EFFECTS OF STRENGTHENING MATHEMATICS AND SCIENCES PROGRAMME ON SECONDARY SCHOOL STUDENTS' PERFORMANCE IN MATHEMATICS IN UKWALA DIVISION, SIAYA COUNTY, KENYA

BY

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DECLARATION

This research project is my original work and it has not been submitted for an award of Masters Degree in any university.

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E56/71995/2011

This research project has been submitted for examination with my approval as university supervisor

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DEDICATION

This research work is dedicated my family members: my father and mother Naphtali Owuor and Rose Owuor who gave me both material and spiritual support during this period. I also want to recognise the humble time given to me by my beloved wife Irene Auma and my two kids Stanley and Claire who missed my presence during the research work.

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My sincere gratitude goes to the Area Education Officer of Ukwala division for granting me permission to conduct the research in the division. I also thank all the respondents who sacrificed their time and voluntarily participated in this study. May God bless you all.

ABSTRACT

The purpose of the study was to evaluate the success of Strengthening Mathematics And Sciences in Secondary Education project on the secondary school students' performance in mathematics in Ukwala Division in Siaya County with the view of enhancing its implementation in the classroom. The objectives were to establish students' attitude toward mathematics; determine whether the Strengthening Mathematics and Sciences Programme has any effects on teachers' teaching approaches in mathematics; investigate if Strengthening Mathematics And Science programme has improved students' performance in mathematics as well as finding out factors that hinder effective implementation of Activity Student Experiment Improvisation-Plan, Do, See Improve approach to teaching.

The study utilized the descriptive survey research design. The study used a census of 35 headteachers whose schools had undertaken a training programme in strengthening of mathematics and sciences in the classroom. Simple random sampling was used to select 60 teachers who had undergone this training. Finally, five students were randomly sampled per class taught by each of the selected teacher. This gave a total sample of 300 students. The three instruments were used namely; Headteachers Interview Guide Mathematics Teachers' Questionnaire, and the Mathematics Students' Questionnaire. The data was analysed using SSPS Version 20.0 package. The resultant data was presented in terms of frequencies and percentages. The main study findings revealed that Strengthening Mathematics and Sciences programme has changed teachers' attitude positively towards the subject and has also slightly improved the performance in mathematics. Some of the areas the study recommends for further study include: investigation of performance of other science subjects, and other factors outside classroom that may affect performance of mathematics such as community attitude and economic factors.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASEI:	Activity, Student, Experiment, Improvisation
CEMASTEA:	Centre for Mathematics, Science and Technology Education in Africa
INSET:	In-service Education Training
JICA:	Japan International Corporation Agency
KCSE:	Kenya Certificate of Secondary Education
MOEST:	Ministry of Education Science and Technology
MPET:	Master Plan for Education and Training
PDSI:	Plan, Do, See, Improve
SMASSE:	Strengthening of Mathematics and Sciences in Secondary Education

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

There is a consensus that improving quality of education depends on quality of classroom practices such as good methodology, group discussion and use of teaching aids Adeyemi, (2008). The performance of Mathematics and Science in secondary schools has attracted a nationwide attention mainly due to dismal performance especially in the final secondary examinations over a period of years. Given that teachers play a significant role in instruction, efforts to improve education have been seen to depend on their beliefs, attitudes and conception of teaching and learning. In order for teachers to considerably shift from their current practices of teaching which are mainly teacher-centred, they require efforts that integrate reform agenda with their professional challenges which include poor attitude towards the subject, poor methodology used, lack of enough finance to buy learning materials and teaching aids. Consequently, In-Service Education and Training (INSET), as part of professional

development hold a key to meaningful interventions in the classrooms.

In Europe and Parts of Africa, concerns have been raised about whether INSET succeeds in equipping teachers with the professional knowledge needed to deliver consistently high-quality instructions. Jurgen, et.al (2010) investigated the significance of teacher content knowledge and pedagogical content for high- quality instructions and students' progress in secondary level mathematics in Germany. In so doing, he wanted to ascertain if there is a correlation between in servicing a teacher and academic performance.

In Kenya, INSET for mathematics and science teachers has been implemented by strengthening of mathematics and science in secondary education (SMASSE) Project from a pilot phase (1998-2003) to national phase (2003-2008). Following consistent poor performance in science subjects over years, the government of Kenya in collaboration with the government of Japan through Japanese international co-operation agency (JICA) carried out research to find out the solution to the existing problem in mathematics and science subjects. Some of the factors associated with poor performance in these subjects include: poor attitude by learners, poor teaching approaches by teachers, limited knowledge by the teachers, economic factors and community attitude. It has been argued that one way of addressing such difficulties, students experience in the science classroom is through appropriate teaching interventions that can be acquired and enhanced through professional development of science teachers, hence the birth of SMASSE project in 1998.

The main goal of the Strengthening of Mathematics and Sciences in

Secondary Education (SMASSE) is to upgrade the capability of young Kenyans in mathematics and sciences (Biology, Chemistry and Physics) through INSET. While its relevance, ownership and sustainability has been established (JICA, 2007), there is need to assess its role in achieving the goals. According to the final evaluation results by Centre for Mathematics and Science Training Education in Africa CEMASTE of phase one (SMASSE report, 2003), the in-service achieved its output successfully. This output included establishing a system of training district trainers at National INSET centre in Nairobi, establishing a system of training in pilot districts, and strengthening the role of National INSET. The project outputs are sustainable from the viewpoint of finance and human resources (Strengthening Mathematics and Science Education in Secondary Education, 2001). The SMASSE project emphasis is on Activity, Student, Experiment, Improvisation (ASEI) and Plan, Do, See, Improve (PDSI) approach to learning. The ASEI-PDSI is concerned with the shift from chalk and talk to student activity oriented teaching. The ASEI emphasis that learning should be student or learner centered by involving him or her in different activities while the PDSI approach targets the teachers and emphasizes on early preparation of the lesson, so as to include sufficient and relevant content delivery including appropriate teaching techniques during and after the lesson.

In 2008, Minister for education Prof. Ongeri said that the government would hold teachers that did not prepare adequately and also those who did not employ new methodology to teaching of mathematics and science responsible for poor performance of students. Teachers were therefore expected to show

marked improvement in their teaching as manifested by good examination results in these subjects once they had under gone in-service training.

Also according to Oyaya (2000) the SMASSE movement considers the quality of classroom activities as critical to achieving effective teaching and learning that is first and foremost activity and should be learner oriented. These are hands-on (manipulation), minds-on (thinking/reasoning), mouths –on discussions, heart (interest activities).Before the introduction of SMASSE, teaching/learning process was mainly teacher centred. This meant that there was little learner activities as the teacher was seen as the main source of information. Regardless of the effort the government put in the SMASSE INSET, Mathematics compared to other subjects under the programme has had no significant improvement year after year as reports from the Kenya National Examination Council from 2008 to 2012 indicate.

The information on performance of mathematics compared to other subjects is captured in Table 1.1

Table 1.1: Mean Standard Score for different subjects

Year	Biology	Chemistry	Physics	Mathematics
2008	7.114	5.998	6.654	5.611
2009	8.012	6.234	6.342	5.326
2010	7.999	5.980	7.230	7.743
2011	9.102	7.876	8.000	4.779
2012	9.543	7.500	9.367	5.386

Source; District Education Officer- Ukwala Division, 2003

The information presented in Table 1.1 shows that the performance of Mathematics every year has by and large has had a downward trend and therefore the effects of SMASSE INSET need to be investigated. It was on the

basis of this background that the researcher assessed the effect of SMASSE project on the performance of mathematics in secondary schools.

1.2 Statement of the problem

There is a need for capacity building for science teachers to change the approaches of teaching and attitude towards the subjects. The low performance of candidates in mathematics in Kenya Certificate of Secondary Education (KCSE) with a mean of 4.914 in the whole country prompted the researcher to find out whether the SMASSE project of innovative teaching and learning approaches are being applied by teachers in a classroom situation. It was expected that the teachers would acquire knowledge required, new teaching approaches that will change students' attitude towards learning and improve students' performance in mathematics in KCSE examination.

1.3 The purpose of the study

The major purpose of the study was to evaluate the success of SMASSE project on the secondary school students' performance in mathematics in Ukwala Division in Siaya County with the view of enhancing its implementation in the classroom.

1.4 The objectives of the study

The objectives of the study were to:

1. establish students' attitude toward mathematics as a subject of study
2. determine whether the Strengthening Mathematics And Sciences programme has any effects on teachers' teaching approaches in mathematics.

3. investigate if Strengthening Mathematics And Science programme has improved students' performance in mathematics.

4. assess headteachers' perceptions' on SMASSE on students' performance

5. find out factors that hinder effective implementation of Activity Student Experiment Improvisation- Plan, Do, See Improve ASEI/PDSI approach to teaching.

1.5 Research questions

The study was guided by the following research questions. These are: 1) Is there improvement in performance of mathematics since the introduction of SMASSE project? 2) To what extent has SMASSE changed teachers teaching methodology? 3) What is the attitude of the learners towards learning mathematics? 4) Are there factors hindering the implementation of SMASSE in the teaching and learning of mathematics?

1.6 Assumptions of the study

The assumptions of the study were:

i. That all mathematics teachers have successfully undergone the SMASSE INSET

ii. That all required teaching and learning materials are available.

iii. All the schools sampled have enough teachers of the subject under investigation.

1.7 Significance of the study

The research findings from this study will provide some useful information to: Kenyan government in collaboration with Japanese government who are the sponsors of the SMASSE INSET with a view of improving it. The sponsors of the ASEI-PDSI approach whether or not it is applied in classroom situation. The ministry of education officials will also obtain feedback whether objectives of SMASSE project are realized. The policy makers will also find basis for resources allocation and decision making to enhance the effectiveness. The study will also raise issues forming foundations for further research by other students and scholars.

