examples and exercises for all students in a given class. The narrow emphasis of the text ignores the importance of objectives such as attitudes, problem solving, creativity, appreciation or values. These are the objectives that seem to be of greatest importance today. They are seldom attained and rarely tested by the textbooks. It is therefore apparent that textbook teaching is highly unsatisfactory. Dependence on the text and only the text is one mark of an

unsuccessful teacher (Miheho, 2004). It was not known whether mathematics teachers in Kenya faced challenges in varying stimuli in their instruction which was the main interest of this study.

Mathematics teachers need to do textbook analysis by looking into how other textbooks approach each topic in terms of rationale, logical flow, and activities for students and summary. The rationale in every topic should be applicable to real life situations and should come out clearly. The approach to every topic should be systematic where information is presented from simple to complex. The same should apply to exercises at the end of every topic. The questions should start from simple to complex. Teachers should be able to add, delete or rearrange questions to make an appropriate exercise for enhancing students understanding of a topic. Students' activities should be clearly given and the summary should be precise and clear.

Before assigning tasks from a textbook, a mathematics teacher should take the following steps;

- I. Look into the objective of the lesson
- II. Read through the exercise picking the relevant questions
- III. Solve the problems relevant to the objectives
- IV. Arrange the questions from simple to complex
- V. Consider the mixed abilities of the learners
- VI. Ensure that questions are not testing the same concept

- VII. Give enough questions considering the time available
- VIII. Ensure that the task is accessible

(MOEST, 2003)

2.4.2 The chalkboard

Next to the textbook, the most commonly used aid by the mathematics teacher is the chalkboard. A chalkboard is a teaching and learning aid which, in the hands of the teacher, can be made to convey a visual message. Since the teacher makes his own impressions on it, the manner in which he uses the chalkboard is regarded as a guide to his efficiency. Compared to other teaching and learning aids, the chalkboard provides an opportunity for creativity and initiative (Patel, 1993). Mathematics teachers can creatively use the chalkboard to organize class discussions. However, when used poorly, the same chalkboard can obscure instructional objectives and make students frustrated. This may happen if a teacher does not organize his/her work well on the chalkboard or if work is erased before learners have taken notes or followed the steps.

The chalkboard as a visual aid provides an immediate and effective mode of presentation of material. This is because most aspects of mathematics can be clarified only through writing on the chalkboard. Its uses are wide and varied and teachers should consider these uses in developing and executing their plans. The chalkboard is uniquely suited to make the following contributions:

providing a medium for participation of the students in class activities, emphasizing on major points by giving outlines and summaries, it permits a point-by-point development and a reference as the lesson progresses, present assignments, problems, or discussion questions and combine visual and oral presentation of ideas (Mutunga, 1992).

As a medium for participation of the students in class activities, the teacher may allow students to work out mathematical problems or draw mathematical shapes on the chalkboard. This helps students to develop confidence in their work as the teacher notes the students' weak areas that need further clarification. Students also challenge one another as they solve mathematical problems on the chalkboard and this motivates and excites them making mathematics lessons more interesting.

There is need for mathematics teachers to improve on their chalkboard use for them to do effective chalkboard work. This is because the chalkboard is a vehicle for the teacher's instructions, information and illustrations he/she wishes to convey to his students. The use of chalkboards can be improved in many ways. First, by writing clearly, neatly, and correctly, combining writing and speaking, not erasing the board too quickly, using very large figures so that all class members can see. Secondly, by ensuring drawings are made simple and accurate using stencils and drawing instruments to give pleasing, accurate figures. It makes presentations realistic by giving attention to perspective and colour. Thirdly, by arranging frequent student participation in

chalkboard work. Board work has the advantage of requiring physical and emotional involvement as well as mental activity. Fourth, using coloured chalk to identify key ideas, to add attractiveness, to emphasize common elements, contrasts, and relationships. For example, use of colour to distinguish between symbols of operations and signs of positive or negative numerals. Lastly, by ensuring that there are adequate materials; a variety of available chalkboard tools that can be used to improve chalkboard work. These include: meter sticks, or yardsticks; geometric figures, including triangles, rectangles, and polygons; stencils for perspective drawings of three-dimensional objects; stencils for grids for graphing; drawing instruments, including compasses, protractors and chalk (Mutunga, 1992).

It is important that every mathematics classroom has a grid marked on the chalkboard for graphing. It should be painted or scratched on one section of the chalkboard, and the section should not be used for other purposes. The use of the chalkboard remains a nightmare to the teachers of Kenya. Chalk is dusty and dirty and this poses a challenge to both the teachers' and the learners' health. It is unfortunate that whiteboards which offer a clean modern and health friendly environment have remained a reserve of the high-cost private schools giving undue advantage to only the children of the rich.

2.4.3 Pictures and Charts

Pictures are drawings of real objects and can be used to teach mathematics topics like common solids, three-dimensional geometry, surveying and many others. Drawings can be done on manila sheets and hang on classroom walls for teaching different concepts. Charts are essential visual summaries of information in the teaching learning process. Charts can bring out steps in mathematics problem solving. Pictures and charts serve different purposes in teaching. Whereas pictures help to illustrate and bring a sense of reality to what is taught, charts contain the lesson material itself. While pictures are used to stimulate interest, create correct impressions and bring lessons to life, charts are more useful as a means of presenting the material that is to be learnt in a memorable form and as such often play a central role in a lesson or a concluding part (Farrant, 1964). This study sought to establish whether mathematics teachers in public secondary schools were using pictures and charts in teaching and if not find the possible challenges.

2.4.4 Models and Manipulative Materials

Models may be sketches on paper or chalkboard, concrete devices like models of common solids or mathematical formulae. Models furnish the basis for solving a problem, discovering a new idea, or creating a new system. They are links between the thought processes of man and the reality of nature. They help make transitions from one level of abstraction to another and are means for expressing ideas and providing stepping stones to new relationships. They

add reality to abstract ideas and facilitate creative thinking. They are a means of relating past experience to a new situation (Johnson, 1972).

There are inherent dangers in the use of physical models to represent abstract ideas. The concrete representation adds qualities that are not mathematical and by so doing may lead to misconceptions. For example, comparing “wheel” and “circle”, where a circle is a mathematical conception. The abstraction cannot be accurately represented by a concrete model, for it is a set of dimensionless points. The wheel can be manipulated as it can be seen as well as felt, rolled, and measured, but while the wheel may clarify certain ideas about circles, it may also mislead the student into thinking of a circle as a disc or a circular region. When teachers utilize models they must be constantly alert to the dangers of misleading students by false constructions. The model lays the foundation for learning an abstract concept, but the concrete representation may not give a complete conception or definition of the abstract idea.

Models are of course, of special value in the study of Geometry, where spatial relationships are the basic concern. However, teachers should not restrict their thinking about models to this area, since models of algebraic and arithmetic relationships can provide students with bases for understanding concepts in these subjects. An example of the use of a model in algebra is in exploring the terms of the square of a binomial made out of toy parts as shown in figure 2.2.

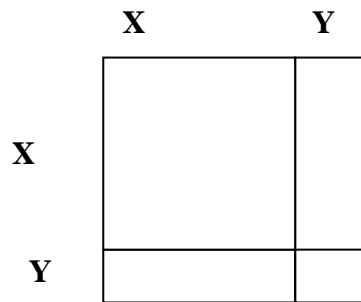


Figure 2:2 The square of a binomial

(Source: Johnson, 1972)

It is easy for the student to see that $(x+y)^2$ gives the area of the outer square. This square is made up of regions whose areas are x^2 , xy , xy , and y^2 . Consequently $(x+y)^2 = x^2 + 2xy + y^2$. This is a simple example of how a model adds reality and meaning to an abstract, symbolic representation. The teacher may involve students in this by asking them to cut pieces of manilla paper as per the diagram and fix them using glue. This will enhance the understanding of how a binomial is expanded to give three terms.

In the ensuing discussion, the word model was restricted only to those concrete devices utilized by teachers and students to demonstrate mathematical concepts. Each time a model is used in the classroom, it should play a positive role in providing deeper student understanding of mathematics. The model may illustrate a specific concept for example a wooden conic section; it may provide the basis for a development for example, unit cubes for building solids; it may be used as a vehicle for student's discovery, for

example, right angled triangles for Pythagoras theorem. In each case the teacher should know the purpose and appropriate use of the model.

The primary purpose of a model is to provide a concrete visualization for thinking about and discussing an idea. For example, a model that allows a student to transform a rectangle physically into a triangle provides a basis for developing the formula for the area of a triangle. The model provides experiences which can then be used for thinking about an idea by providing a frame of reference for sense perceptions and experiences. Such transformations from the abstract to the concrete are often difficult to achieve. They must be supported at all stages by thoughtful teaching which could pose a great challenge to a teacher. The teacher must recognize and anticipate the level of insights that occur to individual students as a result of experiences with physical models. The teacher should be able to rapidly create a bridge between the concrete and the abstract and make the students to understand the conceptual model. A slower student may be encouraged to work with the model at his desk, for the sense of touch may provide him with the needed bridge to the conceptual level. The model should be kept available to reinforce the concept if and when students regress in understanding.

According to Sidhu (1982), models are very useful as teaching aids because they can be handled and manipulated. Their main merit is that they afford pleasure in their making. They have a creative value for anyone who may make them. He further notes that even a square piece of cardboard is a model.

This is because all other geometric forms can be cut out of such a cardboard or a thick paper and used as models. Planes of three dimensional objects can be cut and then fixed together. A model which can be dismantled is most helpful in showing how the various planes have been fixed together.

Models are most useful when the shape of the object is complex and must be shown, the inside detail must be observed and cannot be better shown by a cross section diagram, for example, the spherical earth, when there is so much detail all relevant and when pictures or diagrams are unclear or misleading. In general, models should therefore be employed when the use of the third dimension aids communication. Only details relevant to the message being communicated should be included. Too much unnecessary realism may reduce effective communication. There is little to be gained in terms of learning efficiency by going for a model if the teacher can picture the object, concept or phenomenon adequately, in two dimensions (Romiszowski, 1968).

Teachers who use models are enthusiastic about the contributions they make. They suggest in summary, that models are effective because they perform the following functions: they give concrete representation of abstract ideas, they relate new ideas to previous experience or previously learned ideas, they enhance active participation of the learner in the learning activity and thus provide additional motivation to the learning of mathematics, they concentrate attention on the concepts involved and stimulate interest in these concepts, they teach how to solve problems and how to explore new ideas, they speed up

communication, they consolidate details that are related to the generalization being sought, they lend variety to classroom activities and provide a useful change of pace, they provide a program of enrichment and acceleration for individual students, they provide successful, meaningful activities for the slow learner and that they encourage the participation of practical minded students who need this continuing contact with the concrete world (Johnson, 1972.)

However, models are sometimes misused or used at inappropriate times. At the same time, it should be noted that the most frequent misuse of models is failure to use them at all. Some of the principal abuses and misuses of models are: excessive and indiscriminate use merely for the purpose of using a model, failure to transfer from the concrete representation to a generalization or abstract representation, failure to use the right model at the right time or for a sufficient length of time to establish the concept involved, use of an inadequate model- a model that is too small, too crude, too complex and failure to adapt the model to the needs of the students or to the objectives involved. It is not well documented if mathematics teachers in the Kenyan context face any challenges in the use of models thus the need for this study.

2.4.5 The Electronic calculator

To ease the problems of manual computation, and to facilitate accuracy and speed, people have always tried to find quick methods of calculating. The electronic calculator has come in handy as a device that can handle

calculations with great speed and accuracy. According to Macnab (1986), electronic calculators can be used in school mathematics to reduce reliance on numerical computational algorithms and to stimulate and facilitate mathematical thinking. If one wishes to calculate $3456.26 / 56.7$, then the calculator sequence $(3456.26) (/)(56.7) (=)$ will produce the answer which is 60.956966 immediately with an accuracy of at least 6 significant figures. Thus, use of a calculator allows even the mathematically weak learners to undertake “realistic” calculations, rather than those artificially contrived to keep the arithmetic simple. However, this process may not enhance learning of the skill involved in such a computation. The calculator only provides the correct answer but does not teach the process leading to this answer. It is therefore the role of the teacher to make students understand the processes involved in any operation and it was the interest of this study to find out if mathematics teachers faced any challenges in this.

The argument propounded in favor of the calculator is that by removing the problem of calculation, students would be able to concentrate on solving problems from the world outside the classroom. These are types of problems that apply to their real life situations and which test application from the cognitive domain. On the other hand, teachers will have time to cover the ever wide mathematics syllabuses. The value of the calculator in stimulating or aiding mathematical thinking is that it allows one to perform many calculations quickly and without effort, so that one’s energies can be devoted

to the mathematics involved rather than be dissipated in carrying out extensive routine written work.

Some of the reasons given by students and tutors in the Mathematics tutor support module 101 (1989) in Ghana on reasons for using calculators were that it keeps students abreast with the modern world and technological age, helps pupils understand mathematical concepts and properties, reduces students' anxiety, assists and improves the teaching of mathematics in the classroom, reduces the complexity of some topics, like decimals, which students often find difficult, helps to develop fluency in mental and written calculations hence improving students' performance in computations, makes the use of large and many numbers possible, for example, in statistics and that it motivates and sustains positive attitudes towards the learning of mathematics.

Since 1974, there have been numerous studies mostly confirming that the use of calculators enhances rather than inhibits students' skills and attitude in mathematics. A study that found just the opposite was by Ferretti (1996) in the United States of America who found most students who had used calculators since grade four, intelligent and conscientious. Among students and who had completed at least algebra 2 in high school, very few could work accurately with fractions and more than 40% had not mastered their basic multiplication facts. It was his experience however that the unlimited use of calculators in

pre-college mathematics has detrimental effects on a large number of students in the US (Mathematics Tutor Support Module 101, 198).

Mathematics teachers have to guide their students on the use of the calculator to avoid overuse. For example, one would not expect a student to reach for a calculator to multiply 9 and 7 but one would not object if the student used a calculator to multiply 9.3 and 7.4. During the time of the study, students in Kenya were allowed to use calculators as from form three when they had already mastered basic written and mental algorithms. However, calculators can be introduced as early as form one and only used as alternatives with the guidance of the teacher.

The use of calculators should depend on the purpose of the lesson. For example, if the teacher's purpose is to practice a pencil-and-paper algorithm for multiplications like 83.9×53.7 , there would be no advantage in using a calculator. However if the teacher wanted the students to discover that multiplying two numbers each containing one decimal place usually gives an answer with two decimal places, it is an advantage that a calculator can quickly do $83.9 \times 53.7 = 4505.43$ as part of an exploration of many multiplications. Students could quickly produce many correct results from which they could discover a new mathematical rule. Teachers need to prepare in advance to get the problems that require the use of a calculator. There should also be provision for a mathematics room where students can discover things with the calculator. Teachers should help students to avoid over reliance

on the calculator and teach processing. This will help the students not to stop thinking. Students should know when to use a calculator. The extent of use of calculators is not adequately documented at least in the Kenyan context. Therefore, this study sought to establish the extent of the use of calculators and any possible challenges faced.

2.4.6 Improvised media for teaching mathematics

These are locally available materials that a mathematics teacher may use as concrete objects or teaching aids to help students understand mathematical concepts. These include coins, playing cards, students' shoes, school's tank, money, dice, flag post, strings, match sticks, marbles, cans and many others. Some of their uses are discussed in section 2.4.2 as possible interventions to inadequacy of instructional resources in schools.

2.4.7 ICT integration in teaching and learning Mathematics

Information Communication and Technology (ICT) in a broad sense refers to the processes, applications and equipments by which we access, organize, analyze, evaluate and present information (SMASSE Project, 2011). Technological advancement has brought with it the Information Technology (IT) Revolution. It is becoming evident that any society that will be left out of this revolution risks total isolation from the global family. Technology has also found considerable use in education. However, not many mathematics teachers have the necessary IT knowledge and skills. Capacity building in this

critical area can be achieved through in-service training to enable mathematics teachers to adopt technology.(SMASSE Project, 2012).

ICT integration in education is a policy priority by the Ministry of Education (Ministry of Education, 2006). The ICT options were based on Sessional Paper No. 1 of 2005 and outlined among others, priorities on improving quality teaching and learning, improving educational policy and coordination and considering costs and benefits of educational interventions. There are eight options which included quality teaching and learning through ICT with a focus on e-content development; ICTs in teacher training colleges; computers in secondary schools; computers in primary schools cluster centers; ICT for in-service teacher training; and video for in-service teacher training among others.

On computers for secondary schools, the paper recognized the challenge of poor performance in mathematics and science and outlined potential benefits of ICT integration to enhance greater critical thinking skills, scientific inquiry, and analytical creative and collaborative power of computers. ICT was seen to be a tool for helping address teachers' professional needs and challenges and thus in-service training should incorporate activities that increase efficiency in the teachers' workload and integrate ICTs to improve curricula teaching and learning objectives.

Many people consider ICT integration as ‘having a computer in the classroom’ or ‘doing the basic operations on the computer’. These, however, are common misconceptions about Integration of ICT in teaching and learning. Often, teachers are just expected to integrate technology without having a working definition of the concept (Dias, 1999). Information and Communication Technologies (ICTs) are commonly defined in education as “a diverse set of technological tools and resources used to communicate, create, disseminate, store and manage information” (Blurton, 2002). These technologies include computers, the internet, broadcasting technologies (radio and television), and (mobile) telephones.