1.8 The Scope of the Study

The study was carried out in secondary schools in Ukwala Division, Siaya District on both provincial and district schools. But the study limited itself to only one County. For a more conclusive result all the counties in Kenya should have been studied. Therefore the study results cannot be generalized to the rest of secondary schools in Kenya.

1.9 Limitations of the study

The following were limitation of the proposed study: The researcher used questionnaires to collect information which may sometime not be filled, get lost or give influenced decisions. In some secondary schools mathematics is handled by teachers that have not undergone SMASSE in-service .

1.10 Operation Definition of Terms

Attitude : Is a way of thinking or feeling about something or somebody. The feeling of the learners is intended to be changed by Strengthening Mathematics And Sciences in Secondary Education project.

Effects : Are knowledge, skill, attitude and behaviour changes that occurs as a result of result of output. The main reason for initiation of Strengthening Mathematics and Sciences in Secondary Education was to improve the output in mathematics

Evaluation: Is a process of ascertaining or obtaining useful information for the purpose of making judgement. The assessment of the project is seen in the performance in National examinations

Learning : Is a process of acquiring knowledge, skills and attitudes that are useful in life. This is one way of implementing the Strengthening Mathematics and Sciences programme in schools.

Performance: Refers to academic or any achievement by an organism reflected in a person's behaviour

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.1 Introduction

Mathematics is defined as a branch of science that deals with numbers (Kariuki and Balaraman 2003).Zimmerman (2005) defines it as a discipline that attempts to quantify reality through a precise application of observation coupled with logic and reason. Mathematics deals with concepts which are precisely defined. It is an experimental science whose main objectives as indicated in KNEC (2005) include use knowledge acquired to discover and explain the order of physical world; apply the principles of Mathematics and acquired skills to construct appropriate scientific devices from available resources; develop capacity for critical thinking in solving problems in any situation; select and use appropriate instruments to carry out measurements in the physical environment; contribute to the technological and industrial development of the nation; acquire positive attitude towards mathematics.

According to in Tanzania, (2009) poor performing students in science subjects in secondary schools are an issue that has been well known and discussed by many for so long in Tanzania. Good performing students are seen as essential for economic development. The aim among others in the Government Education Policy for Secondary Schools is to achieve equity in education and also to prepare students for higher education. Despite these ambitions, there are massive failures in mathematics and science subjects in secondary schools. For example, the National Form Four Examination results for 2004, 2005 and 2006 failures in mathematics were 70, 77 and 76 per-cent respectively. This

led to national crisis on the teaching, learning and performance of this vital subject.

Mathematics, as Michael (2005) notes endeavours to understand the underlying laws governing our universe. To gain perspective into how much mathematics has contributed to our livelihoods, only science, with mathematics as its foundation, can solve many of the impending crises facing our society, such as global warming, overpopulation, waning energy and other natural resources, and the poisoning of our planet where other subjects like physics derive their arguments. In Kenya, mathematics is compulsory for all students in primary and secondary schools. The evaluation like for the other subjects is formative at the school level but summative nationally.

Kagan and Tipping (1992) indicate that, after several years of teaching experience, teachers do much instructional planning mentally and may never appear on paper. They further discourage beginning teachers from merely planning mentally by insisting that they should plan on paper since they do not have content mastery with them. This idea of planning as put forward by Kagan and Tipping, (1992) is seen contrary to that of Orlich at el (1998) which states that planning is a waste of time and to improve performance teachers should encourage group discussion, maximum use of time, consistence assessing and giving feedback appropriately which may help improve the performance of mathematics and science subjects.

2.2 Strengthening of mathematics and science in secondary education in-service. (SMASSE INSET)

SMASSE INSET is principally meant to improve teaching and learning of mathematics and science so as to enhance student achievement in the subjects (SMASSE, 1999). The Kenya government, through the Ministry of Education, consulted the Government of Japan a remedy for this poor performance in mathematics and sciences. After an agreement with the Government of Japan to support INSET for mathematics and science teachers, the JICA dispatched project study and implementation missions and JICA-MoE Technical Cooperation on SMASSE Project was launched in July 1998 as pilot project in nine districts (*Kibeet al,* 2008). In 2003, the project expanded to cover the entire country. With the expansion of the project, the Government of Kenya (GOK) in line with Ministry of Education (MOE) established the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) for enhancing dialogue and cooperation among mathematics and science educators in Africa. The issues identified by the baseline study in 1998 form the basis of the four-year SMASSE INSET curriculum. The guiding principle of SMASSE INSET is ASEI(Activity- based, Student-centred teaching/learning, Experimental work as opposed to theoretical treatment along with Improvisation of teaching/learning resources when necessary).

The principle is implemented based on the Plan, Do, See and Improve (PDSI) approach so that corrective measures are taken in subsequent cycles of activity to avoid major disruptions (SMASSE, 2008). The main aim of SMASSE project is to shift classroom practices from being ineffective to effective

(Wambui, 2006). This is important so that teachers can benefit from professional development by sharing of experiences and continuous exposure to new ideas to keep abreast with new developments in the teaching profession (SMASSE, 2008).

Continuous study can improve teachers' mastery in the subject matter. The Measuring Performance and Evaluation Tool (MPET) 1997-2010 reiterates that, teacher's pedagogical skills and knowledge of content be updated through regular in-service. Simon & Schifter (1991) noted that in-service programmes which adopted constructivist approach to teaching and learning provides opportunities for teachers to engage in problem solving were generally successful in facilitating change not only in teachers' classroom practices but also in their beliefs and attitudes towards the subject and its teaching. This study will seek to establish if teachers are now more confident in their teaching after attending SMASSE.

2.3 Activity, Student, Experiment, Improvisation (ASEI) and Plan Do See Improve (PDSI) Approach

Effective teaching requires one to continually adopt ASEI/PDSI approach in teaching (Ogolla, 2001). Ogolla emphasises that the ASEI/PDSI approach is the vehicle for achieving not only the SMASSE goal, but also promoting effective teaching practices and efficient learning. The ASEI and PDSI approach form the pillars of the SMASSE project. A brief discussion of each these approaches are given here under.

2.3.1 Activity Student Experiment Improvisation approach (ASEI)

'ASEI' is an acronym for: Activity, Student, Experiment, improvisation. It is a SMASSE initiative whose focus is to assist teachers to reflect on their teaching for efficient learning to occur (Ogolla, 2001). It also aims at encouraging teachers to focus on instructional strategies that will support meaningful learning and make lessons interesting to learners. Okere (1996) reiterates that learning is only meaningful when learners can make use of whatever is learnt in real life. Through improvisation a teacher is able to demystify conventional experiments by scaling down experiments thereby relating mathematics and science to real life situations. A learner is the focus of attention and activities are planned for learners through the development of ASEI lessons. In these lessons a bridge is created to enable learners to relate and integrate practical activities with theoretical knowledge.

ASEI movement advocates a shift in both the teachers' thinking and practice from teacher-centred approaches to student-centred approaches (Ogolla, 2001). In this approach teaching is for the student and the emphasis is on teaching for understanding by actively engaging learners in the construction of knowledge. This is in agreement with the constructivist view of learning which stresses that knowledge is actively constructed by learners and is not simply 'out there' (Okere, 1996). Okere explains that constructed knowledge lasts longer and is more meaningful to a learner. This is as opposed to chalk-and-talk teaching methods that have been traditionally used by teachers, including teachers of mathematics and sciences. ASEI movement further recognises the power of improvisation in which a teacher carefully identifies

and selects teaching/learning materials from the local environment. Inability or unwillingness to improvise science teaching apparatus has been mentioned as a constraint on the teaching of science in Africa (Tsuma, 1998). Tsuma stresses that improvisation of equipment develops in students manipulative skills, focusing their attention on the value of local materials and of conserving or recycling materials.

Benard and Benard (2005) emphasise a shift to use of experiments as teaching tools in the classroom since its pedagogical advantages have become more apparent. One primary advantage of use of experiments is their ability to actively involve students in the class and learning process.

2.3.2 Plan, Do, See, Improve Approach (PDSI)

In order to attain the 'ASEI condition' outlined above, it is essential to adopt a cyclic approach known as PDSI which is an acronym for Plan, Do, See, Improve. Teachers are encouraged to take time when planning to reflect on the most appropriate activities that will enhance effective learning using the resources available (Ogolla, 2001). The planning involves preparation of an ASEI lesson plan which should take into consideration students' previous knowledge, number of students, facilities and resources available and lesson evaluation. 'Doing' is shared between a teacher and learners where a teacher's role is facilitation and not the dispenser of knowledge. Teaching should be seen as 'non-directive' and removes teachers from their usual role as information dispenser, confirmation provider and limit setter (Cantor, 1946). According to Mwirigi (2011), teacher-student interactions should not be

authoritarian or impersonal in class. He indicates that this would contribute to negative attitude of the students towards learning, especially in Mathematics. Students need to be active participants in the learning process.

'Seeing' encourages a teacher to include a feedback mechanism in their lessons and teaching functions. Lesson evaluation is seen as the key to improvement of lesson delivery. Evaluation therefore should essentially be formative rather than summative. This allows room for remedial work aimed at improving students' performance. Improvement should be done by incorporating information obtained from feedback during and after lessons. This is a continuous activity, which ensures that a teacher's skills improve and confidence increase as the instructional programmes are enriched (Ogolla, 2001).

2.4 Hindrances to effective implementation of ASEI-PDSI approach

Teaching and learning of science and hence mathematics has been a subject to many hindrances. The debate is often centred not only on what is taught (curriculum content and relevance), but how it is taught (teaching approach and methodology). The teacher is thought to have very little direct control over what is taught because it is already prescribed in the curriculum which also suggests the approaches and methods to be used for teaching. However, it may be argued that the selection of the method of presentation to be used in class is ultimately the task of the teacher. Atsiaya (2007) notes that good teaching is largely a matter of personal attitude and requires thorough planning and selection of the approaches and methods that will result in effective learning.

According to Ballone and Czerniak (2001), a teacher is successful with learners if he provides an environment that encourages the students to teach themselves and others through performance of well guided activities. JICA (2000) observes that school science teaching should be learner centered with the role of the teacher being that of a facilitator, guide, counsellor, motivator, innovator and researcher.

Student-centered teaching is an approach that focuses on the learners and all activities of the lesson are planned and executed so as to involve the learner fully. Joyce & Weil (1986), Collins & O'Brien (2003) and Akinibolola (2009) observe that student-centered teaching gives learners an opportunity to think independently in order to obtain knowledge. According to them, this method helps the learner to discover how knowledge becomes known and helps learners to see for themselves how to formulate knowledge through collecting, organizing and manipulating data. In student-centered learning knowledge is constructed by students. Harden and Crosby (2000:335) describe student centered learning as focusing on students' learning and achievement rather than what teachers do. Student-centered learning is about helping students to discover their own learning styles, to understand their motivation and to acquire effective study skills that will be valuable throughout their lives as Brenda (2006) notes. Lea, Stephenson and Troy (2003:322) gives the tenets of student-centered learning as the reliance on active leaning rather than passive learning; an emphasis on deep learning and understanding; increased responsibility and accountability on the part of the student; increased sense of autonomy in the learner; interdependence between teacher and learner as well

as reflexive approach to the teaching and learning process on the part of both teacher and learners.

Kenya National Examination Council (KNEC) reports of 2006, 2007 and 2009 emphasizes that mathematics cannot be adequately taught without letting students participate. **S**tudent-centred – a pedagogical shift so that the main focus of the lesson is on the students rather than the teacher. Activities should be designed to involve the participation of the learners while the teacher becomes a facilitator. **E**xperiment– use of experiments to enhance understanding of scientific concepts and principles. Experiments enhance learning by promoting curiosity and interest. Experiments according to Atsiaya (2007) are the very essence of science and whenever possible they should be done as a class activity with pupils working individually or in groups as opposed to teacher demonstration. Seeing encourages the teacher to include feedback mechanism in their lesson. Lesson evaluation is seen as the key to improvement of lesson delivery. It is through evaluation that the effect of the process on the output can be seen and findings used to improve on the activity (lesson presentation) in order to enhance its quality. Evaluation according to SMASSE (2004) can be done in a number of ways which include: asking students, inviting a colleague to class and self-evaluation. Errors are seen as constructive part of the learning process and need not be a source of embarrassment. Results obtained from evaluation should be used for improvement of subsequent lessons.

2.5 Students' attitudes towards Mathematics

The SMASSE baseline survey of 1998 established that negative attitudes of students, teachers, parents and society in general contributed a lot to the poor performance in sciences. Koballa (1995) defines attitude as favourable or unfavourable responses to things, places, people, events or ideas. Mueller (1986) sees attitude as simply the extent of liking or disliking of something. According to him attitudes are internal states that influence the individual choice of action. Oppenhein (1966) observes that attitude is a tendency, a state of readiness to act or react in a certain manner when confronted with a certain stimuli. Attitudes are reinforced by beliefs and often attract strong feeling that lead to particular form of behaviour. The way people view situations in life depends on the attitude they hold and these attitudes impel them to react to objects, situation or propositions in ways that can be called favourable or unfavourable.

According to Ballone and Czerniak (2001), behaviour is better predicted from an individual belief and that beliefs are the best indicators of decision individual makes throughout their lives. When attitude is negative or unfavourable students will take little or no interest in education and perform poorly in exams as Mueller (1986) observes.

2.6 Teachers' attitude towards mathematics

Keys and Bryan (2001) in their research on teachers' beliefs about the nature of science, students learning and the role of the teacher suggested that these beliefs do affect teachers' planning teaching and assessment. A teacher's belief about learning and knowledge strongly impact the classroom climate

enabling students to explore articulate and analyze their beliefs on topics. Jones and Mooney (1981) admit that students have traditionally considered mathematics as being one of the most difficult areas of science. One of the reasons that make students shy away from mathematics is as Musyoka (2000) notes, its quantitative nature. Other reasons as outlined by Mwaura (2007) include socio-cultural factors where difficult tasks are seen as a male domain and also the contribution of the mathematics teacher in instilling negative attitude. Some students form negative attitudes towards mathematics long before they enrol in secondary school. This is due to the opinions they get from their parents, elder siblings, friends and sometimes teachers in their primary schools. Negative attitudes are displayed through verbal expression such as “I hate Mathematics”, “Mathematics is difficult” or can also be expressed through acted tendencies like sleeping during the lesson; yawning in class and looking bored; absentmindedness during the lesson; refusing to participate in the practical activity and obtaining poor results that do not bother the student

The SMASSE report of 1999 also noted that teachers’ negative attitudes affected performance. Teachers’ attitude as Voss (1981) notes, determine the direction and action the students are likely to take. Teachers’ positive attitudes have been shown to attract more interest in their class and according to Sogomo (2001) students’ attitudes are a reflection of teachers’ attitudes.

2.7 Theoretical framework

The theoretical framework introduces and describes the theory which explains why the research problem under the study exists. It also supports a theory of a research study by guiding a research on what kind of thing you will measure and what type of statistics to be used. The SMASSE approach to teaching of science subjects calls for practical approach; that is to say the learner is to interact with apparatus and makes observations. This clearly links the SMASSE and the constructivist theory which also advocates that children should be left to interact freely with objects from the surrounding in order to learn and acquire knowledge.

2.7.1 The constructivist theory

Constructivists believe that right from the birth children are actively involved in the process of constructing their knowledge structure Piaget (1969). They believe that an individual builds up knowledge using experiences from the environment. By so doing the learner will construct their own understanding of concept and meaningfully apply the concept (Pines and west 1986). Wheatly (1991).

Ernest (1993) postulate that constructivism has become one of the main philosophies of science and mathematics education, research and cognitive psychology. Piaget's (1969) epistemological view is that the learner does not acquire knowledge passively but they actively construct it into schemes. "…….. all knowledge is tied to action and knowing an object or an event is to use it by assimilating it into an action scheme……..This is true on the

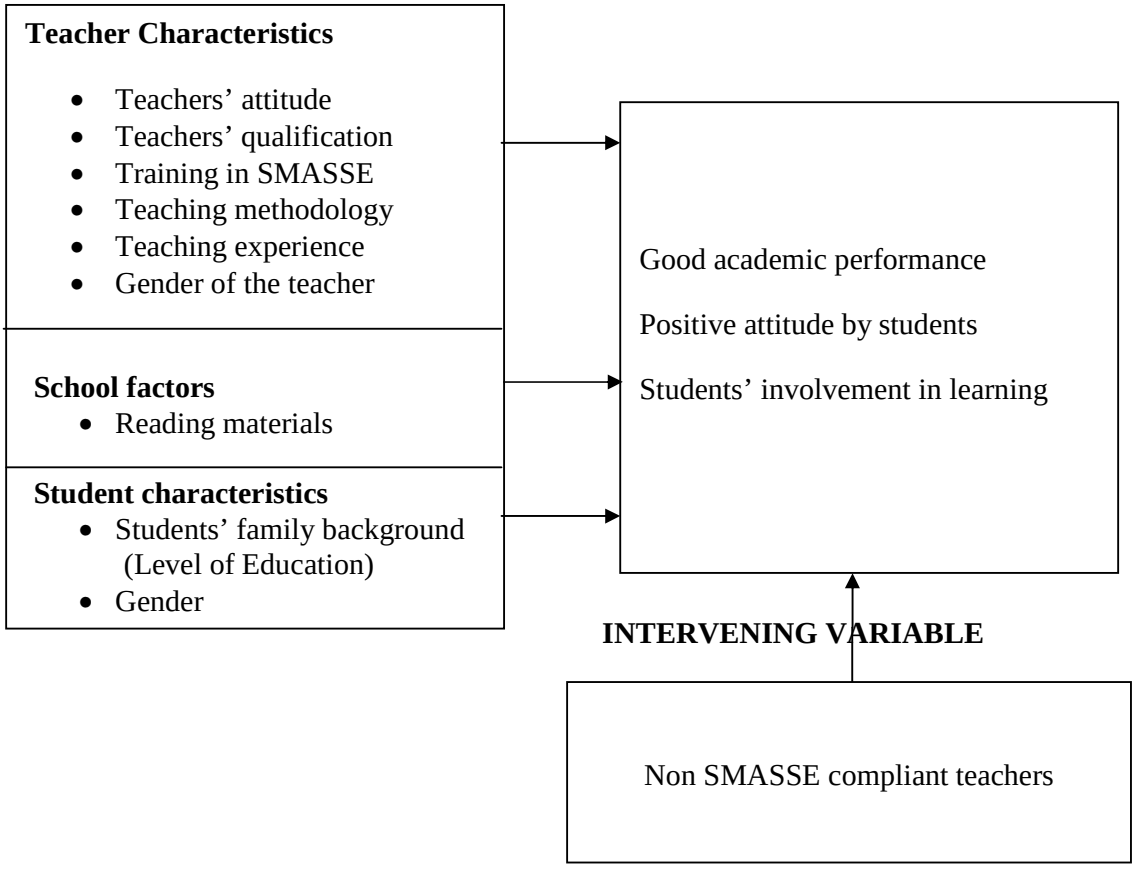
most elementary sensory motor and all the way up to the highest logical mathematical operations" (Piaget 1967:14). The ASEI-PDSI principle proposed that teaching and learning of mathematics and science be based on the fact that students do not simply copy the science world, rather, they construct their own meanings of it. They must be provided with opportunity to construct scientific knowledge through the interaction and observation. The ASEI-PDSI principle advocates for an activity filled learning environment where the learner's interest understanding and knowledge retention is enhanced. This is also in line with what Piaget (1969) believes that knowledge is not passively acquired but is discovered and constructed by the activities of the child. The ASEI-PDSI concept embraces all the ideas proposed by different constructivists such as practical learning makes lesson real and knowledge acquired become constructive. There are definite good returns in terms of student learning if these ideas can be incorporated.