In Kenya the older technologies, such as the telephone, radio and television, although now given less attention, have a longer and richer history as instruction tools (Cuban, 1986). KIE has been using radio and video tapes for content delivery. In 2006 KIE started developing digital content and in 2009 a digital broadcasting centre was launched (current span limited to Nairobi and its environs). In Kenya the different technologies are used in combination rather than as the sole delivery mechanism. The use of computers and the internet was still in its infancy in Kenya at the time of this study as was the case in other developing countries due to limited infrastructure and the attendant high costs of access.

Whether there is any added value of ICT in teaching and learning is a question that is not adequately answered. From experiences in other countries (and

from some schools that were using ICT in Kenya) we can learn that the ‘add on’ approach of ICT in Education is neither productive nor effective. Using computers or technology as an add on means that teachers are going to use the tools to reproduce the way they were always teaching without any quality improvement. Furthermore, provision of computers in a classroom does not mean they are going to be used in a pedagogical way (if used at all). Since computers and technological infrastructure are expensive, it needs to go hand in hand with enhancement of quality of teaching and learning.

The use of ICT can support the new instructional approaches that go hand in hand with the shift towards learner centered learning and make hard-to-implement instructional methods such as simulation or cooperative learning more feasible. ICT can also play a role in helping a teacher explain abstract concepts. Generally, research shows there are three critical benefits of ICTs, when used in the right way. More effective teaching/learning using ICT can help improve pupil performance and skills, maintain the quality of teaching/learning while cutting down on teaching time and using cheaper aids. One example is the use of digital learning materials that allow pupils to learn independently and that enable the teacher to devote more time to pupils who require individual attention. This may allow a teacher to accommodate all types of learners (bright, average or slow) in his/her class.

The world is becoming a global village due to the impact and influence of technology and the provision of both skills and facilities in ICT to all the

teachers and all the schools in Kenya is no longer a choice but a key component to effective learning and teaching. This will promote innovative teaching and learning methodologies that are relevant for global competitiveness, interactions and information sharing which promote global citizenship. There are two reasons to use this technology in our schools:

- i) Technology can reduce the effort devoted to tedious computations and increase students' focus on more important mathematics.
- ii) Technology can present mathematics in ways that help students understand concepts.

In combination the two features can enable teachers to improve both how and what students learn.

The computer as a mathematics instructional resource was not widely used in Kenyan schools at the time of this study and there was little evidence of this in the learning process. Only 2% of schools in Kenya had necessary ICT infrastructure by the time of this study (Wilson, 2014). Factors which were likely to have hindered the effective use of computers included;

- i) the cost of purchasing and maintaining the computer facility and ii) mathematics teachers had not been trained on ICT integration in education. ICTs were therefore not included in this study.

2.5 Possible Interventions

2.5.1 In-service Teacher Training (INSET)

The second objective of this study was to investigate on in-service training of mathematics teachers in Nairobi County. This is because changes in curriculum bring about a need for re-examination of pedagogical aspects. New teaching methods/approaches may be required to teach new curricula. Other than new curricula, there is continuous research on effectiveness of teaching/learning methods/approaches and as such practicing teachers need to be updated on the current trends. For example, there has been a strong recommendation by educators for a shift from teacher-centered approaches to student-centered approaches to teaching. Without in-service training during which such developments are articulated teachers may find it difficult to discard old practices for the new.

Much of the good practices taught and learned in pre-service Teacher Training Colleges are soon undone because of lack of follow-up mechanisms. Newly posted teachers very soon after entering the profession resort to outdated teaching practices most likely due to discouragement by colleagues who are older in the profession who may believe that much of what is taught in colleges is theoretical and does not work in actual practice. Another factor could be frustrations encountered in the course of duty. The use of a wide variety of instructional media is one pre-service practice that is slowly abandoned and most teachers end up using only the textbook. This poses a

challenge to mathematics teachers because the subject is abstract and requires the use of concrete materials in teaching and learning. In-service training thus provides a good opportunity to make a follow-up and undo the retrogressive acts, attitudes and practices.

In-service training is also important for professional development through sharing of experiences and continuous exposure to new ideas to keep abreast with new developments in the teaching profession. Pedagogical, content, administrative and policy issues can be handled during the interactive forum that in-service training provides. According to NRC (2001), teachers' professional development should be of high quality, sustained, and systemically designed and deployed to help all students develop mathematical proficiency. Schools should support, as a central part of teachers' work, engagement in sustained efforts to improve their mathematics instruction. This support requires the provision of time and resources.

Effective programs of teacher preparation and professional development help teachers understand the mathematics they teach, how their students learn that mathematics, and how to facilitate that learning (NRC, 2001). Just as students' opportunities to learn mathematics effectively have been made insufficient, so have teachers' opportunities to learn more about mathematics, students' learning and thinking, and their teaching practice. In a world where advanced Information Communication and Technology seems to have gained ground, it is critical that teachers are regularly kept abreast with information that can

impact in their pedagogical skills as well as being kept on board with the current information to be at par with their counterparts in the world and to maintain pace with the learners who could be privy to technological innovations (Wilson, 2014).

The use of need based seminars and workshops contribute greatly to the professional growth of teachers. Teachers need access to resources and expertise that will assist them in improving their instruction, including access to mathematics specialists in secondary schools (NCTM, 2000). They add that improving students' learning depends on the capabilities of classroom teachers. Although children bring important mathematical knowledge with them to class, most of the mathematics they know is learnt in school and depends on those who teach it to them. The fact that teachers cannot automatically know how to teach more effectively means that learning to teach well cannot be accomplished once and for all in a pre-service program; it is a career-long challenge.

Kilpatrick,(2001) noted that teachers who possess strong mathematical knowledge at a greater depth and span are more likely to foster students' ability to reason, conjecture, and problem-solve, while also being able to more accurately diagnose and address students' mathematical (mis)conceptions and computational (dis)fluencies. The National Council of Teachers of Mathematics, 2006 and the National Mathematics Advisory Panel (2008) came up with two challenges that have been associated with ensuring that

teachers have the adequate content knowledge to teach mathematics effectively. First, because mathematics education research has been fraught with philosophical differences, defining the content or subject matter that teachers should master has been a matter of some debate. Ball (2008) commented, “defining a precise body of mathematical knowledge that would effectively serve teachers and would guide teacher education, professional development, and policy has proved challenging”. Second, the use of indirect indicators or proxies for teacher knowledge, such as teacher certification, coursework, and teacher licensing exams, rather than more robust and direct measures of teachers’ mathematical knowledge, has made the study of content knowledge and its link to student learning difficult.

Research on the relationship between teachers’ mathematical knowledge and student achievement has offered some evidence of the impact of mathematical knowledge on teaching effectiveness and student learning. The research focused on secondary mathematics teaching and suggests general positive influences of teachers’ studying mathematics on student achievement. These positive effects, however, varied by skill level of student (e.g., whether the students were enrolled in advanced or remedial classes) and number of undergraduate mathematics courses taken by the teacher (Monk, 1994). Although results in studies of teachers’ mathematical knowledge and student achievement are mixed, the evidence does suggest teachers’ knowledge of mathematics content as a contributor to instructional quality and student achievement (Wilson, Floden, and Ferrini-Mundy, 2001).

According to the Report of National Committee on Educational Objectives and Policies (Gacathi, 1976), the role and quality of teachers must be given the most critical consideration. The report noted that the qualitative improvement of education can only occur if there is a major improvement in the quality of teachers and teacher training. Riungu, (1988), Eshiwani, (1974) and Kathuri (1986) point to a general agreement that the qualification of teachers is of crucial importance in students' performance in mathematics. Teacher training should therefore stress quality and effective mathematics instruction which should be stressed further through in-service training.

2.5.2 Improvisation of instructional resources

Schools may not always be in a position to provide all the teaching materials that a mathematics teacher would require. In education, we are in the business of learning and it is mandatory for teachers to do whatever is needed using whatever materials and resources they can to best meet students' needs, whether it involves technology or not. As the proverb goes 'necessity is the mother of invention' mathematics teachers have to use their innovative skills to improvise instructional resources for effective teaching/learning. A teacher using a learning activity should be well versed with knowledge on how to back it up with the right and relevant media. Concrete examples should always be provided if possible. The teacher also needs to know how every media used enhances learning.

To cope with the challenge of inadequate instructional resources, mathematics teachers can use improvised media to teach abstract mathematical concepts. Some common types of improvised media include; playing cards, geo boards, students shoes, school tank, coins and currency notes, dice, school's flag post, strings, match sticks, marbles, beans and maize seeds, stair cases, classroom floor and walls and many others. Strings may be used to teach sequences in the following manner: learners are divided into groups of four each and each group given one piece of string. They are then asked to fold and cut the pieces of string at the centre successfully and fill in a table of two columns the number of folds and the number of pieces of strings generated. The teacher may then bridge to the concept by asking the students to make a deduction from the list of numbers generated by the number of pieces. He/she may then define a sequence using the pattern formed.