2.8 Conceptual Framework

This conceptual framework shows interrelationship between dependent variables, independent variables and intervening variables. Dependent variables are those that are influenced or affected by other variables. They include: good academic performance, positive attitude and students' involvement in learning mathematics. Independent variables are those that are not influenced by other variables. They include: teachers' qualification, teaching methodology, SMASSE training, gender of the teacher and teaching experience among others. Intervening variables are those that may come in

and interfere with other variables. For instance, non-SMASSE teacher handling mathematics. Figure below illustrates different variables of SMASSE and how they inter- relate.

INDEPENDENT VARIABLE **DEPENDENT VARIABLE**



2.9 Summary of Related Literature Reviewed

The SMASSE project has been used in Tanzania, Kenya and Japan among other countries in the world has been supporting it. This project is now spreading to other countries in Africa.

CEMASTEA was established to coordinate in-service mathematics and science teachers in the region. It was observed that SMASSE calls for a shift from a teacher-centred to a learner-centred approach of teaching. Teachers are required to initiate method of learning that allows hands on, minds, eyes and ears engaged during the process.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter has described the research methodology used in this study. It has covered the description of the research design used. This is followed by a description of target populations of the study. In addition, the chapter has discussed the sampling procedures and identified the sample. The final sections of the chapter have dwelt on data instruments, collection procedures, and data analysis techniques used in this study.

3.2 Research Design

The study utilized the descriptive survey research design. This design involves observing and describing behaviour of a subject without influencing it in any way (Shuttleworth, 2008). Survey research design is a very valuable tool for assessing opinions and trends (Peil, 1995). Orodho (2003) points out that descriptive survey is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals. It can be used when collecting information about peoples' attitudes, opinions, habits or any other educational or social issues (Orodho&Kombo, 2002). Fraenkel and Wallen (1996) explain that the aim of survey research is to collect data from one group to describe some characteristics of the group. The design was appropriate for this study since the Mathematics teachers under study has already undergone the SMASSE INSET and the researcher did not have the opportunity to manipulate the training conditions, objectives or activities. The

major purpose of this design is description of state of affairs as it exists (Kombo& Tromp, 2006). In this study, training in SMASSE INSET was the independent variables.

3.3 Target Population

The target population of this study comprised all SMASSE trained Mathematics teachers and all secondary school Mathematics students in Ukwala Division. The division consists of 35 (thirty five) secondary schools; 30 (thirty) of them single streamed and 5 (five) multiple-streamed. According to the data available at the District Education Office, the total number of SMASSE trained Mathematics teachers in Ukwala Division was 100 by November, 2013. With each teacher handling an average class population of 40 (forty), students' total population of students was therefore, about 4000 (four thousand) students.

3.4 Sample Size and Sampling Procedures

3.4.1 Sample Size

The general rule in the determination of sample sizes is to use the largest sample possible (Kathuri& Pals, 1993; Mugenda&Mugenda, 2003). Kerlinger (1964) explains that a smaller sample results in larger error than a larger sample. The minimal sample size for survey research is 100 subjects (Kathuri& Pals, 1993; Borg & Gall, 1983; Gall, Borg & Gall, 1996). According to Gay (1987), the minimum sample size for a descriptive survey research is 10% of the accessible population. Krejcie and Morgan (1970) provide formulae for calculating sample sizes. This formulae was used by Kathuri and Pals (1992) to develop a table showing suitable sample sizes for

given populations. From the table provided by Kathuri and Pals (1992), 50 (fifty) Mathematics teachers will be sampled from a population of 100 in the study area. However, Balian (1988) proposes a percentage adjustment of 10% to 30% to initial sample sizes to compensate for attrition, respondent refusal to participate, or other circumstances which gives an upward adjustment. The study therefore settled for a sample size of 35 headteachers, 60 (sixty) mathematics teachers out of 200 (two hundred) and 300 (three hundred) students out of approximately 100 (one hundred) of subjects/respondents for a survey design study which falls within the proposed range.

3.4.2 Sampling Procedures

Simple random sampling was used to select a study sample from the list of SMASSE trained Mathematics teachers in the district. The list of SMASSE trained Mathematics teachers used as a sampling frame was obtained from the District Education Office, Ukwala Division. Simple random sampling is important in reducing the influence of extraneous variables in a study (Mugenda&Mugenda, 2003). Balloting was used to randomly pick the sample of 60 teachers. This procedure is justified for selection of small samples as opposed to the use of tables of random numbers (Peil, 1995). Systematic random sampling was used to select participating students in this study from class registers. According to Peil (1995), this method is satisfactory where there are no systematic differences according to positions on the list. In the class registers, names of students are ordered based on their admission numbers and this does not allow any systematic differences according to positions in the registers. The number of students in the class register was

divided by five so that every nth subject will be included in the study (Kathuri& Pals, 1993). For example, in a class of forty students, 8th, 16th, 24th, 32nd, and 40th students in the class register will be sampled. This procedure was meant to ensure random sampling of students of different intellectual abilities. All headteachers from sampled secondary schools were included in the study.

3.5 Research Instruments

Three instruments were used to collect the data required to achieve the objectives of this study from the Mathematics teachers and students. The three instruments were the Headteachers Interview Guide (HIG) Mathematics Teachers' Questionnaire (MTQ) and the Students' Questionnaire (SQ).

3.5.1 Headteachers' Interview Guide

This was based on general questions regarding the research questions (Appendix II). The questions cut across all the research questions for this study.

3.5.2 Teachers' Questionnaire

A Mathematics Teachers' Questionnaire (MTQ- Appendix III) was constructed by the researcher. It was used to solicit information from SMASSE trained Mathematics teachers. It gathered information on the frequency and effectiveness of class experiments organised by the teachers before and after undergoing SMASSE INSET. It was also used to collect information on the number and use of improvised teaching/learning resources before and after undergoing SMASSE INSET. Some questions were based on

a Likert Scale ranging from 'Very ineffective' to 'Very effective'. The minimum score was "one" (1) for 'Very Ineffective' and the maximum score was "five" (5) for 'Very effective'. Five matrix items assessed the teachers' attitudes towards teaching of Mathematics. The minimum score was "one" (1) for 'Strongly Disagree' and the maximum score was "five" (5) for 'Strongly Agree'. The closed-ended questions were used to ensure objectivity and clarity of the subjects' responses for ease of statistical analyses while the open-ended items allow the respondent some room for independent opinion (Mugenda&Mugenda, 2003).

3.5.3 Students' Questionnaire

Students' Questionnaire (SQ- Appendix IV) was also constructed by the researcher. It was used to collect data from Mathematics students taught by the teachers under study. Five students per class were used to respond to student questionnaires. Most questions were in Likert matrix assessing the frequency of students' active participation during Mathematics lessons. The scale ranged from 'Not at all' to mean no students' participation to 'Very frequent' to mean very active students' participation. The minimum score was one for 'Not at all' and the maximum score was five for 'Very frequent'.

3.6 Validity of Research Instruments

Validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda&Mugenda, 2003). It has to do with the accuracy of the data collected in representing the variables of the study so as to make accurate and meaningful inferences.

According to Kathuri and Pals (1993), validity refers to how well the measured indicators really measure what they are supposed to measure. This is especially true in educational research where constructs like achievement, attitude, motivation, creativity and aptitude which cannot be directly measured, but must be inferred from representative measurement. Five research specialists from the Faculty of Education and Community Studies of University of Nairobi validated the instruments, whose focus was the face and construct validities (Kerlinger, 1964; Gall, Borg & Gall, 1996). Two secondary school teachers also helped in content validation of the instruments.

3.6.1 Reliability of Research Instruments

The reliability of an instrument refers to its suitability over time or the level of internal consistency (Fraenkel&Wallen, 2000). To estimate their reliability, the instruments were pilot–tested on teachers and students from one of the neighbouring divisions in Siaya County. Piloting was done to establish whether relevant data was collected and to identify problems that are likely to occur during administration of the instruments. It was also done to check the clarity of items in research instruments. This was done after sampling but before the actual study began. The acceptable pilot sample size is 1% to 10% of the sample size (Mugenda&Mugenda, 2003). Five teachers and 25 students were used in the pilot study. According to Fraenkel and Wallen (1990), an alpha value of 0.7 is considered suitable to make possible group inferences that are accurate enough. For this study, the alpha was found to be 85.2% which highly indicated that the instruments were reliable.

3.7 Data Collection Procedures

The researcher sought research authorisation from the National Council for Science and Technology (NCST) and later sought for permission from the District Education Office to be allowed to visit schools. The questionnaires were self-administered by the researcher to improve the return rate and interview performed with the sampled headteachers.

3.8 Data Analysis Techniques

Descriptive statistics was used in this study. The resultant data were presented in frequencies and percentages was computed from the data so as to answer the research questions. SPSS version 20.0 for windows package was utilized in the analysis of the information gathered from the respondents. The data collected was summarized, organized and presented in form of tables, bar graphs, pie charts and histograms.

CHAPTER FOUR
DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents data analysis, findings and interpretation. The data were analyzed using the statistical package for social sciences (SPSS) and the chapter is organized into sections based on the research objectives, respondents' response rate and demographic information. These sections include the respondents' demographic information, students' attitude toward Mathematics; effects of SMASSE on teachers' teaching approaches in Mathematics, the effects of SMASSE on performance of Mathematics as well as finding out factors that hinder effective implementation of Activity Student Experiment Improvisation-Plan, Do, See Improve ASEI/PDSI approach to teaching.

4.2 Response Rate

The response rate by the targeted groups is summarised in Table 4.1

Table 4.1: Response rate of the targeted group

Respondents' Category	Sample size	Responses	Response rate
Headteachers	35	29	82.9%
Teachers	60	48	80.0%
Students	300	270	90.0%
Total	**395**	**347**	**87.8%**

The data presented in table 4.1 has shown that the response rate was 82.9%, 80% and 90% for headteachers, teachers and students respectively. The overall response rate was 87.8% which was considered adequate for this study. According to Edward *et al* (2002) a response rate of less that 60% is

considered inadequate while that of 60% to 80% is adequate. In addition, if the response rate is over 80%, it is considered excellent for this study.

4.3 Demographic Information

This section presents students' information by class, gender and age. In addition it has marital status, teaching experience, professional qualifications, attendance of Mathematics SMASSE INSET cycles as well as the resources found in the school.

4.3.1 Distribution of Students by Class

The students who participated in this study are from form 2, 3 and 4

Table 4.2: Distribution of Students by class

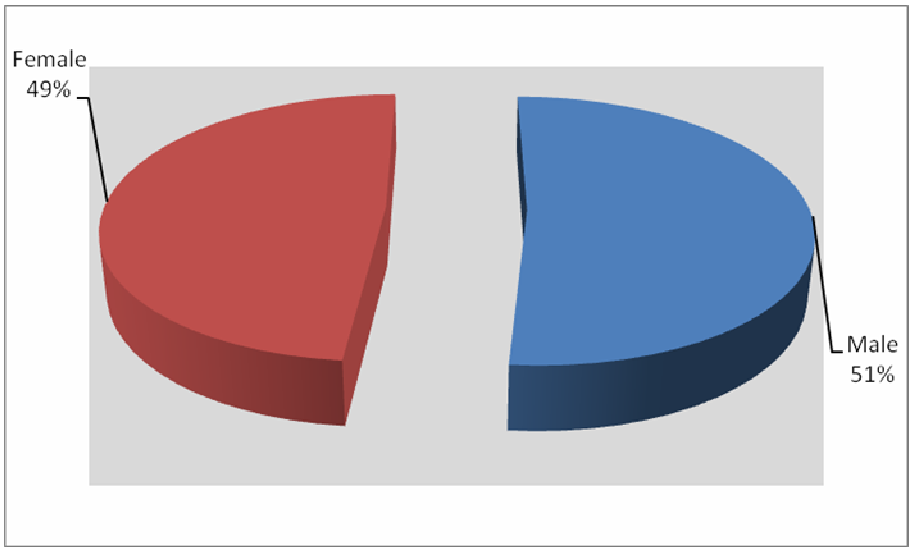
Form	Frequency	Percent
Form 2	90	33.3
Form 3	90	33.3
Form 4	90	33.3
Total	**270**	**100.0**

The results indicate that Form 2, 3 and 4 students were represented. The percentage for this table has been rounded up to 100 percent.

4.3.2 Distribution of Students by their Gender

The Figure 4.1 presents the distribution of the student respondents' by gender

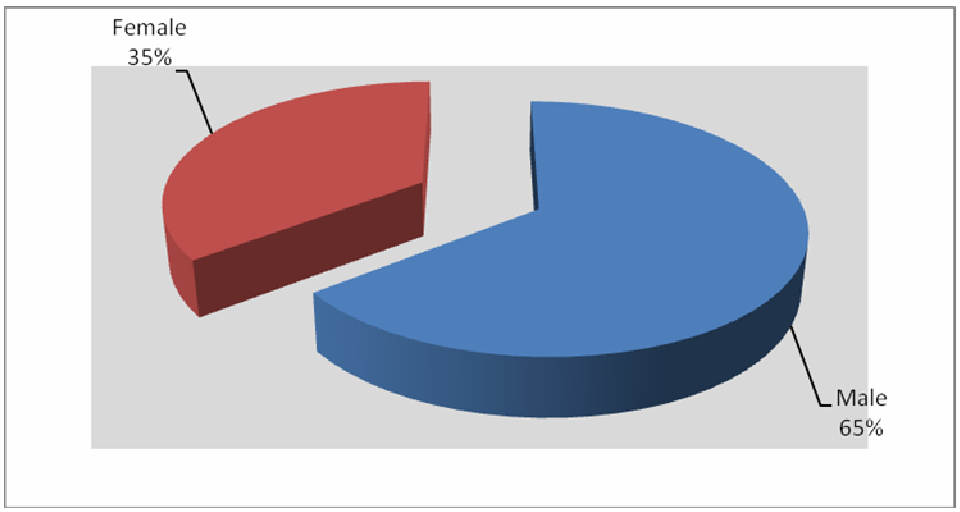
Figure 4.1: Gender of the Students



From the Figure 4.1, it can be observed that slightly over half of the student respondents (51%) that is, 139 students were male, while the other (49%) that is 131 students were female which closely reflects the national figure of students in secondary school by gender.

Having analysed the results of demographics of students, information on teachers' profile by gender is captured in Figure 4.2

Figure 4.2: Gender of the Mathematics Teachers



Among the Mathematics teachers that participated in this study, 35% were female while 65% were male as indicated in Figure 4.2. The gender distribution of the headteachers was 83% male and 17% female. Researches by USAID (2008) and UNESCO (2007) indicate that there is poor participation and performance in science and Mathematics by females. This has been attributed to lack role models in science and Mathematics because there are few female teachers in mathematics and science subjects. These subjects have been traditionally perceived to be too hard for girls. The Ministry of Education through the Gender Policy of 2007 is committed to improving gender participation and performance in science by increasing participation of women in these subjects and all sectors of education.

4.3.3 Distribution of Respondents by Age

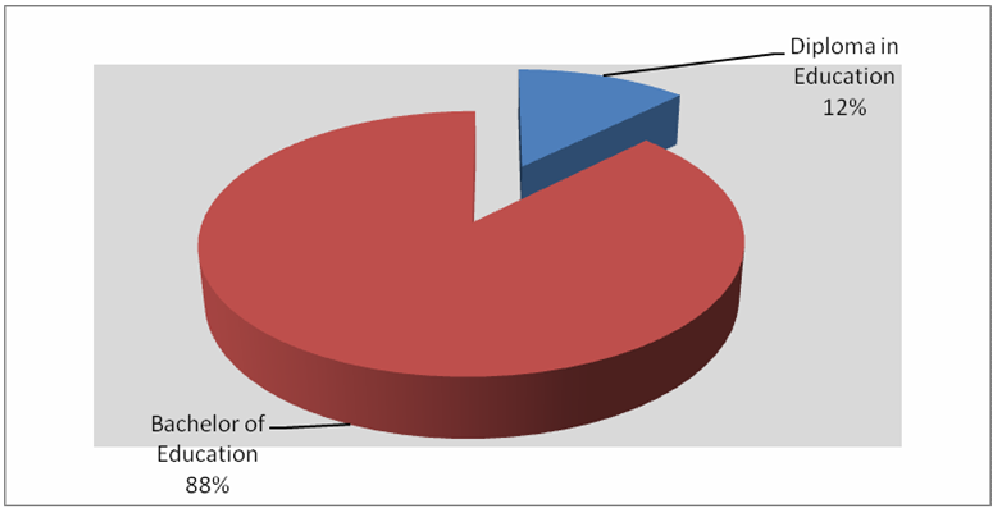
Table 4.3 presents the distribution of the mathematics teachers respondents' age.

Year	Frequency	Percent
25 – 29 years	21	44.0
30 – 39 years	15	30.0
40 – 49 years	6	13.0
Above 50 years	6	13.0
Total	**48**	**100.0**

From the results in Table 4.3, twenty one of the Mathematics teachers, 44.0%, were aged between 25– 29 years. Findings also indicated that, 30.0% were aged between 30 – 39 years, 13.0% aged between 40 – 49 years while 13.0% were above 50 years.

4.3.4 Professional Qualification of the Teachers

The Figure 4.3 presents the teachers' professional qualification

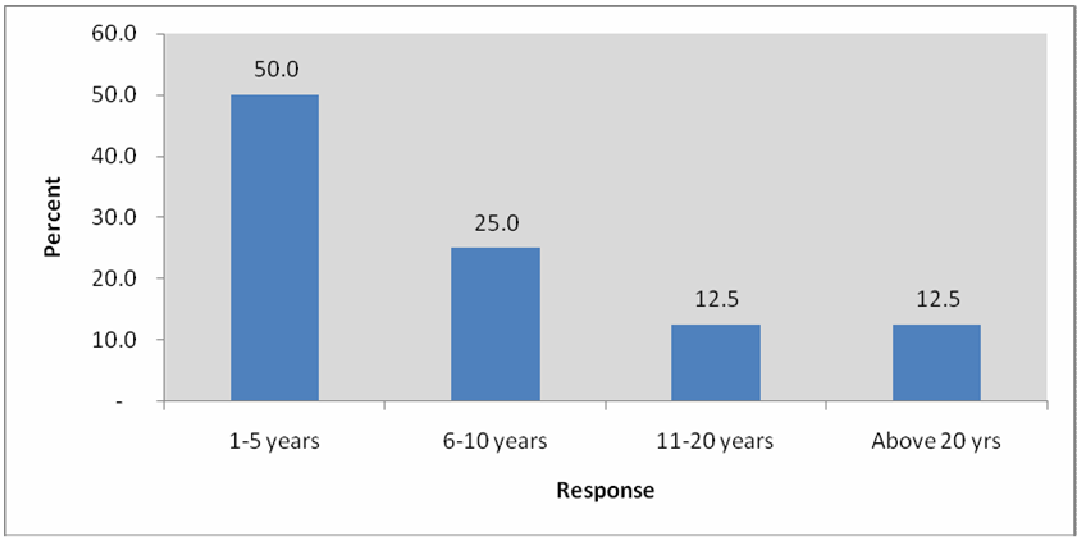


According to the results in Figure 4.3, the majority (88%) of Mathematics teachers had Bachelor of Education. The remaining 12% held Diploma in Education.