Coins and dice may be used in teaching combined events in probability where students are put into groups of three. In one group a student tosses the coin once, one reads the observation while the third records. In another group, one student rolls a die the other reads the observation and the other records. Using the sample space, students find the probability of getting a head and a six. Coins may also be used to teach Binomial expansion where students toss a coin four times and record 16 different ways in which a sequence of heads (H) and tails (T) could occur. Four heads may occur once, 3 heads 4 times, 2 heads 6 times, 1 head 4 times and 0 head once. The pattern formed is thus 1, 4,6,4,1. The number of arrangements corresponds to the fifth row of Pascal's triangle.

The teacher may then ask the students to investigate arrangements with a coin tossed twice, thrice and five times and repeat the procedure. (Kamau, 2004).

Indirect proportionality may be taught using manila sheet, masking tape and meter rules. Learners subdivide a manila sheet strip into six equal parts. They shade one part to show a person's fraction of work in one day. They then subdivide another manila sheet same size as the first one into six equal parts. They shade two parts to represent a second person's fraction of work. Finally they combine the two persons' fractions of work to find amount of work they do in one day. Learners may use the combined answer to find the time taken to complete the task.

It is difficult to compare fractions with different denominators directly. A mathematics teacher may demonstrate this by asking three students to run round a track as the others record their speeds. One student makes 3 laps in 6 minutes, the second one makes 4 laps in 10 minutes while the third one makes 5 laps in 15 minutes. The students are then asked to write down the ratio of the number of laps to the number of minutes for each in form of fractions. The teacher may then ask the students to say who jogged fastest and who jogged slowest. The students will find it difficult to answer the questions and teacher may capture their curiosity and teach comparison of fractions using equivalent fractions (Kamau, 2004)

To teach interest gained on some amount of money, a teacher may ask one student to give out sh100 to another student and demand an additional sh10 as he receives back his money. He is asked to repeat the same to four other students as the class records the interest gained. The students finally realize that the interest gained from the five students is sh550. The teacher is then able to bridge from the activity to the concept of simple interest by using the formula ($I = \frac{PRT}{100}$) and arrives at the same answer as the students.

When introducing Three-Dimensional Geometry to students, a mathematics teacher may ask them to look around and name all the things they see in the environment. Wherever they look, they see three-dimensional shapes; buildings, furniture, plants, people and many others. All these are seen in three dimensions; length, width and height. Drawings that are created to represent the idea of these three dimensions are often called “3-D drawings” (Kamau, 2004). Mathematics teachers are therefore expected to have skills of drawing in three dimensions. This study would find out if teachers faced any challenges in this.

From the discussed examples, it is noted that there are numerous locally available materials that a mathematics teacher may improvise and use as instructional resources to teach different mathematical concepts. The activities generated by the use of the resources are also quite meaningful in that they all bring about the discovery or development of a certain concept. However, the preparation and the execution of each activity requires time and this could be a

possible challenge faced by mathematics teachers in their efforts to create meaningful teaching and learning activities. This study sought to establish other possible challenges.

2.6 Summary of Literature Review

This chapter presented relevant literature on types of instructional media and challenges facing teachers in their utilization in teaching mathematics. It was noted that how teachers design tasks for students has many implications on how students learn mathematics. There is a wide range of instructional resources including text books, chalkboard, models, pictures and charts, calculators, computers and improvised materials like coins, strings, shoes, match sticks, stairs and many others. The use of a wide variety of these instructional resources was quite limited in most classrooms. The challenges facing mathematics teachers in utilizing these resources was the focus of this study.

There was limited information on ICT integration in teaching and learning mathematics in Kenya. This was because there were very few public secondary schools that had incorporated ICT in teaching and learning mathematics at the time of this study.

It is important that mathematics teachers attend In-service Training (INSETS) and apply the approaches learnt in their lessons. INSETS are important for

professional development through sharing of ideas and continuous exposure to new ideas that keep teachers abreast with new developments in the teaching of mathematics. INSETS help mathematics teachers to put into practice theories, teaching methods and student management styles learnt during pre-service training. There is limited information on attendance of INSETS by mathematics teachers in Kenya and this study sought to look at the situation in Nairobi County in particular.

Mathematics teachers are advised to utilize locally available materials, which are cost effective. The environment is also a resource and teachers should provide materials that students are familiar with. Research on the use of mathematics instructional media and improvisation of instructional materials was inadequate and this study sought to fill this gap.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the procedures which were used in conducting the study. The chapter was organized in the following sub-headings: research design, location of the study, target population, sampling techniques and sample size, research instruments, pilot study, data collection procedures, data analysis techniques, logistical and ethical considerations.

3.1 Research Design

This study employed descriptive survey research design to establish the challenges that teachers face in utilizing instructional resources when teaching mathematics. Mugenda and Mugenda (1999) observed that survey design is the best method available to social scientists who are interested in collecting original data for the purposes of describing a population which is too large to observe directly. Figure 3.1 presents the process used to carry out the study.

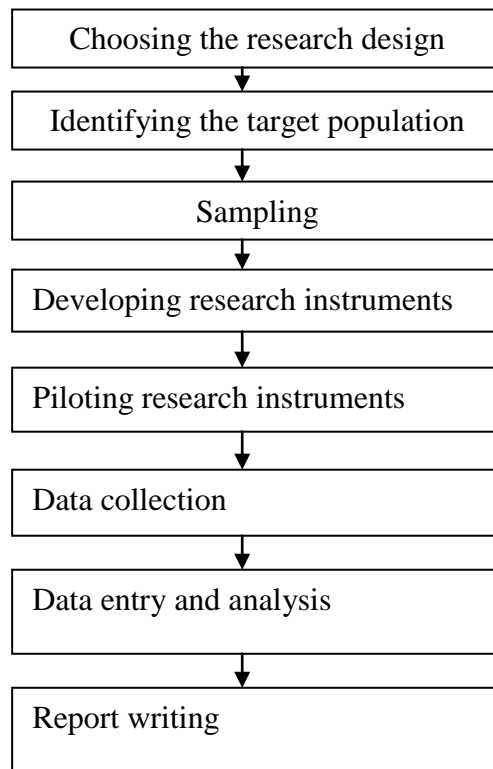


Figure 3.1 Research Process

3.2 Location of the Study

This study was carried out in Nairobi County, Kenya which has a total of 80 public secondary schools. The County is mainly urban. The choice of the County was determined by accessibility and familiarity of the locality to the researcher which made it easy to develop immediate rapport with the respondents hence making data collection easy. The researcher also found the location quite accessible. Best, (1993) argue that, since research requires careful thought, a number of practical factors including accessibility and cost factors become legitimate considerations.

3.3 Target Population

Orodho, (2005) considers a target population to be a set of elements that the researcher focuses upon and which the results obtained by testing the sample should be generalized. From these premises, the target population for this study was 412 mathematics teachers from the 80 public secondary schools in Nairobi County by the time of the study (KNEC, 2013).

3.4 Sampling Techniques

The population was sampled using the stratified sampling techniques so that all categories of schools were included in the study and then proportionately sampled to give a sample size of 50 respondents from 10 selected public secondary schools. The categories of schools included National, County and District secondary schools.

3.5 Sample Size

From the 10 sampled schools an equal number of mathematics teachers (5) were selected from each school yielding to a sample of 50 mathematics teachers. Gay (2003) suggests that 10% of the accessible population is adequate to serve as a study sample. Sampling was done as presented in Table 3.1.

Table 3.1 Sampling Grid

| School Category | Total Number of schools | Schools sampled | Total number of teachers | Number Sampled |
|------------------------|--------------------------------|------------------------|---------------------------------|-----------------------|
| National | 7 | 2 | 56 | 10 |
| County | 68 | 7 | 336 | 35 |
| District | 5 | 1 | 20 | 5 |
| Total | 80 | 10 | 412 | 50 |

3.6 Research Instruments

The study used Mathematics Teachers' Questionnaire (Appendix B) and Classroom Observation Schedule (Appendix C) to collect data.

3.6.1 Mathematics Teachers' Questionnaire (MTQ)

Questionnaires are used to reach a large number of subjects who are able to read and write independently.(Orodho,2004). MTQ enabled the researcher to solicit information on training status of mathematics teachers, extent of use of instructional resources, challenges faced in utilization of instructional resources and possible solutions to the challenges. MTQ had been successfully used before by several other researchers in the field of Mathematics Education.

3.6.2 Classroom Observation Schedule (COS)

The use of classroom observation schedule as an instrument was to allow for more objectivity in the study. It was used as a back-up for the responses given

by teachers in the questionnaires and was used to evaluate teachers on the actual use of instructional resources during their lessons and to find any difficulties experienced by teachers in resource utilization. The frequency of the use of instructional media was also observed. The instrument was used in form three classes during mathematics lessons. This was because form three classes were known to be well adjusted to their school systems which meant that their teachers had already established the most suitable teaching techniques for the classes.