Among the headteachers, 5 (five) had Diploma in Education while 24 (twenty four) (83%) had Bachelor of Education. Quality of teaching is dependent on the professional qualification of teachers. Woolnough (1994) observes that for quality teaching to take place, well qualified and enthusiastic graduate teachers should be engaged. The results of this study shows that the teachers are well qualified. In addition to professional qualification, 50% of teachers have taught for six and above years as captured from Figure 4.4.

4.3.5 Teaching Experience of the teachers

Figure 4.4 presents the Mathematics teachers' teaching experience.



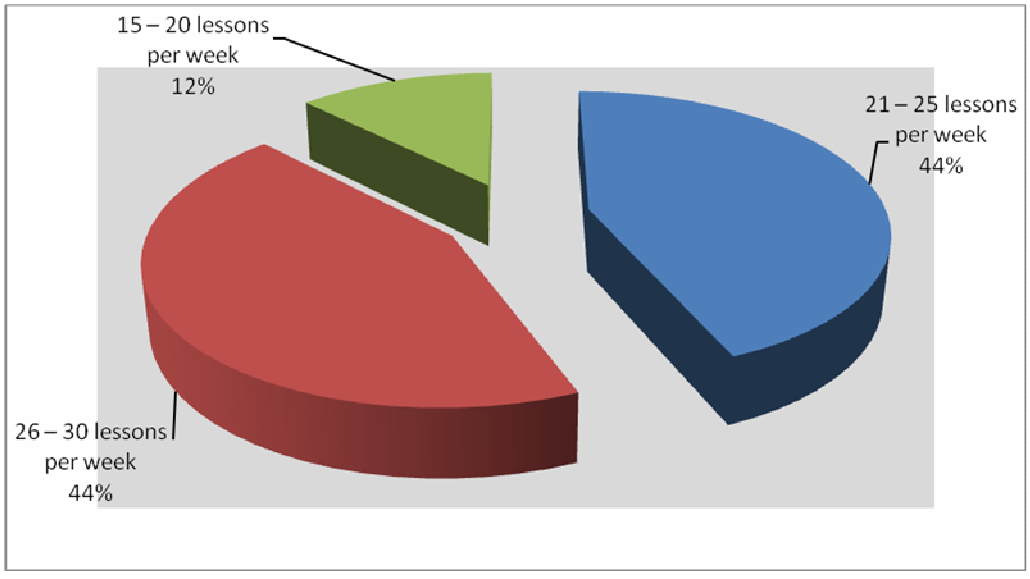
The findings shown in Figure 4.4 reveal that 50% of teachers had 1 – 5 years teaching experience. Other teachers (12.5%) had 11 – 20 years; 25% had 6 – 10 years while 12.5% had above 20 years teaching experience.

Teaching experience is an asset. Experienced teachers are expected to be competent in their work since in the course of teaching they acquire new knowledge, skills and abilities. Adeyemi (2008) in a study on teachers' teaching experience and students' learning outcomes secondary schools concluded that teaching experience is a critical variable .He observed that experienced teachers normally have better strategies that they applied at any given situation and better ways of bringing the subject matter being taught to students.

4.3.6 Teaching Load of mathematics teachers

Information on Mathematics teachers teaching load is summarised in Figure 4.5.

Figure 4.3: Teaching Load of the Mathematics Teachers



From the Figure 4.5 it can be seen that 44%Mathematics teachers had a teaching load of between 21 – 25 lessons per week; another 44% had 26 – 30 lessons per week. The remaining 12% teachers had 15 – 20 lessons per week.

This implies that, majority of teachers interviewed (88%) had a teaching load of above 20 lessons per week with 12% actually having below20 lessons per week. It was also noted that the more the number of lessons the poor the delivery of the content as was evident in schools which were understaffed. The teaching load recommended by the Government is approximately 16-20 lessons per week.

4.3.7 Teacher attendance of Strengthening Mathematics And Science programme cycle

As far as the attendance of in service of mathematics teachers is concerned, a number of teachers had attended all the mandatory four SMASSE INSET cycles, few number had attended once, while other teachers had not attended any. Those Mathematics teachers said that they had not attended inservice because they had been recently employed by the TSC or BOG. Mohanty (2002), Somers & Sikirova (2002) and Busher & Wise (2001) agree that with effective planning and teaching of in-service courses there is evidence that teachers do change their practices. Most of the teachers had attended SMASSE INSET cycles and had enough bases to judge the impact of the programme on attitudes, facilitation of student-centered learning using ASEI/PDSI paradigm and student performance in KCSE.

4.3.8 Headteachers' Involvement in SMASSE INSET Organization

The researcher sought to find out if the headteachers had been involved in SMASSE INSET organization. From the findings, 8 (eight) of the 12 (twelve) principals had as facilitators, in funding of the INSET cycles and also by ensuring the teachers attended. However, 4 (four) headteachers were not involved in the SMASSE INSET organization. In addition, 10 (ten)

headteachers facilitated forums such as staff and departmental meetings where the teachers shared their experiences after the SMASSE training. One headteacher did not facilitate such forums because most teachers were employed by the BOG and did not attend SMASSE INSET cycles. Overall, the findings suggest that the majority of the headteachers supported the programme.

4.4 Student's Attitude towards Mathematics Learning

The first objective sought to find out student's attitude towards learning Mathematics. The findings are presented in the Table 4.4.

Table 4.4: Students' Attitude towards learning Mathematics

Statement	Frequency	Strongly Agree	Agree	Not Certain	Disagree	Strongly Disagree
a) Learning Mathematics is interesting and enjoyable	32	31.0	63.0	6.0	-	-
b) Practical activities can be performed during Mathematics lessons	48	13.0	81.0	6.0	-	-
c) I am interested in my Mathematics teachers and the difficulties they face in learning Mathematics	25	38.0	56.0	-	-	6.0
d) Effective teaching can be achieved through improvisation	56	31.0	69.0	-	-	-
e) Both boys and girls are capable of Sdoing well if effectively taught	29	88.0	6.0	6.0	-	-
f) I spare some time to help the fellow learners	18	6.0	69.0	19.0	6.0	-
g) I pay individual attention to students in Mathematics class	22	6.0	63.0	31.0	-	-
h) Other school duties cannot hinder effective teaching/learning session in Mathematics	12	-	50.0	19.0	25.0	6.0
i) My teacher always set positive and realistic goals for their students	10	44.0	50.0	-	6.0	-
j) I always consult other colleagues whenever a problem arises	18	50.0	37.4	6.3	6.3	-

The findings presented in the Table 4.4, majority of the students (94%) agreed The findings presented in the Table 4.4, majority of the students (94%) agreed that teaching Mathematics is interesting and enjoyable. Still 94% of students said that their teachers are interested in their learners and the difficulties learners face in learning Mathematics and also agreed that effective teaching can be achieved through improvisation. In addition, 74% of the students interviewed agreed that teachers pay individual attention to students and also they spared time to help fellow learners. As concerns other school duties allocated to teachers 50% of the learners agreed that those duties did not hinder effective teaching. Further majority of the teachers (94%) do set positive and realistic goals for their students and also they consulted their colleagues whenever there was need.

Attitudes can be evaluated using attributes such as interest, enjoyment, patience confidence and impartiality. The positive attitude may be due to the first SMASSE INSET cycle organized with the intention of addressing the issue of teacher's attitudes towards teaching of science, towards their students and towards their teaching environment. Adesina & Akinibobola (2007) observes that attitudes once established, help to shape the experience the individual has with objects. Indeed targeted students seem to be confident about doing well in mathematics. The results on students' perception of difficulty of mathematics as a subject are captured in Table 4.5.

Table 4.5: Mathematics is not as difficult

Mathematics is not a difficult subject	Frequency	Percentage
Strongly agree	86	32
Agree	150	56
Undecided	7	2
Disagree	23	9
Strongly disagree	4	1
Total	**270**	**100**

The results in Table 4.5 show that (88%) of respondents both strongly agree and agree that Mathematics is not a difficult subject. The findings are dissimilar to findings of Jones & Mooney (1981) and Musyoka (2007) who found that students considered Mathematics as being one of the most difficult areas of science due to its quantitative nature. Changeiywo (2000) in his study on student's image of science in Kenya found that students who held negative stereotypes toward science especially Mathematics were easily discouraged from pursuing it and those who did, performed poorly. Kenya National Examination Council (KNEC) (2000) reported a decline in academic achievement which was attributed to students' innate predisposition among other factors. However, KNEC report of 2009 shows an improvement in Mathematics performance which may be attributed to changed attitudes among learners as indicated above.

4.5 Effects of SMASSE on teachers' teaching approaches in mathematics

The third objective researcher sought to find out the extent to which teachers involve students during Mathematics lesson. The findings from teachers are

presented as % in the Table 4.6

Table 4.6 Teachers teaching approaches

Statement	**Frequency**	**Yes**	**No**	**I don't know**
Does my teacher use group discussion	82	75	17	8
Is there use of question and answer during the lesson?	48	63	20	17
Am I engaged in practical	52	88	10	2
Do I get enough home work	48	70	15	15
Does the teacher make lesson plan	40	67	13	20
Total	**270**			

The findings in Table 4.6 reveal that the majority of the teachers at 75% engage students in group work in some of the lessons. 63% of teachers use appropriate question/answer technique with reinforcement of student response in most of the lessons. Majority of the teachers (70%) assign students home work while 88% assign practical work in some of the lessons and allow them to report the results of the practical work. 13% of the teachers rarely make lesson plans with only 67% preparing lesson plans in some lessons.

4.6 Headteachers' perception on the effects of Strengthening Mathematics And Science programme on performance of Mathematics by students

The fourth objective sougsht to find out if students' performance in mathematics had improved since Strengthening Mathematics And Science programme began. The findings are contained in Table 4.6.