3.7 Pilot Study

The research instruments were pre-tested in two public secondary schools which were not included in the sampled schools. Piloting was done to correct any errors which could have been made in the research instruments before they were applied in the actual research. Mugenda and Mugenda (1999) note that piloting ensures that research instruments are stated clearly and have the same meaning to all respondents. Piloting enabled the researcher to have meaningful observations because it helped to detect deficiencies in the instruments, rephrasing vague questions, and revealing the appropriateness of the anticipated analytical techniques (Orodho, 2005). Another purpose of pilot testing was to refine the information (Mwiria, 1995). It also helped in determining the validity and reliability of the research instruments.

Pre-test was carried out in one boys' school and one girls' school. The procedures used in pre-testing the instruments were identical to those that were used during the actual study or data collection.

3.7.1 Reliability

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. The lesser the variations produced by an instrument on subsequent trials, the more reliable it is Mugenda and Mugenda (1999). A test- retest or coefficient of stability method was used to estimate the degree to which the same results could be obtained with a repeated measure of accuracy of the same concept in order to determine the reliability of the questionnaires. The following steps were carried out to test the reliability of the questionnaires used in this study.

- a) The developed mathematics teachers' questionnaires were given to six mathematics teachers who were not to be included in the main study. This was to help the researcher know whether the questions in the instruments were clear.
- b) The answered questionnaires were scored manually by coding the items.
- c) The same questionnaires were administered to the same group of teachers after a period of two weeks to find out how the responses compared to those of the first test.

- d) The second questionnaire responses were scored manually and a comparison was made between the two attempts.

A Pearson's product moment formula for the test-retest was employed to compute the correlation coefficient (r) in order to establish the extent to which the contents of the questionnaire were consistent in eliciting the same responses every time the instrument was administered.

Pearson's Product Moment Formula.

$$r = \frac{\sum XY}{(\sum X)(\sum Y)}$$

where $X = X - \bar{x}$

$Y = Y - \bar{y}$

Letter X stood for scores from first half and Y stood for scores from the second half of the pilot sample. \bar{x} and \bar{y} were their respective means. A score of 0.78 was arrived at in this study which meant that its reliability was quite high. Orodho, (2005) states that a correlation coefficient of about 0.8 is considered high enough to judge the instrument as reliable for the study.

3.7.2 Validity

Reliability of the questionnaire would not be of much use unless it also had validity. Validity is concerned with establishing whether the questionnaire content is measuring what it is supposed to measure. It is a non-statistical

method used to validate the content employed in the questionnaire (Orodho, 2005). Content validity in this study was established by seeking judgments from a panel of three judges competent in the area of study. These included supervisors who assisted in developing and revising the research instruments. On assessing the questionnaire and its relevance individually, the supervisors provided feedback and their recommendations were incorporated in the final questionnaire.

3.8 Data Collection Procedure

The researcher self-administered the questionnaires to each of the respondents who were then given ample time of two weeks to respond to the questions. This ensured achievement of a good return ratio and helped respondents to get a chance to seek clarification on items which proved difficult.

For COS, the researcher used research assistants and they both made concurrent observations independently and the degree of agreement between them was checked. The observation procedure was repeated until high agreement was reached. This enhanced validity and reliability of the items.

3.9 Logistical and Ethical Considerations

The researcher presented letters of introduction to the various secondary school principals requesting for permission to carry out research in their schools. On securing permission, the researcher made preliminary visits to the sampled public secondary schools to explain the purpose of the study verbally and then made necessary arrangements for the administration of

questionnaires and data collection. The researcher also familiarized herself with mathematics teachers during these visits but no data was collected. This was done to minimize Hawthorn effect. The names of schools sampled were not presented for confidential purposes.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.0 Introduction

The purpose of this study was to establish the challenges facing teachers in utilizing instructional resources in designing activities for teaching mathematics in Secondary schools in Nairobi County, Kenya. The findings of the study were as presented in the following sections in which data analysis, presentations and discussions were based on the objectives of the study. Descriptive statistics such as percentages and frequency distributions are used to analyze the data. In every case data analysis is followed by interpretation and discussion.

4.1 Data Analysis

Data was first edited. Coding was then done to translate question responses into specific categories. Code numbers were assigned to each answer of survey question and from these a coding list was obtained. Coding was expected to organize and reduce research data into manageable summaries. The coded items were analyzed with the aid of computer software known as Statistical Package for Social Sciences (SPSS). Quantitative analysis was done to present statistical data in form of frequency distribution tables whose explanations were mainly descriptive. Percentages were used to describe the data as they could easily communicate the research findings to a majority of readers and also to compare sub groups that differ in proportion and size. Qualitative

analysis was used to analyze the views teachers gave on the challenges they faced in utilizing instructional resources and factors that influenced the use of resources.

The analysed data were presented in form of tables and bar-graphs where applicable. Discussions were then done from the information obtained from both qualitative and quantitative analysis which led to the drawing of conclusions and recommendations.

4.2 General information of the respondents

In this section, the respondents were asked questions on other subjects they taught, their highest academic qualification, teaching work load, teaching experience and duration of service in their current schools. The findings were as presented in the following sub-sections.

4.2.1 Academic Qualifications of Mathematics Teachers in the sample

The study sought to establish how qualified the respondents were professionally so as to find out if there were any challenges emanating from this. Thus, the respondents were asked to state their qualifications from three suggested levels of education; Diploma (Ed), Graduate (Bed) or Post-Graduate (Med). The findings were as shown in Figure 4.1.

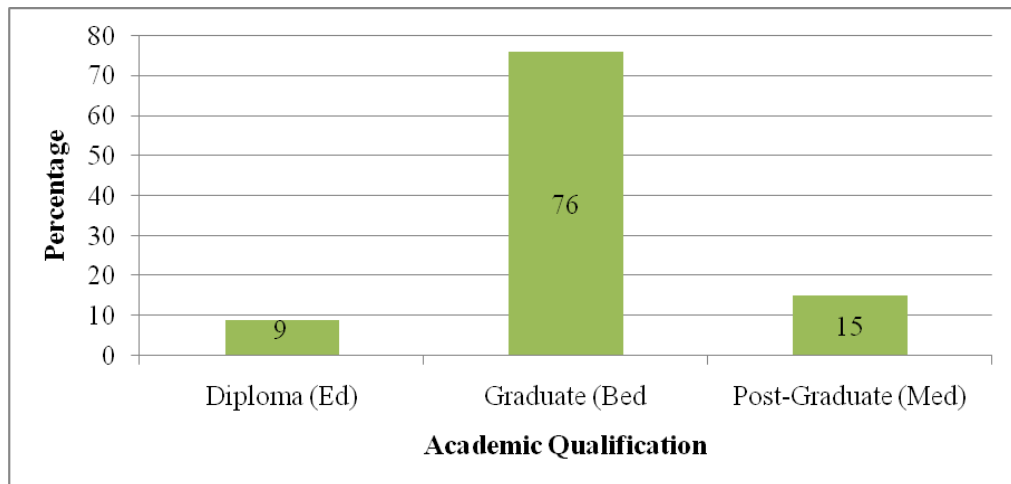


Figure 4.1 Academic Qualifications of Mathematics Teachers in Nairobi County

These findings indicate that 76% of mathematics teachers were first degree graduates in education, 15% were post-graduates in education, and 9% were diploma holders in education. This was an indication that mathematics teachers in Nairobi County were actually qualified to teach and any failure to develop and use instructional media could not be attributed to their qualifications, but was rather caused by other factors. Pre-service training of teachers entails teaching techniques and the use of instructional media in teaching, among other areas. Since teaching and learning mathematics depends on the teachers' capabilities, training is necessary as teachers cannot automatically know how to teach effectively. Both pre-service and in-service teacher training is crucial in enhancing and improving teaching techniques. Most importantly, the teachers must apply the aspects learnt during training in their classrooms.

According to the Report of National Committee on Educational Objectives and Policies (Gacathi, 1976), the role and quality of teachers must be given the most critical consideration. The report noted that the qualitative improvement of education can only occur if there is a major improvement in the quality of teachers and teacher training. Studies conducted by Riungu (1988), Eshiwani (1974), and Kathuri (1986) revealed a consensus that the qualification of teachers is of crucial importance in students' performance in mathematics. Teacher training should therefore stress quality and effective mathematics instruction, which should be further promoted through in-service training.

4.2.2 Duration of Service in the current Schools

The researcher further asked the teachers to indicate the length of service in their current schools, as this would affect how a teacher responded to the questions regarding availability and accessibility of instructional resources. According to the study findings, 44% of the teachers interviewed had been in their current schools for over 8 years, 39% had served for 5-8 years, and 13% had served for 1-4 years, while only 4% of the respondents had served for a period of below 1 year. This showed that most of the respondents had taught in their current schools for a considerable length of time. Thus, it was assumed that they would be able to provide reliable information regarding availability and use of instructional resources in their schools and discuss the challenges faced.

4.3 Attendance of In-Service Training by Mathematics Teachers in Nairobi County

The study further sought to find out whether mathematics teachers in Nairobi County had attended in-service training in a span of three years. The findings revealed that 47% of the respondents had attended in-service training within the past three years while the remaining 53% had not. From these findings, it was noted that more than half of the participating teachers had not attended in-service training for three years and possibly more. Attendance of in-service training is instrumental in informing and updating teachers on any new developments in education. It is in these sessions that teachers are updated on new teaching techniques, improvisation of learning materials, selection of appropriate instructional resources, and how to involve their students in the learning process. Eshiwani (1993) noted that, since improvement of education depends mainly on increasing teacher competency, there is need for systematic upgrading and training programs for primary, secondary, and all teaching staff through long- and short-term courses, and for upgrading teachers on the new trends in education.

NCTM (2000) found that teachers need access to resources and expertise which can assist them in improving their instruction in Mathematics. According to Kilpatrick, Swafford and Findell (2001), teachers who possess strong mathematical knowledge at a greater depth and span are more likely to foster students' ability to reason, conjecture, and problem-solve, while also

being able to more accurately diagnose and address students' mathematical misconceptions.

4.3.1 Benefits of Teacher Training and INSETs

An important part of this study involved establishing the benefits of teacher training and INSETs. The respondents were asked to indicate their level of agreement with different statements on the benefits of teacher training and INSETs. The findings were summarized in table 4.1.

Table 4.1 Benefits of Teacher Training and INSETs

| Statement | Strongly Agree | | Agree | | Neither Agree nor Disagree | | Disagree | | Strongly Disagree | | Total (%) | |
|---|----------------|----|-------|----|----------------------------|---|----------|---|-------------------|---|-----------|-----|
| | F | % | F | % | F | % | F | % | F | % | F | % |
| Teacher training helps teachers to understand the mathematics they teach, how their students learn mathematics, and how to facilitate learning. | 35 | 70 | 10 | 20 | 1 | 2 | 4 | 8 | 0 | 0 | 50 | 100 |
| Teacher training enhances knowledge of mathematical activities that foster students' manipulative abilities. | 38 | 76 | 7 | 14 | 1 | 2 | 3 | 6 | 1 | 2 | 50 | 100 |
| Teachers who attend in-service training use instructional resources more frequently. | 40 | 80 | 6 | 12 | 1 | 2 | 2 | 4 | 1 | 2 | 50 | 100 |
| Teacher training allows for necessary instructional adjustments such as changing the method or type of instruction. | 42 | 84 | 7 | 14 | 0 | 0 | 1 | 2 | 0 | 0 | 50 | 100 |

From these findings, 70% of the respondents strongly agreed that teacher training and INSETs help teachers to understand the mathematics they teach,

how their students learn and how to facilitate learning, 76% of the respondents strongly agreed that teacher training enhances teachers' knowledge of mathematical activities that fosters students manipulative abilities, 80% strongly agreed that teachers who attend in-service training use instructional resources more frequently and 84% strongly agreed that teacher training allows for necessary instructional adjustments such as changing the method or type of instruction. It was evident that mathematics teachers were aware of the benefits of teacher training and INSETs but there was a very high rate (53%) of non-attendance to INSETs. It was likely that teachers were not motivated to attend or there were no measures put in place to ensure that every teacher attended. Teachers need incentives through promotions or provision of more attractive allowances when they attend INSETs to boost their morale.

4.4 Extent of utilization of instructional resources in teaching mathematics in public secondary schools in Nairobi County

The study also aimed at establishing the extent of utilization of instructional resources and the respondents were asked to indicate the extent to which they used available instructional resources. The respondents were provided with criteria to use when deciding among five categories of responses as follows;

- Very large extent - every lesson
- Large extent - most lessons
- Moderate extent - some lessons
- Small extent - few lessons

Their views were summarized in Figure 4.2.

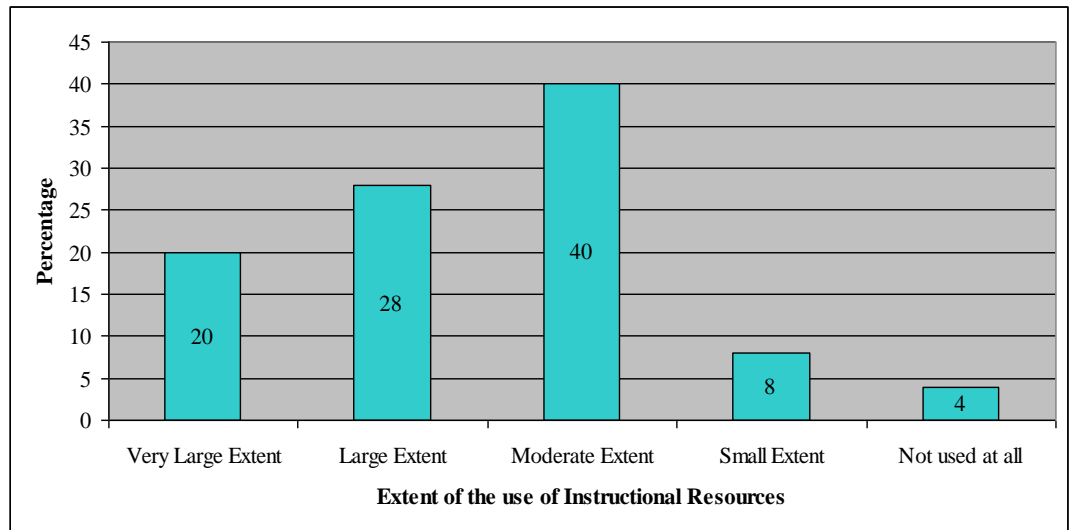


Figure 4.2: Use of Instructional Resources

It was noted that 40% of the respondents used instructional resources to a moderate extent, 28% to a large extent, 20% to a very large extent and 8% to a small extent. The first three percentages added up to 88% which meant that instructional resources were largely used. Only 4% of the respondents indicated that instructional resources were not used at all. This called for the identification of the specific resources that were largely used and those that were not used at all. Observations made using COS also indicated that there was limited use of some instructional resources like models, pictures charts and diagrams.

Very few teachers used locally available materials in instruction. The use of instructional materials such as audio visual aids should be emphasized because it enhances learning. As discussed in chapter one, audio visual aids are used in

teaching because they hold attention, motivate to take an action, increase permanence of learning, make the job of teaching easier and create interest.

4.4.1 Use of specific Instructional Resources in Teaching Mathematics

To establish the extent of use of specific instructional resources, the respondents were asked to indicate the extent of use of different suggested instructional resources using the same criteria on page 61. The findings were as shown in table 4.2.

Table 4.2 Use of specific Instructional Resources in Teaching Mathematics

| Instructional Resources | Very large extent | | Large extent | | moderate | | Small extent | | No extent at all | | Total (%) | |
|-------------------------|-------------------|----|--------------|----|----------|----|--------------|----|------------------|----|-----------|-----|
| | F | % | F | % | F | % | F | % | F | % | F | % |
| Text books | 39 | 78 | 8 | 16 | 0 | 0 | 3 | 6 | 0 | 0 | 50 | 100 |
| Electronic Calculators | 44 | 88 | 6 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 |
| Geometrical equipment | 45 | 90 | 5 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 |
| Models | 10 | 20 | 9 | 18 | 7 | 14 | 21 | 42 | 3 | 6 | 50 | 100 |
| Pictures and charts | 3 | 6 | 5 | 10 | 8 | 16 | 22 | 44 | 12 | 24 | 50 | 100 |
| Chalkboard | 46 | 92 | 4 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 |

From these findings, the study found that 92% used the chalkboard to a very large extent 90% of the respondents used geometrical equipments to a very large extent, 88% used electronic calculator to a very large extent, 78% used text books to a very large extent, 42% used models to a small extent and 44% indicated that they used pictures and charts to a small extent. The study

revealed that mathematics teachers tended to mainly use conventional instructional materials which are mainly provided by schools. These include the chalkboard, textbooks, geometrical equipments and electronic calculators. Improvised media like models, pictures and charts were used to a small extent. The researcher was thus interested in finding out if there were any challenges in the use of improvised media. Mathematics teachers have to be more creative and innovative in sourcing locally available materials for instruction. Learners need to be involved in improvisation and learning should be connected to the students' world and interests. The raw and unstructured resources from the living environment allow learners to explore freely and individually. This enhances creativity in learners.