Table 4.6: Mathematics performance

	Frequency	**Strongly Agree**	**Agree**	**Not Certain**	**Disagree**	**Strongly Disagree**
KCSE performance has improved	09	25.0	50.0	17.0	-	8.0
There is more efficient use of science facilities	10	8.0	92.0	-	-	-
Attitude of teachers towards Mathematics is now positive	10	58.0	17.0	25.0	-	-
Total	**29**					

The results in Table 4.6 have indicated that headteachers at 25% strongly agreed while (50%) agreed that KCSE performance has improved since the SMASSE INSET began. In addition 92% agreed that there was more efficient use of science facilities. Further 58% strongly agreed that students had now positive attitude towards mathematics. Using the teachers' questionnaire the researcher enquired on schools Mathematics performance at KCSE. 8.3% of the headteachers strongly disagree that the performance of mathematics has improved since the school Mathematics mean scores for 2005, 2008 and 2010 were 2.43 (D),3.77 (D+)and3.24 (D) respectively. The findings of the study indicate there has been only a slight improvement in

performance since 2005 nationally. The SMASSE programme focused on changing attitudes and teaching approaches so as to create a positive cycle of good performance, higher self-esteem and more interest in the subject.

These seem to agree with findings of Gathigi (2003) that found the programme had a positive impact on teaching and learning of Mathematics in Kajiado district. He concluded that SMASSE had contributed towards the positive improvement in performance at KCSE and better teaching methods. Muthemi (2004) also found that SMASSE had contributed positively towards performance of Mathematics in KCSE in Kibwezi Division of Makueni District. In addition, Oirere (2008) found a general improvement in Mathematics and sciences due to effectiveness of SMASSE INSET in Kenyenya Division of Gucha District.

4.7 Hindrances in Implementation of Strengthening Mathematics And Science programme

The fifth objective sought to find out from teachers some of the hindrances towards implementation of Strengthening Mathematics and Science programme. The challenges faced by teachers are summarised in Table 4.7

Table 4.7: Hindrances in Implementation of SMASSE Programme by teachers

Challenge	Frequency	Percentage
High workloads	9	31.00
Lack of sufficient facilities	7	24.00
Curriculum exam oriented	2	7.00
Lack of commitment in implementation	2	7.00
Students' absenteeism	2	7.00
Intellectual ability of students	2	7.00
Negative attitude towards SMASSE	2	7.00
Scope of content	2	7.00
Lack of enough time to improvise facilities	1	3.00
Total	**29**	**100.00**

The data in Table 4.7 presents high teacher workload as the main challenge supported by 31% of teachers followed by lack of sufficient facilities in the school which was agreed by 24% of the respondents. The headteachers cited teachers' negative attitude towards SMASSE programme. 3% 0f the respondents cited time as one of the factors hindering the implementation of the SMASSE programme.

4.8 How the students like the subject by gender

The researcher also sought to find out the extent to which students like mathematics and other science subjects by gender. The analysis is summarised in Table 4.8.

Table 4.8: Subjects liked by students by Gender

Subject	Frequenc	Male			Female		
		I like most	Moderate	Least	I like most	Moderate	Least
Mathematics	48	43%	41%	16%	37%	39%	24%
Biology	100	54%	40%	6%	55%	37%	8%
Physics	68	49%	40%	11%	46%	41%	13%
Chemistry	54	48%	40%	12%	45%	43%	12%

The results in Table 4.8 indicate that more males like mathematics than females. That is 43% of males like mathematics most compared to 37% females who like mathematics most. Other science subjects also follow the same trend unlike Biology where more females like than males whereby 55% of the females like Biology compared to 54%males who like the same subject.It was also noted that a good percentage of females dislike mathematics and physics that is 24% and 13% respectively.

4.9 Reason why students did not like mathematics

Table 4.9 gives the reasons why students do not like mathematics as a subject.

Reason why I don't like mathematics	Male		Female	
	Total	Percentage	Total	Percentage
Poor teaching methods by teachers	70	50.00	75	57.00
Community attitude	18	13.00	20	15.00
Poor subject background	12	9.00	7	5.00
Lack of enough teaching materials	15	11.00	19	15.00
Strictness by subject teachers	9	6.00	3	2.00
I simply hate It	15	11.00	7	6.00
Total	**139**	**100**	**131**	**100.00**

According to the results in Table 4.9 poor attitude of the learners towards mathematics and other science subjects is created by poor teaching

methodology by various subject teachers and this is supported by approximately 50% male and 57% female respectively. Community perception of the students also contributes greatly towards the dislike of the subjects 13% and 15% among males and females respectively. Therefore teachers are advised to improve their teaching methodology as demanded by Smasse project.

4.10 Suggested ways of improving the performance in mathematics

Table 4.10 presents what the researcher found out to be the ways of improving the performance in mathematics from different respondents.

Statement	Headteachers		Teachers		Students	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
Changing teaching method	13	45.0	19	40.0	130	49.0
Reducing teacher work load	----	----	9	19.0	----	-----
Taking teachers for SMASSE training	2	7.0	----	----	-----	-----
Employing more teachers	2	7.0	8	17.0	20	7.0
Preparing lesson plan	5	17.0	---	-----	20	7.0
Giving more assignments	2	7.0	2	4.0	20	7.0
Making learning practical by using teaching aids	3	10.0	5	10.0	30	11.0
Catering for individual differences	2	7.0	5	10.0	50	19.0
TOTAL	**29**	**100**	**48**	**100**	**270**	**100**

The results in Table 4.10 indicate that all the respondents' headteachers, teachers and students strongly support the change in teaching methodology which is learner-centred by 45.0%, 40.0% and 49.0% respectively as the main way of improving performance in mathematics. This is also in line with what Akinibolola (2009) cited that student-centered teaching gives learners opportunity to interact, think independently in order to construct their own knowledge. According to headteachers work load was not a big problem but placed emphasis on areas like preparing before going to class and making the subject as real as possible by engaging learners in practicals which was supported by and 10.0% of the headteachers.

According to some teachers, that is 19.0% suggested that if work load is reduced then teacher can be very effective and may improve the performance of mathematics. 19.0% of learners suggested that teachers should cater for their individual differences and 11.0% supported practical teaching as some of the ways of improving performance in mathematics.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusion and recommendations based on the findings of this study. The chapter also presents suggestions for further studies.

5.2 Summary of the Study

The purpose of the study was to evaluate the effects of SMASSE project on the secondary school students' performance in mathematics in Ukwala Division in Siaya County with the view of enhancing its implementation in the classroom. The objectives were to establish students' attitude toward mathematics; determine whether the Strengthening Mathematics and Sciences Programme has any effects on teachers' teaching approaches in mathematics; investigate if Strengthening Mathematics and Science programme has improved students' performance in mathematics as well as finding out factors that hinder effective implementation of Activity Student Experiment Improvisation-Plan, Do, See Improve (ASEI/PDSI) approach to teaching.

The study utilized the descriptive survey research design where the target population comprised SMASSE trained Mathematics teachers and a sample secondary school Mathematics students in public secondary schools in Ukwala Division. The study used a census sample size of 29 headteachers while simple random sampling was used to sample out 48 teachers. Five students were sampled per class to respond to questionnaire items. This gives a total

sample of 270 students. Three instruments were used to collect the data required to achieve the objectives of this study from the Mathematics teachers and students. The three instruments were the Headteachers Interview Guide, Mathematics Teachers' Questionnaire and the Students' Questionnaire.

For the purpose of validity, two secondary school teachers helped in content validation while one research specialist from the Faculty of Education and Community Studies of University of Nairobi validated the instrument, whose focus was the face and construct validities. To estimate their reliability, the instruments were pilot–tested on teachers and students from one of the neighbouring divisions in Siaya County. Piloting was done to establish whether relevant data was collected and to identify problems that are likely to occur during administration of the instruments. The alpha was found to be 85.2% which highly indicated that the instruments were reliable. For ethical purpose, the researcher sought research authorisation from the National Council for Science and Technology (NCST) of the Ministry of Education through the Department of Foundation Education in University of Nairobi and later sought for permission from the District Education Office to be allowed to visit schools. The data collected was summarized, organized and presented in form of tables, bar graphs, pie charts and histograms. Descriptive statistics, specifically frequencies, means, standard deviations and percentages was computed from the data so as to answer the research questions.

5.3 Findings of the study

5.3.1 Student's Attitude towards Mathematics Learning

On students' attitude towards learning Mathematics, the findings indicate that majority of the students have a positive attitude towards learning Mathematics. This is evidenced by the fact above 90% enjoy studying Mathematics, rarely skip lessons and believe they can do well. Still a majority (94%) believe Mathematics is an important and necessary subject which can be studied by both boys and girls. Further on, about 80% agree that the teacher is interested in their performance and have made them feel that they can do well. The findings also show that about 65% study Mathematics during free time and try solving new problems.

5.3.2 Effects of SMASSE on teachers' teaching approaches in mathematics

The study found that majority of the Mathematics teachers engaged students in most of the lessons.70% mainly used question/answer technique, practical work (experiments) and group discussions in some of the lessons. They also encouraged students to report the results of practical and group work. A similar percent try-out experiments before presenting them to students which gives them an opportunity to make any necessary adjustments. Majority of the teachers (70%) gave students take home assignments in most of the lessons. However, 50% rarely gave students with difficulties more exercises and practice on observation.

In as far as the teaching tools were concerned the study established that majority of teachers prepare, update and make good use of schemes of work, lesson notes, records of work and assessment records. However, the preparation and use of lesson plan was rated poor. The finding of this study is that only 6% of the teachers invited colleagues to some of their lesson. A majority of teachers used as an evaluation tool for assessing students' performance.

According to the findings, about 50% students participate in asking or answering questions and in seeking clarification on areas not understood. A majority of the students about (70%) averagely participates in group work/discussion and also in making observations, taking measurements, analyzing and presentation of findings. some 37 % of students did not volunteer to perform tasks during lessons. Further, 36% of students did not carry out experiments outside normal class work while still 25% never participated in improvisation of materials.