4.5 Challenges facing teachers in utilizing Instructional Resources in teaching mathematics

This study aimed at establishing the challenges facing mathematics teachers in utilizing instructional resources in teaching mathematics. 100% of the respondents indicated that they faced challenges. They were then asked to indicate their level of agreement with different suggested statements on possible challenges. The findings were summarized in Table 4.3.

Table 4.3 Challenges facing teachers when utilizing instructional resources

| Statement | Strongly Agree | | Agree | | Neither Agree nor Disagree | | Disagree | | Strongly Disagree | | Total (%) | |
|---|----------------|----|-------|----|----------------------------|----|----------|----|-------------------|----|-----------|-----|
| | F | % | F | % | F | % | F | % | F | % | F | % |
| Inadequate teacher Professional development in Mathematics. | 25 | 50 | 19 | 38 | 2 | 4 | 3 | 6 | 1 | 2 | 50 | 100 |
| Non-availability and inadequacy of instructional resources. | 36 | 72 | 14 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 |
| Students' negative attitude towards mathematics | 14 | 28 | 20 | 40 | 5 | 10 | 9 | 18 | 2 | 4 | 50 | 100 |
| Teachers' negative attitude towards mathematics | 5 | 10 | 6 | 12 | 8 | 16 | 17 | 34 | 14 | 28 | 50 | 100 |
| Teachers' heavy work load | 39 | 78 | 11 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 |
| Large class size | 33 | 66 | 17 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 |

From these findings, the key challenges facing teachers in utilizing instructional resources in designing activities for teaching mathematics were;

- i) Teachers' heavy work load as strongly agreed by 78% of the respondents
- ii) Non-availability and inadequacy of instructional resources as strongly agreed by 72% of the respondents
- iii) Large class sizes as agreed by 66% of the respondents
- iv) Inadequate teacher professional development as strongly agreed by 50% of the respondents.
- v) Students' negative attitude towards mathematics as agreed by 40% of the respondents. 34% of the respondents

disagreed that teachers' negative attitude towards the use of instructional resources was a challenge to their utilization.

Large class sizes and inadequacy of instructional resources have an effect on distribution of instructional resources. The teacher-student ratio of 1:50 as observed through the COS was a threat to delivery of quality mathematics education. The ministerial recommendation at the time of the study was 1:40. Teachers with large classes are not able to meet the needs of all learners with regard to provision of individualized attention. Mathematics teachers with heavy work load have little or no time to prepare and develop, select and organize teaching and learning materials. It is also a challenge to improvisation of learning materials from the environment because it requires time. With manageable classes, teachers are able to determine the learners' needs so the instruction can be adapted and adjusted accordingly. In Wasiche,(2006), large class size and teachers' heavy work load were also found to affect mathematics teaching techniques. Keeping students actively engaged in a large class and helping them perform better in mathematics is a challenge to teachers.

Inadequacy of teaching and learning resources contributes to poor performance in mathematics in KCSE (Eshiwani, 1993).

From the COS it was observed that students did not have enough mathematics text books and the ratio of text book student ratio was on average 1:3. Teachers in most schools were found gambling with inadequate resources at the expense of the learners and peril to the expectant parents. The problem of unavailability or inadequate use of media resources in various subjects is well documented. KIE (1988) carried out a summative evaluation and the following were listed as some of the most common problems affecting teacher' ability to disseminate information; a) schools lack physical facilities and equipments including textbooks and b) lack of teaching and learning media resources. Ruth, W.B.O (2000). However, mathematics teachers have to know how to use available and limited teaching/learning resources in the classroom and outside the classroom. They have to use their innovative skills to improvise instructional materials.

On professional development, mathematics teachers need to continually develop themselves professionally. Schools can facilitate their attendance of in-service training or the teachers can sponsor themselves and attend courses to advance their profession. This enhances continuous exposure to new ideas and approaches to teaching.

Mathematics teachers can change students' negative attitude towards mathematics by using instructional media to cater for different moments such as to start or conclude lessons, to illustrate a point and to extend a lesson.

Involving students in development of learning materials like models arouses interest and curiosity which also motivates them.

4.5.1 Other findings

- a) Most mathematics teachers had a second teaching subject.
- b) The average teaching workload for mathematics teachers was 28 lessons per week which was quite heavy.
- c) Wide syllabus and pressure to cover it from their schools' administrations
- d) Inadequate time allocated for the subject and
- e) Lack of support from their schools' administrations in terms of provision of funds needed to purchase instructional materials when need arises.

There was need to change the examinations oriented curriculum to one that focused on students' acquisition of skills. The kind of curriculum that focuses on content alone and where learners have to be able to do all mathematics is no longer useful. This kind of curriculum makes teachers to concentrate on covering the syllabus leaving no time for preparation of a variety of learning activities and use of different types of instructional media. The goal of teaching mathematics should not be to cover the syllabus but to teach students to be able to navigate their lives in this modern world. This involves dealing

with taxes, loans, credit cards, purchases and other real life experiences where mathematics is applicable.

4.6 Possible solutions to the challenges facing teachers in utilizing instructional resources in teaching mathematics

- a) There is need for a policy by the Ministry of Education to regulate class size in public secondary schools to a more manageable size. Schools should also enroll students in relation to available facilities and resources.
- b) More mathematics teachers should be employed in secondary schools to curb the problem of heavy work load and also to cope with increased enrollment in secondary schools. This will allow more time for teachers to plan and develop instructional materials.
- c) Schools should avail the necessary instructional resources required for teaching mathematics by setting aside mathematics rooms and regularly equipping them with appropriate and relevant mathematical equipments.
- d) Mathematics teachers should regularly go for in-service training to upgrade their skills on the use of instructional resources in teaching mathematics. This helps them learn how to change the negative attitude of students to mathematics which in turn improves the performance of students in Mathematics.

- e) Mathematics teachers should embrace the use of instructional resources. This enhances students' understanding of mathematical concepts.
- f) Mathematics teachers should be trained on integration of ICT as a modern tool in teaching and learning. This will reduce the effort devoted to tedious computations and increase students' focus on more mathematical activities. ICT will also make mathematics more interesting to the students and eventually lead to good performance in the subject.

4.7 Chapter Summary

In this chapter, the researcher presented: data analysis, presentation, interpretation and discussion of the findings of the study. The findings were presented as per the objectives of the study. On training status of mathematics teachers in Nairobi County, the study revealed that a high percentage (88.99%) had undergone pre- service training but only 47% had attended in-service training. INSETs are necessary for teachers because they update teachers on new teaching techniques and promote activities that lead to improvement in overall classroom interactions. Regarding the extent of utilization of instructional resources in teaching mathematics in public secondary schools, the study found that improvised instructional resources such as models, pictures and charts were used to a small extent while the conventional ones like geometrical equipments, chalkboard, electronic

calculators and text books were used to a very large extent in teaching mathematics. As indicated in the literature review, the role of models in teaching and learning mathematics cannot be underestimated. Mathematics teachers are expected to use models, pictures and charts to a very large extent because they are concrete representations of abstract concepts found in mathematics. Students understand mathematical concepts better when they see and even manipulate real objects.

From the findings of the study, it was evident that mathematics teachers faced challenges that hindered them from fully utilizing instructional resources. The challenges identified were;

- a) Large class sizes
- b) Heavy teaching work load,
- c) Inadequate instructional resources
- d) Inadequate teacher professional development and
- e) Students' negative attitude towards mathematics.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The main purpose of this study was to find challenges facing teachers in utilizing instructional resources in teaching mathematics in public secondary schools in Nairobi County, Kenya. The study was guided by the following objectives: to find the challenges facing teachers in utilizing instructional resources in teaching mathematics in public secondary schools in Nairobi County, to establish the training status of mathematics teachers in Nairobi County, to find possible solutions to the challenges faced ,to establish the extent of utilization of instructional resources in teaching mathematics in public secondary schools in Nairobi County and to make possible recommendations from the findings of the study. The study employed descriptive survey research design. Data was collected using mathematics teachers' questionnaire (MTQ) and classroom observation schedule (COS).

5.1 Summary of Findings

The following is a summary of the findings based on the general research questions of the study;

- a) **Challenges facing teachers in utilizing instructional resources in teaching mathematics**

The factors that challenged teachers in utilizing instructional resources in designing activities in teaching mathematics were;

- i) Teachers' heavy work load as strongly agreed by 78% of the respondents.
- ii) Non-availability and inadequacy of instructional resources as strongly agreed by 72% of the respondents
- iii) Large class sizes as strongly agreed by 66% of the respondents.
- iv) Inadequate teacher professional development as strongly agreed by 50% of the respondents. Other challenges included students' negative attitude towards mathematics as agreed by 40% of the respondents. 34% of the respondents disagreed that teachers' negative attitude towards the use of instructional resources was a challenge to their utilization.

b) Status of in-service training of mathematics teachers in public secondary schools in Nairobi County

The study established that all mathematics teachers were professionally qualified with 76% first degree holders in education, 15% post graduates in education and 9% Diploma holders in education. However, more than 50% of these teachers had not attended in-service training.

c) Recommendations of the study

With regard to the challenges facing teachers in utilizing instructional resources in designing activities for teaching mathematics, the sampled teachers and the study recommended the following;

- i. KIE should incorporate more suggested instructional materials and activities in text books. This will help teachers to involve students in more learning activities and also utilize a wide variety of instructional materials
- ii. Follow up mechanisms of the SMASSE program to be put in place to ensure that there is implementation of the aspects learnt.
- iii. Mathematics teachers should embrace improvisation and use of instructional media in teaching and learning.
- iv. Schools should look into the quality of instructional resources, their availability, adequacy and the condition of the facilities.
- v. Incentives like promotions to be provided to teachers who attend INSETs.

d) **Extent of utilization of instructional resources in teaching mathematics**

The study found that the conventional instructional resources like the chalkboard, geometric equipments and calculators were used to a very large extent with 92%, 90% and 88% response rates respectively. Improvised instructional materials like models, pictures, charts and diagrams were used to a small extent. From the COS, it was observed that improvised instructional media were inadequately used.

5.2 Suggestions for Further Research

This study was carried out in public secondary schools in Nairobi County. The researcher evaluated the challenges facing mathematics teachers in utilizing

instructional resources in designing activities for teaching mathematics. The researcher recommended;

- i) A similar study in public and private secondary and primary schools in other Counties in Kenya.
- ii) Research in ICT integration in teaching and learning of mathematics and its challenges.
- iii) Implications of FPE and FSE on the quality of education in Kenya.

5.3 Conclusion

From the findings of the study, it was concluded that teachers faced challenges in utilizing instructional resources in designing activities for teaching mathematics in public secondary schools in Nairobi County. These challenges included: large class sizes, heavy work load, inadequate instructional resources, inadequate teacher professional development, students' negative attitude towards mathematics and inappropriateness of resources.

Large classes are a challenge to the management of practical learning activities. In a practical activity, a teacher is expected to put students in groups, give instructions on how the activity is to be carried out and then go round checking and guiding students. Prior lesson planning and preparation are necessary for a teacher to achieve his/her objectives in a practical activity. This may be a challenge if the teacher has a heavy work load which in most cases includes a second teaching subject.

Inadequacy of instructional resources, for example text books, is a great challenge in their utilization in that teachers are made to work with what is available. Mathematics teachers are expected to give assignments after every lesson and in a situation where text books are inadequate, the teacher either writes the work on the chalkboard or the students are made to share the few that are available. This causes delay even in the completion of the syllabuses. Mathematics teachers are encouraged to use improvised instructional media and not over rely on school administrations for the provision of all learning materials.

Most of the teachers interviewed were professionally trained but there was low attendance of in-service training. INSETs are important because they update teachers on new teaching techniques and promote activities that lead to improvement in overall classroom interactions. Teachers who do not attend INSETs have a challenge especially in improvisation, selection and use of appropriate instructional materials. During INSETs teachers are also taught how to motivate their learners and help them change their negative attitude towards mathematics.

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APPENDICES

APPENDIX A: LETTER OF INTRODUCTION TO THE SCHOOL

PRINCIPAL

TO WHOM IT MAY CONCERN

RE: PERMISSION TO CARRY OUT RESEARCH IN YOUR SCHOOL.

I am a Master of Education (M.E.D) student at Kenyatta University. I am required to submit as part of my assessment a research thesis report on “Challenges facing mathematics teachers in utilizing instructional resources when teaching mathematics in public secondary schools in Nairobi County”. To achieve this, your institution has been selected to participate in this study. The information gathered will be used purely for academic purposes. The findings of the study will be of benefit to all mathematics teachers and students and will be available for reference at the university.

Your assistance and cooperation will be highly appreciated.

Thank you in advance.

Yours faithfully,

Josephine N. Wagura

APPENDIX B: MATHEMATICS TEACHERS' QUESTIONNAIRE

(MTQ)

This questionnaire seeks information on the utilization of instructional resources in teaching and learning mathematics, the status of teachers' training with regard to the use of instructional resources, challenges in utilization of instructional resources and possible solutions to the challenges.

Please spare some time to fill this questionnaire to the best of your knowledge using either a tick or filling the spaces where appropriate. Respond to all the questions as honestly and accurately as possible since the information you give will be treated confidentially and will only be used for research purposes.

Instructions

Please indicate the appropriate answer(s) by use of a tick (✓), in the provided box(es). Where appropriate, fill the spaces provided with your response.

GENERAL INFORMATION

- 1. (a) Level of school a) National [] b) County []
- b) Number of students per class
- c) Other subjects you teach in your school_____

2. Your highest academic qualification

a) Diploma in Education [] b) Graduate (Bed) []

c) Post Graduate (Med) [] d) Any other (specify)

3. Teaching work load

| Lessons per week | |
|------------------|--|
| 10 – 15 | |
| 16 – 20 | |
| 21 – 25 | |
| 26 – 30 | |

4. i) What is your mathematics teaching experience in years?

a) Below 1 [] b) 1-4 [] c) 5-8 []

d) 8 and above []

ii) Duration of service in your current station

a) Below 1yr [] b) 1-4yrs []

c) 5-8yrs [] d) above 8 years []

CHALLENGES FACING TEACHERS IN UTILIZING INSTRUCTIONAL RESOURCES WHEN TEACHING MATHEMATICS

5. Do you face challenges in utilizing instructional resources for teaching mathematics? Yes [] No []

6. The following are some challenges in utilization of instructional resources in teaching mathematics. Please indicate the extent of their effect in relation to the situation in your school?

1-Strongly Agree 2-Agree 3-Neither agree nor disagreed

4-Disagree 5-Strongly disagree

| Factor | 1 | 2 | 3 | 4 | 5 |
|---|----------|----------|----------|----------|----------|
| Inadequate teacher Professional development in Mathematics | | | | | |
| Non- availability and inadequacy of instructional resources | | | | | |
| Students' negative attitude towards Mathematics | | | | | |
| Teachers negative attitude towards the use of instructional resources | | | | | |
| Inappropriateness of instructional resources | | | | | |
| Teachers' heavy work load | | | | | |
| Large class size | | | | | |

7. In your own view state other challenges in the general use of instructional resources in teaching and learning mathematics in your school.

i) _____

ii) _____

iii) _____

STATUS OF TRAINING OF MATHEMATICS TEACHERS

8. Are you a trained teacher? Yes [] No []

9. (a) Have you attended an in-service training course in the last three years?

Yes [] No []

10. The following are some statements on benefits of teacher training and In-service training. Please indicate the level of your agreement with each statement. 1-Strongly Agree 2-Agree

3-Neither agree nor disagreed 4-Disagree 5-Strongly disagree

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Teacher training helps teachers to understand the mathematics they teach, how their students learn and how to facilitate learning | | | | | |
| Teacher training enhances knowledge of mathematical activities that foster students' manipulative abilities | | | | | |
| Teachers who attend in-service training use instructional resources more frequently than those who don't. | | | | | |
| Teacher training allows for necessary instructional adjustments such as changing the method or type of instruction | | | | | |

**POSSIBLE SOLUTIONS TO THE CHALLENGES FACING
TEACHERS IN UTILIZING INSTRUCTIONAL RESOURCES**

11. In your own words, what are the solutions to the challenges facing teachers in utilizing instructional resources in teaching mathematics in secondary schools?

**EXTENT OF USE OF INSTRUCTIONAL RESOURCES IN
TEACHING MATHEMATICS**

12. Considering what is available as instructional resources for teaching mathematics in your school, indicate the extent to which they are used using the criteria given below;

- 1-Very large extent (every lesson) 2-Large extent (most lessons)
 3- Moderate extent (some lessons) 4-Small extent (few lessons)
 5-Not used at all

| Instructional Resources | 1 | 2 | 3 | 4 | 5 |
|-------------------------|---|---|---|---|---|
| Text books | | | | | |
| Electronic Calculators | | | | | |
| Geometrical equipments | | | | | |
| Models | | | | | |
| Pictures and Charts | | | | | |
| Chalkboard | | | | | |

APPENDIX C: CLASSROOM OBSERVATION SCHEDULE (COS)

Section A: General information about school and utilization of instructional resources.

School type (National or County).....

Number of students per class.....

Class.....

Section B: Instructional resources used during the lesson

Rating scale is as follows:

FU Frequently used (2)

NFU Not frequently used (1)

NU Not used at all (0)

| Instructional resources | FU | NFU | NU |
|-------------------------|----|-----|----|
| Text books | | | |
| Models | | | |
| Charts and pictures | | | |
| Geometrical equipments | | | |
| Calculators | | | |
| Improvised media | | | |

Any other observation made (specify).....

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