5.3.3 Effects of SMASSE on performance of Mathematics

The findings, have suggested that there has been an improvement in the students' performance in KCSE. Majority of the headteachers (75%) agreed that performance had improved. However considering the schools' mean grades in performance in mathematics of slightly over half this improvement is minimal. The performance of mathematics in the school studied is still below average. The best mean grade recorded was C+ in only one school.

5.3.4 Hindrances in Implementation of SMASSE Programme

The study found that the implementation of SMASSE programme has encountered a number of challenges. High teacher workloads and lack of sufficient facilities were cited as the main challenges. Others challenges include teachers' negative attitude towards SMASSE programme and students' negative attitude towards Mathematics as a subject were cited.

5.4 Conclusion

Through the INSET, SMASSE targeted to change teachers' and students' attitude towards Mathematics and to improve effectiveness in the classroom in order to achieve the overall goal of upgrading students' performance in the national exams. The programme came up with the ASEI/PDSI approach to make learning student-centered where the students would be active in their own learning.

The findings of the study show that teachers' attitudes towards Mathematics as a subject and also towards its teaching are now positive. There is also evidence that students' attitude towards Mathematics is positive. Both teachers and students are interested in Mathematics and enjoy themselves during the lessons. Students' performance at KCSE has improved slightly in mathematics.

On the basis of findings, it is clear that ASEI/PDSI approach has not been fully implemented. Though majority of the teachers used activities which are student-centered like question/answer, group discussions and experiments there is minimal improvisation. Students' participation in some of the

activities for instance, is also minimal. Teachers execute lessons in an orderly and organized manner but it was noted that majority do not write ASEI lesson plans. The effective implementation of the programme has been affected by high teacher workloads, insufficient learning resources and teachers' negative attitude towards SMASSE.

5.5 Recommendations

From the discussion and conclusions derived from the data collected and analyzed, the researcher suggests the following recommendations:

- The challenge of high workloads and insufficient facilities in schools should be addressed to facilitate better Mathematics performance among the students.

- In order to motivate science teachers' SMASSE certificates should be recognized for promotion/upgrading purpose.

- Mathematics teachers should seek ways of encouraging and motivating students during the Mathematics experiment lessons, for example, in volunteering to perform a task, in suggesting possible outcomes to the experiments, and in improvising materials to perform experiments.

- Furthermore, the students should be encouraged to perform and carry out experiments outside normal class work under supervision.

- Special INSET for newly employed teachers should be organized yearly so as to ensure "old" and "new" teachers of mathematics are

updated with learners-centred methods of teaching.

5.6 Recommendations for Further Research

On the basis of the findings, the following recommendations for further research have been suggested:

1 Since research was conducted in only Ukwala Division, future research can be done in other divisions and in other counties apart from Siaya.

2 Similar studies should be undertaken in other science subjects like Physics, biology and chemistry within the district.

3 Since study focused mainly on the classroom activities; a further study can be done on factors outside class that affect implementation of SMASSE such as economic background of the learner, and community perception of the mathematics as a subject.

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APPENDICES

Appendix I: Letter of Introduction to Headteacher

University of Nairobi

Department of Educational Foundations,

P. O. Box ……,

NAIROBI

The Principal

.....

Ukwala Division.

Dear Principal,

RE: RESEARCH INFORMATION

I am a student at University of Nairobi pursuing a Masters Degree in Education. I am conducting a research on the impact of SMASSE programme on performance of Mathematics in secondary schools in Ukwala Division. I would be very grateful if you, your mathematics teacher(s) and students would respond to my questionnaires. I would like to assure you that the information gathered will be for the purpose of this research only and will be treated with strict confidentiality. To ensure confidentiality, do not write your name in this questionnaire.

Thank you.

Yours Faithfully,

Owuor Festus

Appendix II: Headteachers' Interview Schedule

SCHOOL……

1. Gender Male [ ] Female [ ]

2. Age 30-39 [ ] 40-49 [ ] above 50 [ ]

3. What is you highest professional qualification?

DipED [ ] PGDE [ ] BEd [ ] MEd/MA/MSC [ ] PHD [ ]

4. How long have you been a principal in this school?

……...

5.What is your teaching subject?

……...

6. Have you ever been involved in SMASSE INSET organization? Yes/No

If yes, state how?

7. Respond to the following statements on the impact of SMASSE INSET on mathematics in your school.

Statement	Scale		
KCSE performance has improved	Very much ☐	Improved ☐	Not improved ☐
Attitude of teachers towards mathematics has improved	Very positive ☐	Positive ☐	Not positive ☐
Teachers are more confident in their teaching	Very confident ☐	Confident ☐	Not confident ☐

8. In your opinion what factors do you think hinder the implementation of SMASSE?

i……

ii……

iii……

iv……

9. Give suggestions that can help to improve the performance of mathematics in your school

i……

ii……

iii……....

iv…….....

Thank you for your participation and co-operation.

Appendix III: Teachers' Questionnaire

The purpose of this questionnaire is to collect data used to examine the effect of SMASSE in-service education and training on performance of mathematics in secondary schools. The information required by this questionnaire shall only be used for academic research purposes. Your response is voluntary and shall strictly remain confidential. You are therefore required to be as truthful and objective as possible in your responses. Attempt all the questions by filling in blank spaces or by use of a tick (√) in the boxes and parentheses.

SECTION 1

Tick □ where appropriate

1. Gender Male [ ] Female [ ]

2. Age 25-29 [ ] 30-39 [ ] 40-49 [ ] above 50 [ ]

3. What is your highest professional qualification?

Dip Ed [ ] PGDE [ ] BEd [ ] MEd/MSC/MA [ ] PHD [ ]

4. How long have you been in the teaching profession?

1-5 years [ ] 6-10 [ ] 11-20 [ ] Above 20 [ ]

5. What is your teaching load per week?

……

6. Have you attended any mathematics SMASSE INSET cycle? Yes/No

If yes, how many?

…….....……..

If no, why not?

.....

7. How often do you give CAT? 1 week [ ] 2 weeks [ ] monthly [ ] after a topic [ ]

SECTION II

What is your opinion on the following statements? Please tick appropriately

Statement	Strongly Agree	Agree	Not certain	Disagree	Strongly disagree
8. Teaching Mathematics is interesting					
9. I am interested in my learners					
10. Effective teaching can be achieved through improvisation					
11. Boys are capable of doing well if effectively taught					
12. Girls are capable of doing well if effectively taught					
13. I spare sometime to help the slow learners					
14. I pay individual attention to students in mathematics class					
15. Other duties cannot hinder effective teaching/learning session in mathematics					
16. Mathematics is a difficult subject to teach appropriately					

SECTION II

17. What factors in your opinion hinder implementation of SMASSE approach in your teaching mathematics?

i……

ii……

iii……

iv……

Thank you for your participation and co-operation.

Appendix IV: Students' Questionnaire

Please do not write your name anywhere in this questionnaire.

1. CLASS……..

2. SEX: MALE [ ] FEMALE [ ]

SECTION 1

3. Read the following statements and kindly give your honest opinion by placing a tick in the appropriate box.

Statement	**Strongly Agree**	**Agree**	**Undecided**	**Disagree**	**Strongly disagree**
a) I enjoy studying mathematics					
b) Teachers use practical approaches in handling Mathematics					
c) I know I can do well in mathematics					
d) My teacher also encourages group discussion					
e) My teacher has made me feel I have the ability to improve					

Statement	**Strongly Agree**	**Agree**	**Undecided**	**Disagree**	**Strongly disagree**
f) I often find myself studying mathematics during my free time					
g) Am satisfied with the way the teacher teaches mathematics					
h) I like solving new problems in mathematics					
i) I rarely skip mathematics lessons					
j) The teacher gives me feedback.					

SECTION II

4. The following statements refer to your participation in a mathematics lesson. Read each statement and evaluate your level of participation by placing a tick □ in the box.

Key

Very frequently [3] Frequently [2] Rarely [1] Never [0]

Statements on participation during mathematics lesson	3	2	1	0
a) Asking question				
b) Seeking clarification on areas not understood				
c) Volunteer to perform a task during a lesson				
d) Make observations				
e) Teacher always give Continuous assessment test				

5. Write down the factors that affect the performance of mathematics in your school

i) …….....……

ii) ……

iii) ……

6(a) Among the following SMASSE subjects indicate the **one** you like most and one you do not like.

Subject	**I like most**	**I like**	**I don't like**
Mathematics			
Biology			
Physics			
Chemistry			

6(b) Explain why you like the subject you have indicated most.

……

……

6(C) Explain why you do not like the subject you have indicated

……

……

7. What suggestions would you give that would help improve the teaching and learning of mathematics?

……

……

Thank you for your participation and co-operation.

APPENDIX V

THIS IS TO CERTIFY THAT:
MR. FESTO OCHIENG OWUOR
of UNIVERSITY OF NAIROBI, 6-40607
Ukwala,has been permitted to conduct
research in *Siaya County*

on the topic: *EFFECTS OF SMASSE ON THE PERFORMANCE OF MATHEMATICS IN SECONDARY SCHOOLS IN UKWALA DIVISION, SIAYA COUNTY.*

for the period ending:
31st December,2016

.....
Applicant's Signature

Permit No : NACOSTI/P/14/1063/2698
Date Of Issue : 13th August,2014
Fee Recieved :Ksh 1,000

.....
Secretary
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 2833

CONDITIONS: see back page

APPENDIX VI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

13th August, 2014

NACOSTI/P/14/1063/2698

Festo Ochieng Owuor
University of Nairobi
P.O.Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effects of SMASSE on the performance of mathematics in secondary schools in Ukwala Division, Siaya County,"*** I am pleased to inform you that you have been authorized to undertake research in **Siaya County** for a period ending **31st December, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Siaya County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
The County Director of Education
Siaya County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified