IMPACT OF SMASSE PROGRAMME ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN PHYSICS IN BOMET COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this University or any other for the award of a Degree.

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DEDICATION

This work is dedicated to my wife, our children, fellow teachers and principals. I wish to thank them all for their support and encouragement

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ABSTRACT

Science subjects are the backbone of the scientific and technological advancements in the world. Achievement in science subjects in secondary schools in Kenya has been below average. In an attempt to address the poor performance in Physics, the Strengthening of Mathematics and Science in Secondary Education (SMASSE) teaching approach was introduced in Konoin Sub-County in 2004. However, it is not clear how this approach is impacting the students' achievement in the subject. The purpose of the study was to find out whether SMASSE approach had impacted the achievement in physics. The study used expost-facto research design which involved extracting data from past school examinations records and a survey research design to assess the adoption of SMASSE teaching approach by physics teachers in the sub-county. The target population was 5017 candidates in 24 secondary schools in Konoin Sub-County in period (2000-03) and 5204 in the period (2012-15).The sample size was 12 secondary schools and the study used stratified, systematic and purposive sampling to select the schools with a total of 1,013 students for the period (2000-2003) and 1,390 in the same 12 schools for the period (2012-2015) giving a total sample size of 2,403 for this study. The research instruments used for the study were a document analysis tool and a Teachers Questionnaire on Students Achievement in Physics (TQSAP). The population of the physics teachers in the sub-county were 107, a sample of 25 teachers was selected from the sampled schools. The instruments were validated by experts in the Department of Curriculum, Instruction and Educational Management. Piloting was done in four schools in Buret Sub-County. Cronbach's alpha coefficient was used to determine the reliability where TQSAP had a reliability of 0.7231.The threshold for acceptance was $\alpha \geq 0.70$. Means, range and standard deviations were used for the descriptive statistics while for inferential statistics ANOVA and t-tests were used to analyze the data. All statistical tests were subjected to test significance of coefficient alpha (α) of 0.05. Results show that SMASSE teaching approach did not impact students' achievement in Physics and that boys performed better than girls even after both were exposed to the approach. Theministry through the Quality Assurance and Standards Officers (QUASO) should design monitoring tools to ensure that the programme is actually implemented in the classroom to achieve its intended objectives of improving the performance in science and mathematics.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASEI	Activity, Student-Centered, Experiment and Improvisation
CATS	Continuous Assessment Tests
CEMASTEA	Centre for Mathematics, Science and Technology in Africa.
GOK	Government of Kenya
INSET	In -service Education and Training
JICA	Japan International Co-operation Agency
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KIE	Kenya Institute of Education
MOE	Ministry of Education
MOEST	Ministry of Education Science and Technology
NSSP	Nuffield School Science Project
PDSI	Plan, Do, See and Improve
PSCS	Physical Science Curriculum Study
QUASO	Quality Assurance and Standards Officer
SMASSE	Strengthening of Mathematics and Science in Secondary Education
SPIA	**S**SMASSE Project Impact assessment Survey
SPSS	Statistical Package for Social Sciences
SSP	School Science Project
TIPDP	Teachers' In-Service Professional Development Programme
UNESCO	United Nations Educational Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Science education is crucial in human lives and in the development of nations around the world, as it contributes much towards economic empowerment of nations (Aoki, 2001). Science knowledge has been utilized in scientific inventions in medicine, engineering and technology towards solving most of the human problems (Das, 1985). Over the years, science has contributed to the improvement of quality of human life (Mori, 2017). Most basic Human needs have also been met through scientific inventions. Furthermore, Science education yields new knowledge, new skills and new desirable attitudes for the learners (Kerich, 2004). Teaching science would therefore equip students with the established body of scientific knowledge appropriate to their needs, interests and capacities (Millar, 2004).

There have been several changes in science teaching approaches and methods. A number of innovations came into being with far reaching effects across many parts of the world. In the United Kingdom, Nuffield Science Project (NSP) was launched in 1962.This project was sponsored by the Nuffield Foundation. In Kenya, Science subjects were included in school curriculum through the School Science Project (Kenya Institute of Education, 1969). The School Science Project (SSP) was designed especially for those schools with well-equipped laboratories. The SSP required students to carry out investigations and discuss their findings and finally draw conclusions with the help of their teacher. Wachanga (2005) pointed out that in 1984 the 8-4-4 education system was introduced in Kenya with the aim of making education more relevant to the needs of Kenyan society. The 8-4-4 education system revised syllabus of Biology, Physics and Chemistry in all secondary schools in Kenya was done by Kenya Institute of Education (KIE,1992), currently called Kenya Institute of Curriculum Development (KICD). Physics curriculum has also undergone several changes starting from 1958 when Physical Science Curriculum Study (PSCS) was established in the United States with the following objectives; to examine classroom Physics materials available before 1960, produce a Physics curriculum which encourages creative and imaginative approach to the study of Physics, and the teaching and learning of Physics through inquiry and use of leaner’s environment as the starting point in Physics education..PSCS influenced the launch of Nuffield Science Project (NSP) in United Kingdom in 1962.In Kenya, the development of Physics curriculum was initiated by the Kenya Institute of Education and United Nations Educational Scientific and Cultural Organization (UNESCO)through the African Curriculum Development Centre (ACDC) in 1963.There was the Nuffield Science Project of 1969 which adopted the learning of the natural science (Biology, Physics and Chemistry) in selected secondary schools in Kenya.Physics is one of the science subjects taught at secondary school level of education in Kenya. Physics definition stems from Greek word meaning nature hence it deals with natural phenomena. It is therefore a science subject whose main objective is the study of components of matter and their mutual interactions. It is also defined as the study of matter and its relation to energy (KLB, 2010). Since the study of Physics enables understanding of basic concepts of matter and their mutual interactions it forms the base of natural science. The studies of Physics make learners understand simple phenomena of life like causes of the solar system, work and energy. The study of Physics in schools and other levels like colleges and universities is relevant to the students and society today. Physics is an experimental science with the main objectives, according to KNEC (2012) as: Physics makes learners discover and explain the order of the physical world, develop capacity for critical thinking in solving problems, contribute to technological and industrial development of the nation and acquire of positive attitude towards Physics.

The Kenya Institute of Curriculum Development (K.I.C.D) (2015) syllabus presents Physics as a body of knowledge about the physical environment. It employs a systematic scientific methodology of study to arouse learners' way of reasoning and create a positive attitude. To this end, the use of teacher/learner discussion, teacher demonstration and group/class experiments as methods of instruction is encouraged. The syllabus not only emphasizes the understanding of the fundamental scientific concept and principles, but also the experimental approach of investigation. The experimental approach should prepare the learner to present scientific concepts and ideals in the modern technology. Further, the syllabus presents project work and this approach provides the learner with opportunities in undertaking investigations for purposes of finding solutions to problems. Physics is basic for understanding the complexities of modern technology, and essential for technological advancement of a nation in various sectors such as telecommunications, architecture, engineering, electricity production and transmission, construction, and transport (Erinosho, 2013).

The introduction of the 8-4-4 secondary school Physics syllabus followed a recommendation of the Presidential Working Party in 1981 that stipulated the 4-year Physics course. The objectives of studying Physics are; relate and apply relevant Physics knowledge and understanding to social and economic development in rural and urban settings; demonstrate resourcefulness, technical skills and scientific thinking necessary for economic development, acquire firm foundation of relevant knowledge, skills and attitudes for further education and training in related scientific fields (Majani et al.,2003). A national assessment survey carried out in 1999 by the Ministry of Education (MOE), resulted in the revision of secondary education Physics curriculum in Kenya. The revised curriculum was to address aspects necessary for industrial transformation by the year 2030 (MOE, 2002). The revised syllabus had many practical activities unlike the previous one that had small scale practical activities: This is still the syllabus in use to date. The consistently low performance in the science subjects in the KCSE is what prompted the ministry of education in Kenya to introduce SMASSE as an intervention measure. The achievement in the science subjects and mathematics just before the introduction of SMASSE to the whole country is shown in Table 1.

Table 1:Number of Students per Grade in KCSE Science and Mathematics Nationally in 2003

Subject	B+and Above	%	D+ and Below	%	Total candidature
Biology	11,339	6.1	103,282	55	185,319
Physics	5,571	9.8	26,768	47	56,333
Chemistry	12,341	6.2	140,455	71	197,608
Mathematics	9,903	4.8	158,867	77	205,232
Overall	39,154	6.34	429,372	69	617,492

Source: KNEC Results (2003). Pg. 64

The low achievement in Physics as shown in Table 1 and other science subjects in terms of quantity and quality grades is what prompted the Government of Kenya through the Ministry of Education, Science and Technology (MOEST) in conjunction with the Government of Japan through Japan International Co-operation Agency (JICA) to jointly launch Strengthening of Mathematics and Science in Secondary School Education (SMASSE) project. The quality grades were less than 10 percent in all the science and Mathematics subjects in 2003 as evident in Table 1 with physics producing 9.8 percent. The project then introduced the SMASSE programs to try and improve on the quality grades in KCSE. The low achievement in science as observed in the national examinations could be due inappropriate teaching approaches (Oyaya& Njuguna,2000). SMASSE programme was launched in 1998 in nine pilot districts of Kisii,Gucha, Kakamega, Makueni, Kajiado, Murang'a, Maragua, Butere-Mumias and Lugari in Kenya as phase one to cover 4 cycles. This project was eventually extended to cover the whole country in 2004.SMASSE project was therefore conceived as an intervention measure to upgrade the capability of young Kenyans in science and Mathematics. The project was aimed at identifying those factors that contribute to this low achievement in sciences and Physics in particular. On the basis of this, a programme was formulated for intervention through In-service Training (INSET) of teachers and sensitization of key stake holders. The main problem areas that the project was supposed to address were: poor attitude of the learners and key stakeholders, inappropriate teaching methods and approaches, poor content mastery by the teacher, poor utilization and distribution of school resources and inadequate supervision from Ministry of Education, Science and Technology (SMASSE, 2004).

SMASSE project was an In-Service Education Training (INSET) programme that sensitized teachers on teaching strategies that will address the above problems and improve science performance in national examinations. The institutionalization of INSET was for capacity building with the aim of changing the teachers' attitudes, teaching approaches and methods along with prudent use of school resources and improvisation as far as academic activities are concerned (SMASSE, 2004). SMASSE teaching programme involves; Activity, Student -centered, Experiments and Improvisation (ASEI) condition and Plan, Do, See and Improve (PDSI) movement (CEMASTEA, 2016). ASEI is a SMASSE initiative whose focus was to assist teachers to reflect on their teaching strategies and acquire skills for effective teaching and for efficient learning to occur

(Oyaya& Njuguna, 2000). It also aimed at encouraging teachers to focus on institutional strategies that will support meaningful learning and make lessons interesting to learners. The ASEI teaching approach advocated for a shift in both the teachers' thinking and practice from the teacher centered approaches to student-centered approaches (Ogolla, 2001). PDSI is a teacher's approach to teaching that involved proper planning for the lesson, actual teaching, seeing it and including feedback from other teachers and improving where it requires, making the lesson delivery effective (SMASSE,2005).

Konoin sub-county had been posting below average performance in science subjects in the Kenya Certificate of Secondary Examinations (KCSE) over the years. This had been attributed partly to poor preparedness and approaches employed in teaching of science (SMASSE, 2004). The Kenya Certificate of Secondary Education results analysis before INSET on SMASSE teaching programme in Konoin Sub-County is shown in Table 2.

*Table*2**:***Students' KCSE Performance in Science Subjects in Konoin Sub-County (2000-2003) before the INSET*

	2000	2001	2002	2003	
Subject	Mean Score	Mean Score	Mean Score	Mean score	Average
Biology	4.162	4.733	4.833	5.023	4.790
Physics	3.896	4.092	4.647	4.789	4.344
Chemistry	3.841	3.443	3.723	3.952	3.783
Overall	3.963	4.087	4.400	4.588	4.306

Source: District Education office, Konoin (2004) pg. 3

Table 2 shows the performance of the three science subjects before the inception of the SMASSE in KCSE in Konoin sub-county. The average score for the three subjects is below 50% or 6 points on a 12-point scale, where A= 12 points is maximum possible score and E = 1point, is the least score. There was a steady improvement in the physics mean score from 3.896 in 2000 to a mean score of 4.789 in 2003.SMASSE programme was introduced in the whole of Kenya in 2004.This was with a view of improving the performance in the science and mathematics subjects. Physics teachers were supposed to implement the teaching approaches in their own schools. Tables 3 shows performance in Science subjects after the two cycles were completed, being provided at the sub-county.

Table 3:KCSE Analysis for Science Examination in Konoin Sub-County (2009-2015)

Subject	2009 Mean Score	2010 Mean Score	2011 Mean Score	2012 Mean Score	2013 mean Score	2014 Mean Score	2015 Mean Score	Average Mean Score
Biology	3.1296	5.4873	5.0207	4.395	4.5336	5.1379	4.57604	4.5339
Physics	4.0455	4.9186	4.5807	4.5445	4.5359	4.5436	4.7007	4.5362
Chemistry	3.0566	3.6782	3.5423	3.450	3.6520	4.4190	4.1513	3.6520
Overall	3.4106	4.6947	4.3812	4.1298	4.240	4.6976	4.4760	4.2359

Source: Konoin Education (2016)

The table shows the achievement in all science subjects after the INSET, the period after SMASSE was introduced in Konoin sub-county. The students' low achievement in national examinations can make the students lose interest in the subject and consider it a waste of time to concentrate on a subject they will not pass (Veroff, 2016).Wachanga (2000) in his findings on effect of inquiry teaching approach in learning Chemistry noted that the cause of most failures in schools might be due to the teaching approach or inadequate instruction. Table 4 is the 2007 KCSE performance showing how the boys and girls scored in science and mathematics in Kenya. The year 2007 was the fourth and last INSET cycle for teachers so this can be taken as the base year of the performance in science and mathematics before they were fully equipped with the approach so that they could implement it from form one.

Table 4:2007Overall Candidates Mean Performance By Subject And Gender

	Overall		Female		Male	Overall
Subject	No.	Mean	No.	Mean	No.	Mean
Name	Sat	%	Sat	%	Sat%**%**	%
Mathematics	274,120	19.74	125,248	15.74	148,872	23.10
Biology	246, 662	41.95	118,745	38.99	127,917	44.70
Physics	83.387	41.32	23,788	39.04	59,599	42.23
Chemistry	268,001	25.38	123,078	22.65	144,923	27.69

Source: KNEC (2008) pg 23

As Table 4 shows the achievement of boys is higher that of the girls in the 2007 KCSE.The study therefore sought to find out if SMASSE was able bridge this gap. Furthermore, it was found that male Biology students in Bomet were positively influenced by SMASSE teaching approach in terms of achievement while female students were not (Mutai, 2018). This programme was also expected to bridge a gap that exists in the performance of boys and girls in Mathematics and science subjects in the majority of the schools. Given the above scenario the study investigated the impact of MASSE on the students' achievement in secondary school Physics in Konoin Sub-County.

1.2 Statement of the Problem

Students' achievement in Konoin sub-county in Physics was below average and in the Kenyan secondary schools in general. The sub-county was selected for the study due to the fact that the achievement in physics at KCSE level was the lowest as compared to the other sub-counties in Bomet sub-counties. Furthermore, there was no SMASSE INSET Centre within the sub-county where the teachers can access the SMASSE resource. In an attempt to address this poor achievement, the government of Kenya introduced Strengthening of Mathematics and Science in Secondary Schools Education (SMASSE) teaching approach. However, it is not clear how this approach impacted on the students' achievement particularly in Konoin Sub-County. This study therefore examined whether SMASSE teaching programme has impacted on students' achievement in secondary school Physics in Konoin Sub-County.

1.3 The Purpose of the Study

The purpose of the study was to assess the impact of SMASSE programme on students' achievement in Physics in Konoin Sub-County secondary schools. The study was also to assess the impact of the programme on the students' achievement by gender in Physics in the sub-county.

1.4 Objectives of the Study

The study was guided by the following objectives.

i) To assess the impact of SMASSE programme on students' achievement in physics in the KCSE after its introduction inKonoin sub-county

ii) To assess the impact of SMASSE programme on male and female students' Physics achievement in KCSE after its introduction in Konoin sub-county

1.5 Hypotheses of the Study

The following null hypotheses were tested in this study**:**

$H_0$1: There is no statistically significant difference in students' achievement in KCSE Physics in Konoin Sub-County before the introduction of SMASSE programme (2000-2003) and after (2012-2015).

$H_0$2: There is no statistically significant difference in male and female students' achievement in KCSE Physics in Konoin Sub-County before (2000-2003) and after (2012-2015) introduction of SMASSE program.

1.6 Significance of the Study

The study may help education policy makers come up with ways of improving future programs aimed at better performance in Physics. Other than increasing the body of empirical literature on the topic, this study may also become a point of reference for future researchers. The findings could inform decisions and actions towards improving teaching and learning of Physics in Konoin Sub-County schools and other parts. It may also inform on the teacher training in teacher training institutions. It may also sensitize teachers' position as far as SMASSE programme is concerned and make them to pay more attention to the areas in the programme that requires improvement.

1.7 Scope of the Study

The study was undertaken in Konoin sub-county, Bomet County. This study involved the use of student KCSE records of results before the introduction of INSET (2000-2003) and the period after the four SMASSE cycles (2012-2015).

1.8 The assumptions of the Study

The major assumptions of the study were as follows:

i) The physics teachers in the sampled schools in Konoin sub-county were experienced and underwent all the four SMASSE cycles.

ii) The management of the sampled schools offered co-operation by allowing the researcher to conduct the study in their schools.

iii) The respondents were cooperative and provided reliable information.

iv) The triangulation of data collection methods was useful in enriching the study.

1.9 Limitations of the Study

The study focused n the students past KCSE records in Konoin sub-county. This means that the generalization of the findings was confined to the sub-county .the findings of the study would not be used to generalize results for the sake whole country

1.10 Definitions of Terms

Achievement: It means something that has been accomplished especially by hard work and ability (Maundu, 1986). In this study, it refers to students' grades scored in physics in the Kenya Certificate of Secondary Examinations (KCSE).

Gender: Gender refers to the roles assigned to the members of the opposite sex, male or female (Davidson & Honing, 2003). In this study it refers to the difference between boys and girls in both physical as well as the socio-cultural aspect.

Impact: It is a marked effect or influence that an action has on somebody or something (Jude *et al*., 2007). In this study impact is used to mean difference in students' achievement in KCSE Physics in the period before and after exposure to SMASSE in the secondary schools.

Mean grade/ score: This refers to the average grade obtained when all the students' individual grades are added and then divided by the total number of students in the school. It is the score on a 12-point scale where the highest possible score is 12 and the least is1. In this study the mean score in Physics is the grade on this 12-points scale.

Physics: This is a branch of science which is the study of the matter and energy that make up our world.

SMASSE Programme: This refers to a teaching strategy that incorporates two classroom activities; PDSI (Plan, Do, See and Improve) and ASEI (Activity, Student-Centered, Experiment and Improvisation). In this SMASSE Programme both conditions require that the teacher plans what to do, executes it and involves learners in experiments and improvisation of apparatus where the conventional ones are unavailable (SMASSE,2004).

Teachers' In-service Professional Development Programme(TIPDP): This refers to the session teachers undergo in order to introduce changes in the teaching approaches without changing the curriculum (Igenya& Thomson, 2002). For this study, IPDP refers to the session teachers were training during the INSET on SMASSE approach.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents literature review on the areas relevant to the study. The first section deals with trends in teaching approaches in science education and the effects of practical in science achievement, followed by performance in KCSE Physics by gender, then teachers' in-service professional development program, the theoretical framework and finally the conceptual framework of the study.

2.2 Global and Regional Perspective on Secondary school Physics Education

During the past two decades, Australia and much of Western world have raised growing concern about low enrolment in Physics at senior secondary level. The number of senior secondary school students who choose Physics is relatively small and has shown a declining tendency (Smithers & Robinson, 2006). In Australia, the study of science is not compulsory at the upper secondary level (year 11-12). At this stage, science is taught as a Public Examination Subject (PES) or as a School Assessed Subject (SAS). The majority of students at year 12 study PES subjects that enable them meet entry requirements or selection criteria for tertiary courses at universities. Otherwise, students have an option of studying the PES, SAS or none at all depending on the courses they intend to pursue at higher levels. However, the proportion of secondary school students enrolled in PES subjects as compared to the total number of year-12 students has been declining over a period of many years. Thus, in Australia and the Western world, consequently the number of students who decide to pursue technology and engineering related courses in university is very low (Semela, 2010).

The other concerns are highlighted in other nations like United Kingdom over declining number of Physics students at both secondary and post-secondary levels pointing out that a decrease in students enrolled in physics at these levels leads to concerns of sustaining an educated base capable of working in science and technology, research, education and industry (Owen et al.,2008).Schibeci and Lee (2003) alsoobserved see negative impact of decreasing enrolment in Physics in society. They state people need a basic amount of scientific literacy to make informed decisions in regards to both personal and social wellbeing. If the society's general understanding of Physics is low, then people will struggle to make proper choices in even their political process. Duggan and Gott (2002) commented on the importance of scientific literacy in industry and in turn the economies of nations. They explained that a significant portion of the workforce in the UK, almost 30%, claim to use Science and mathematics on a daily basis. They assert that most employers have a desire to hire employees who have problem solving capabilities more than employees with basic scientific knowledge. This is to say, they desire employees who know and use the scientific process rather than memorize scientific facts. Physics at the high school level is truly an exercise in the scientific process. Students are required to analyze and interpret whatever problem there is and what information they have been given to solve. Then the student must devise a means of determining a solution and execute this process.

Several researchers have also shown that the interest of students is declining (Trumper, 2006). It therefore means that in such circumstances, the number of students pursuing Physics related courses like engineering at university level is equally low. In China Physics is taught as a compulsory subject from year 8 to 11, although in year 11, Physics is offered in two forms: Physics for art students and Physics for science students. The content of Physics for art students is simpler than that for science students. In year 12 art students can omit Physics. Thus, students in other parts of the world have the option of proceeding with the subject to the final year or not. China seems not to have such problems in students' Physics enrolment at senior secondary level. The country has a different educational system with most of the western countries such as Australia. The pathway from compulsory school science to enrolling in a tertiary course in the field of Physics or engineering is very different from those in the western countries. However, Chinese scholars have pointed out that Chinese students generally feel senior secondary Physics is difficult, uninteresting and irrelevant to life experience (Zhu, 2007) did a study that looked at students reasoning for taking Physics in the Netherlands. In this study, he identified four major factors influencing a student's choice to take Physics: future relevance (to keep options available to themselves for post-secondary and occupational aspirations), appreciation of Physics concepts, building self-confidence and finally interest. He also highlights that the main hindrances from taking Physics were lack of interest, concerns about marks and perceived difficulty.

A similar situation has been noted in Nigeria where the number of students taking Physics in high school and consequently at tertiary level continue to decline and thus a small number of them qualify to join courses related to medicine, engineering, architecture or pharmacy (Taale, 2011). In their study of students' low achievement in Physics Bamidele (2004) and Akanbi (2003) while investigating students' performance in senior secondary school Physics, both observed that there was a low enrolment of students in Physics in Nigeria. According to Onasanya and Omosewo (2011) Physics education is faced with problems, which limit its impact in Nigeria and the rest of Africa. The researchers argue that Physics is mostly perceived to be difficult by many students in school. A study by Owolabi (2004) revealed low achievement of Nigerian students in Physics at Ordinary Level. Factors cited to contribute to low achievement is lack of laboratory facilities, inability of Physics teachers to communicate ideas and inadequate learning facilities in schools against increase in enrolment of students in the subject. Another study conducted by Uchenna and Mbamara (2015) investigated causes the low achievement in Physics by students in secondary schools in Nigeria and found that students' perception of Physics that it was difficult to understand which led to the low enroll in the subject.

Secondary school education is a critical level in any educational system. As a transitional level to higher educational level, it is important for economic development of a nation, socialization and empowerment of the youth who are faced with massive levels of unemployment (UNESCO, 2005). Nations all over the world put a lot of seriousness on secondary school education. The structure and content of the secondary school curriculum of a nation is constantly revised with the aim of making it more relevant and sensitive to the country's educational goals and aspirations. According to Lavonen*et al*. (2007) there were background variables that may explain why students desire or do not desire to study physics. They noted that little research has been done on students' perceptions about physics and physics learning. They also demonstrate that there are several factors that seem to affect a student's decision in regards to taking physics and grouped these factors in three categories: teaching methods, other classroom activities and external factors. They also noted that for the students, much of physics curriculum is often considered boring. This is where teaching method and classroom activities come into play, if one can make the content delivery interesting, then the students' interest in the subject should increase. According to the authors report for both genders of students taking physics, there was a perception that it was a highly interesting subject.

2.3 Trends in Teaching Approaches in Science Education in Kenya

Teaching and learning of science has been a subject of discussion for a long time by educationists. The discussion is often centered not only on what is taught but how it's taught. 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 approaches and methods to be used for teaching (Ogolla, 2001). A teacher is tasked with the selection of the approaches to be used in presentation of the lesson. Good teaching is largely a matter of personal aptitude and motivation and is acquired through planning and selection of approaches that will result in effective learning. There are three basic facets in science education; that is learning science, learning about science and doing science through adopting an approach to be used in the classroom. Science teachers should be conscious about some of the aims of teaching science in secondary education (MOE, 2006).
These are:

i) To help learners develop a positive attitude towards learning science.
ii) To develop in the learner's capacity for critical thinking and problem solving in any situation.
iii) To foster and develop an individual with a scientific way of thinking and who can communicate this with others.
iv) To enable learners, make sense of their world by helping them restructure their ideas in useful and skillful ways. The learners should build coherent scientific perspectives that can relate to what they learn and to the world in which they live in.

The approaches that have been used in science education are didactic, expository, heuristic, inquiry, constructivist and SMASSE approach.

2.3.1 Didactic Approach in the teaching of Physics in secondary schools

This approach is where students are given rigidly formulated statements which they have to didactic approach found that when a teacher engages in didactic instruction, the teacher presents models to the students for mutual contemplation. Little or no emphasis is placed on understanding. Learners are simply made to cram things. This approach believed that human brain was a blank slate where knowledge can be put and stored (Rabari*et al*., 2004). However, the approach is not suitable for Physics teaching since no practical are involved.

2.3.2 Expository Approach

This is the approach where the teacher's talk is dominant and involvements of students in practical activities are minimal. The teacher gives facts and explains concepts and gives illustrations. Expository teaching model is said to encourage meaningful rather than rote reception learning (Ausubel,1963). In his approach to learning, teachers present material in a carefully organized, sequenced, finished form. He also observed that learning should progress deductively from general to specific and anything taught practically is through the teacher’s demonstration. Student participation is limited to listening, answering and asking questions and writing notes as lesson progresses. The approach is not considered good for teaching of Physics (Rabari*et al*., 2004).

2.3.3 Heuristic Approach

Heuristic is the art and science of discovery and invention. This approach asserts that the learners could be trained to discover scientific skills by using faculties of observation, reasoning and memory. Learners are involved in observation, recording, analyzing data and drawing conclusions on their own. According toJianandRui (2016) heuristic approach refers to a particular method of teaching allowing the students to learn by discovering things themselves and learning from their own experience. Students will be encouraged to try and solve problems through critical thinking and reasoning. This way, problems will be solved through discussion among students with the help of the teacher. This is better approach to science than the expository approach. However, the approach consumes a lot of time hence less coverage of the prescribed curriculum, therefore most teachers don’t like using the approach (SMASSE, 2006).

2.3.4 Inquiry Approach.

This is a student-centered approach where the teacher involves students in activities that help in the development of scientific skills such as the ability to make observations, perform experiments, collect data and make deductions and present the results. Studies done on effects of co-operative class experiments in Chemistry suggested that like co-operative learning, the inquiry approach should be emphasized more at teacher training institutions and in-service courses in the universities and tertiary colleges for effective delivery of teaching (Wachanga, 2004). There was also the Nuffield Science Project which encouraged pupils to carry out experiments which could bring better understanding of scientific concepts. The philosophy that followed this approach was, 'I hear I forget; I see and I remember and I do and I understand'. The teachers' role is to guide students clarify instructions where necessary and being available to answer any question that will arise in the course of the activities. The approach is believed to be effective but consumes a lot of time (Maundu*et al*., 1998).

2.3.5 Constructivist Approach

Chen (2015) in his study found that constructivist teaching approach assist learners to construct knowledge and emphasizes presenting learning activities in meaningful context. It provides an alternative theoretical foundation for rethinking and redesigning teaching practices. Constructivism provides a sound theoretical foundation for teaching any complex knowledge domain. This approach is based on the fact that when the learners enter formal education, they have already interacted with the environment and have developed ideas and concepts in relation to what they have experienced (David,2014). The role of the teacher here is to provide guidance by giving students challenges that would help them correct their misconceptions and enable them draw correct scientific concepts. The teacher does this through class discussions, students' experiments, demonstration, visual aids, audio, charts, diagrams and models. This approach helps learners to test their understanding using scientific approach. The activities should encourage the ability to plan and carry out investigations in which students observe, compare, describe, note, and express themselves (SMASSE, 2004). However, the approach consumes a lot of time.

2.3.6 SMASSE Approach

Teachers are trained to teach while they undergo their college training program. Once in the field there is always need to retrain the graduate teachers, through in-service training, on the new challenges which they meet in the actual classroom situation. Teaching and learning of science and hence Physics has been a subject of debate for a long time. The debate is often centered not only on what is taught in terms of curriculum content and relevance, but how it is taught in terms of 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. The primary objective of in-service training of teachers is to enable them get new understanding and instructional skills. The in-service training is geared towards creating learning environments which will make the teachers develop their effectiveness in the classroom. For this reason, in-service training for teachers is always important if any change has to occur in the field of teaching and learning. It is necessary therefore, that teachers keep abreast with the most current concepts, thinking and research in their field and enhance personal professional growth among teachers in order to promote efficient and effective teaching and learning environment for students. Kazmi*etal*.(2011) asserts that in-service training for teachers enables the teachers to be more systematic and logical in their way of teaching.

In-service training is a basic aspect for the growth of teacher's professionalism related to the teacher's vision to improve the quality of their classroom work. By going for in-service training, teachers can find out and asses critically the school culture which can be used to bring about changes to the working environment or culture. Studies by Ekpoh (2013) suggest that, teachers who attend in-service training perform better in their work more so on the knowledge of the subject, management of classroom, teaching strategies and students' evaluation. Studies done by Jahangir *et al.* (2012) also show that in-service training is a major factor in improving the performance of the teacher in a school.

Sometimes during in-service training, there is need to evaluate the materials and equipment that are being used regularly in order to ensure their effectiveness and suitability which depends on the materials and resources being used and whether new materials are made available during the course (Hacer, 2012).Teaching in general has shifted from the traditional demonstration and showing method to a more hands-on-approach as advocated by the SMASSE (SMASSE, 2003). Physics educators have advocated for the need to use student-based activities to enhance retention. Methodology should therefore encourage the application of student-centered approach to teaching of science subjects. Integration with other approaches when teaching sciences should also be encouraged because not all areas in Physics can be taught through activities, on such approach is mastery-learning approach (MLA) (Wambugu *et al*., 2007). One problem with conventional method of teaching Physics lies in the presentation of materials (Mazur *et al*.,2006). Frequently, the materials learned in Physics come right from the textbooks or lesson notes.

The traditional presentation is nearly always delivered as a one-way communication in front of a passive recipient making the problem of delivery even bigger. Only very exceptional teachers are able to capture the attention of learners for a long time without actively involving them and even still, the amount of retention is way below average. Retention of information learned is obviously because of active participation by the learner and being in touch with the learning materials. It is also important for the teacher to start from what the students already know and then use that to guide the students to the new material to be learned.

Taylor and Francis (2013) noted that School Physics is always regarded as being relevant in daily life, and Physics teachers are seen as being able to direct students' interest in the subject of Physics. The way Physics as a subject is being taught by the Physics teachers, it is they who make the subject look real, interesting and attractive to learners or the other way round. This is seen as a medium through which students can be influenced or get motivated to take the subject. Mbaabu*et al.* (2011) noted that it is important to underscore the fact that teacher competence will translate into learning gain that the students require if these competences are used well in the process of teaching and learning. The Teachers' way of handling the subject and more so their competence impacts students' attitude towards Physics. Mbithe (2012) also found that teachers influenced the students' choice of Physics through their absenteeism for their classes, poor relationship with students, unsuitable pace of content delivery and poor teaching approaches. If teachers promote sciences, and Physics in particular, related programs in their schools, then it would be widely expected that students would have to develop positive attitude and interest towards the subject and the related career. Teacher’s effectiveness in teaching Physics is a significant variable of student’s achievement.

Kiboss (2002) showed that students conceptions about science might be negatively affected by the way the teacher presents the subject. For example, the use of such techniques as lecturing, giving notes and drilling students on past examination papers, which most teachers find as useful strategies, may make pupils perceive science subjects as the mastery of some formulas and simply away of receiving and storing information without understanding the first principles. UNICEF (2009) asserts that in many developing countries majority of teachers lack the prerequisite levels of education and training needed to rise from challenges of school reforms geared for improved performance. Further Elementary and secondary schools were not laying a satisfactory foundation for advanced science and engineering education and this was due to poor preparation in mathematics and science. The way in which physics is taught within the school at junior cycle also impacts students' attitudes and orientations to the subject and thus their likelihood of continuing to take physics. Further, teacher student relationship affects the achievement of Physics.

The Strengthening of Mathematics and Science in Secondary Education (SMASSE) in-service was started in 1998 as a joint programme between the government of Kenya and the government of Japan through JICA (Japanese International Cooperation Agency) as a means of responding to the need for quality teaching and learning of mathematics and sciences at the secondary school level of education. It was first piloted, in the year 2000, in nine sub counties namely Kajiado, Gucha, Kakamega, Lugari, Butere-Mumias, Kisii, Muranga, Maragua and Makueni. A baseline survey was conducted and information gathered on what used to go on in the classroom at that time. Interviews were conducted for head teachers, teachers, students, 3 parents and laboratory assistants and more data were collected by administering questionnaires to teachers and students. The SMASSE programme was later rolled out nationally in the year 2003.

Together with Kenya, the SMASSE project was also implemented in other countries in Africa. This was done through SMASSE-Western, Eastern, Central and Southern Africa (SMASSE-WECSA) in the region as an association of educators of mathematics and sciences. It was started in 2001 for the purpose of strengthening the quality of teaching and learning of mathematics and science in the member states. The member states have adopted SMASSE's ASEI movement and PDSI approach as a means of ensuring improved classroom delivery practice. The overall objective of the project is to upgrade the capability of young Kenyans in mathematics and science. The purpose of the project is to strengthen the quality of mathematics and science education at secondary school level through in-service training (INSET). The project utilized two approaches in strengthening quality of Education: conducting capacity building development workshop for school administrators and organizing INSETs to strengthen quality of the serving teachers in mathematics and science.

INSET is one of the approaches used to up-grade teachers' skills and competence the global over (Karega,2008), and is in conformity with worldwide agreement that upgrading quality of education is dependent on improvement of quality of classroom delivery practices (Kibe *et al*.,2008). Sometimes there are cases encountered of schools where there were qualified teachers or adequate equipment and materials, yet students' achievement and enrolment in the science subjects was still unexpectedly low. On the contrary, there were schools that were lacking in terms of teaching staff, teaching and learning facilities and scholarly material, yet such schools still have relatively good examination results in Physics based on the effective teaching and management of learning environment.

A baseline survey that was conducted in the year 1999 and the report analyzed revealed some concerns regarding teaching and learning of sciences–The teacher had the knowledge, determining what the learners should learn and how to learn, the teacher was the 'main actor' and students were passive recipients of teaching activity, lecture method (chalk and talk, talk and talk) was often and sometimes the only method of teaching, very few if any experiments or practical were carried out in the science classroom, teachers complained of lack of resources and did not use or improvise what was available and the general inability to carry out experiments and/or demonstrations successfully and over-reliance on laboratory technicians to do what teachers are expected to do themselves. Mohanty (2002) observes that students pay regards to those teachers who have proficiency in the subject and competent in their topics. Richard *et al*.(2007) found that students learning of science depend on teachers having adequate knowledge of it. They advise that teachers need sustained professional development in training and while in service. Alonzo (2002) also admits that teachers with more content knowledge are more likely to teach in ways that help students construct knowledge. Such teachers pose more questions and are more likely to have students consider alternative explanation or propose more investigation. Continuous study can improve teachers' mastery in the subject matter. During the four cycles of the SMASSE INSET, teachers have had an opportunity to discuss topics in which both teachers and students encountered difficulties. These topics include pressure, waves, electromagnetic, induction, refraction, thin lenses, photoelectric effect, radioactivity, electronics and quantity of heat. During the session the teachers exchange ideas and come up with innovative activities that which they can engage their learners in. SMASSE also advocates for team-teaching when teachers are continuously consulting each other as they teach and encourage them to try out problems and experiments before assigning them to students.

Assessments in form of assignments, tests and exams, according to SMASSE (2005) act as a pointer of whether concepts learnt are understood. They provide students with a focus since they highlight their learning gaps and areas that they can develop on. Although many schools have a policy on the frequency of tests and quizzes or assignments or homework, this is usually left to the individual teachers. This sometimes leads to assignments being given at the end of a topic or as rare as once a month. The SMASSE programme puts a lot of emphasis on the need to streamline assessment so that teachers can get the desired feedback as early as possible so that necessary action can be taken.

The analyzed results of the survey established numerous shortcomings that affected science and mathematics education. These shortcomings were categorized widely as those within the scope of SMASSE and those beyond the scope of SMASSE. The shortcomings beyond the scope of SMASSE, were those affecting schools such as finance, staffing, indiscipline and drug abuse, those affecting students such as food, family challenges and entry behavior and those affecting teachers such as unfriendly working environment, prolonged stay in job groups and heavy workload leading to overloaded syllabi and timetables. The shortcomings within the scope of SMASSE included: Poor attitude (which included both teachers and students) towards mathematics and science; Inappropriate teaching skills or methodology; Poor content mastery by the teachers; Inadequate assignments given to students; Teachers lacked or had no time for interaction and change of ideas; Professional guidance by subject quality assurance and standards officers were lacking or irregular; and scanty or lack of information about schools. In order to address these SMASSE shortcomings, an INSET curriculum was then to be developed aimed at improving teachers' competence which would focus on the following main areas: Attitude, Pedagogy/teaching methodology; Mastery of content; Developing teaching/learning materials; and Administration and management. In general, the analysis of the baseline report mainly revealed that teachers used inappropriate teaching methods and approaches. Most teaching was teacher-centered and ignored the process and the content. The teaching did not consider the most important person in the learning process- the learner and was mainly knowledge based 'chalk and talk' with little or no active learner involvement

(SMASSE, 1999). The SMASSE report of 1999 also noted that teachers' negative attitudes affected performance and enrolment. The first SMASSE INSET cycle was organized with intention of addressing the issue of teachers' attitudes towards teaching of science, towards their students and towards their teaching environment. Through discussions, teachers were helped to reflect on their attitudes and also figure-out strategies to change those that were unfavorable. It is therefore important in this study to find out the effect of the programme on the attitude.

According to CEMASTEA (2008), the students were made to accumulate a great deal of unrelated facts, skills, formulae, laws and procedures without any attempt to relate them to their previous knowledge and experience. Activity and assignment were found to be few and inadequate thereby denying students the opportunity to engage in Physics. Whatever activities occurred, students were not given the opportunity to reinforce and apply the concepts learnt during the lesson through practice and consolidation. Students therefore became passive recipients of knowledge with very little or no active involvement and participation. Not enough effort was put into raising the learners' interests or curiosity in learning sciences. Full-scale experiments with conventional equipment and apparatus were the norm whenever the experiments were done. However, it was not unusual that these experiments were ignored altogether where the equipment and apparatus were not available.

Researchers agree that learning needs to be done through inquiry-based approaches so that learners can play a more active part in learning. Abusharbain (2002) advises teachers to concentrate on learning ideas from learners, abilities in science processing instead of traditional memorized facts. She claims that teachers must recognize and pursue new responsibilities such as reaching all learners, transferring accountability to learners, tracking interactions between groups, offering alternative assessments and offering suitable instruments for studying. Science teaching should engage students actively and Physics teachers should design active learning environments since the activities and content that the teacher chooses affects the knowledge, abilities, understanding and attitudes that students develop. 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, counselor, 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. Collins and O'Brien (2003) and Akinibolola (2009) observed 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. Brenda (2006) states that student-centered learning is about assisting learners explore their own learning styles, understanding their motivation, and acquiring useful lifelong learning abilities.

Lea *et al*.(2003) give student-centered learning principles as follows: dependence on active leaning rather than passive learning; emphasis on deep learning and comprehension; increased student responsibility and accountability; increased learner autonomy; interdependence between teacher and learner; reflective teaching and learning strategy on the part of teachers and learners. Student-centered learning according to SMASSE (2005), promotes critical thinking skills such as analysis, synthesis and evaluation. Students-centered learning describes learning that is active, engaging, one that arouses curiosity and is concerned with the whole process of learning. To put this approach into practice Brenda (2006) offers advice on the need for teachers to assist learners set achievable objectives; encourages learners to evaluate themselves and their classmates; helps them to work cooperatively in teams and to guarantee that they understand how to use all accessible teaching resources. In practicing student-centered learning SMASSE (2001) reiterates that attitude of both the teacher and students are important. To change students' attitudes, the role of the teacher is important: the teacher sets up an environment in which students can ask questions freely.

Realization of student-centered teaching/learning requires that teachers are equipped with skills that will help them select the most suitable activities that will engage learners meaningfully. It is with the realization of this that the SMASSE project advocated for the ASEI movement. The ASEI movement is one of the most important tools of upgrading and revolutionizing the teaching methods. It considers the quality of classroom activities as critical to achieving effective teaching and learning. ASEI movement advocates for teaching and learning that is:Activity-focused-teaching should involve activities aimed at helping students arrive at the learning outcome. Activities which are carefully selected when formulating the kind of instructional techniques and procedures best suited for achieving the objectives of a particular lesson. These activities according to SMASSE (2004) can be hands-on (manipulation), minds-on (intellectual, thinking, and reasoning), mouths-on (discussion) and hearts-on (stirs up the learners' interests/feelings about the subject). KNEC reports of 2006, 2007 and 2009 emphasizes that Physics cannot be adequately taught without letting students participate.

Student-centered – 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.

Experiment-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.

Improvisation – use of locally available materials to improvise if there is a shortage of conventional resources. Improvisation includes the use of standard non-conventional materials. It may also involve using materials in the setting to increase the interest and curiosity of the students as well as helping the learners connect the ideas learned to the event in daily life. SMASSE (2004) shows with improvisation that it is possible to organize countless meaningful and centered operations for the students. Improvisation generates the teacher's consciousness of the infinite possibilities in searching for and using resources locally accessible.

Effective practice of ASEI calls for proper *Planning, Doing* (carry-out the planed activity), *Seeing* (evaluating the outcome of activity) followed by *Improvement*; hence the acronym PDSI. During planning, teachers are encouraged to take time to reflect on the most appropriate activities that will enhance effective learning. The teacher should arrange for the learners to collaborate with others in pairs or small groups as they work on activities and assignments. Through participation in such discussions, the learner constructs and communicates content related understanding. In the process, the learner recognizes naive ideas or misconceptions he/she has which he/she replaces with valid ones.

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. Any mistakes that may arise in the course of teaching and learning should be taken as constructive part of the teaching and learning process and need not be a source of embarrassment. Results obtained from evaluation should be used for improvement of subsequent lessons. The PDSI approach depicts a continuous activity and it ensures the teachers' skills improve, confidence increases and the instructional programme is enriched.

The second cycle of SMASSE training was on theme of "Hands-on Activities". This training of cycle two focused only on three pedagogical areas, which were resource utilization, use of practical work in teaching and learning of mathematics and sciences and ASEI Instructional design. Pedagogical topical issues in cycle one and in cycle two were contextualized in additional subject matter content areas which analysis had shown a problematic to teachers and learners. In the third year of training, the theme was on "Actualizing of the lessons" based on ASEI–PDSI teaching approach. Up until now, the training had been using peer teaching to handle the desired pedagogical skills. Training in this third cycle made the teachers who were the trainees go into actual classrooms with students available where teaching was done, with collegial support and evaluation from colleagues. The actualization was strengthened by training on how to use communication skills for effective classroom interaction and also how to assess and evaluate teaching and learning process. More subject content matter among those areas that gave challenges to teachers and learners was covered. In the fourth cycle, the theme was "Impact transfer". It was done together with review of some of the topics on pedagogical issues covered in cycle one, two and three, while stressing on how to impact on the learners. Actualization was then carried out again besides covering more of the content matter that had been identified as challenging to teachers and learners

After the initial four cycles, there was a repeat of the cycles now targeting those teachers who may have joined the teaching service in the course of the INSETs and missed some cycles. Later other trainings are mounted based on needs assessment done periodically to help identify needy pedagogical areas and target groups. This study looked at the influence of teaching approaches of SMASSE programme used by the teachers to create interest in the learners and hence raising enrolment in Physics.

2.3.7 The Effect of Practical on Physics Achievement in Kenya

Practical work is any teaching and learning activity which involves students in observing or manipulating real objects and materials Millar (2004). Aduda (2010) found that the current science syllabus was intended to promote creativity and improve achievement. Aduda further notes that most schools' systems are driven by the single desire to pass exams and little attention is paid to creativity and practical activities and students are taught to memorize concepts. Some of the subjects are taught in an abstract manner instead of engaging the students in practical activities. He also pointed out that most teachers resort to buying test papers instead of preparing them on their own leading to poor assessment in schools that eventually lead to inadequate preparation of students in national examinations. This poor teaching approach has been seen to be a major contributor to poor performance in secondary school science. Students' attitude towards science also contributes to dismal performance.

2.4 Physics Achievement and Gender in Kenya

Akubuiroand Joshua (2004) in their study found out that when an individual has an interest or positive feeling towards any object, he/she behaves favorably towards that object. MutieandNdambuki (2007) observed that Social problems will also hinder academic achievement. Teachers will dislike the students because of poor performance, students' fear of failure to meet the expectations of the parent and not getting the homework done in Physics subjects. SMASSE programme therefore focuses on practical activities at every lesson (SMASSE, 2007) The national education system has been characterized by gender disparities at the national level and between the various regions in favor of males. Between 1999 and 2004 north eastern and coast provinces had gender disparities of over 10 percent, while central province had a gender disparity of only 2 percent. The widest gender gap exists at the higher education levels, despite the enrolment of females increasing by 48 percent between 1990 and 2000, in comparison to 27 percent for males. In 2004, female students made up of only 36 percent of those enrolled (MOEST, 2007). Gender disparities in achievement in national examinations are also evident. In Kenya Certificate of Primary Education boys often outperform girls in all papers except English and Kiswahili compositions (MOEST, 2007). In the Kenya Certificate 16 of Secondary Education, boys tend to perform better in key subjects such as English, Mathematics, Biology, Physics and Chemistry. These disparities need to be addressed in order to achieve social equality and empower women, as there are obvious benefits that accrue from investing in educating women. Performance and enrolment in physics is caused by among other factors, being unable to have well-developed manipulating skills good enough to handle practical examinations. Thomas(1990) when researching for Girls In Science and Technology (GIST), found that boys persistently intimidated girls in science laboratory and denied them access to equipment as a result, girls "loose out" in the use of apparatus and materials and hesitate to take risks that may seem dangerous with apparatus (Twoli, 1986). In analyzing performance in the KCPE and KCSE examination over a five-year period, Makau (1993) found that in the two examinations, the female performance was significantly poorer than that of male in humanities as well as science and mathematics. These findings raise questions if theyare there in-built gender stereotypes in curriculum development and implementations which females find unattractive? In the last two decades the narrowing of gender differences in achievements in science and languages in American schools has coincided with the growth of the movement towards equal opportunities among the two sexes. The movements strive to create equality and social responsive actions on gender issues (Sadker&Sadker, 1991). Most research findings indicate that differences in achievement between boys and girls in science begins showing at secondary level especially at a defined age (Twoli, 1986).At primary level, most of science taught is much environment or general science hence does not bring in the demand for Higher Order Thinking Skills (HOTS). Male verses female disparity in science achievements begins to surface at the upper primary school level and increases in 17 secondary school, and several factors curtails female participation in tertiary science and technology courses (Oburu,1991). This begs the question. To what extent is this assertion justified? Does the learning experience of students within the secondary school not make a difference to their achievement at that level? In addition, this study implies that when choosing pedagogy, gender often matters. Pedagogy that works for one student may not work for another and traditional physics pedagogy has historically catered to the male majority.

Pedagogy and curriculum further have the ability to reproduce the participants of a discipline by defining learning and knowledge that favor a particular group. In other words, physics learning and knowledge cannot be separated from the history, organization, composition, and the activities of the community itself (Nespor,1994). However, this makes changing the physics curriculum, especially at the school level where we enter the realm of the physicist, increasingly complex. The study critically analyzed the role of gender in the achievement of girls in physics. The disparities in the achievement of physics in secondary schools and the impact of SMASSE on the overall performance of the subject will be analyzed in the study.The achievement of Boys and girls vary significantly in Physics in various class levels in our schools. Boys achieve higher grades in tests and are more interested in learning Physics than girls. With regard to social and linguistic behavior, it's claimed that boys and girls hold different notions of what it means to understand Physics. Briefly, girls seem to think that they understand a concept only if they can put it into a broader world view. Boys appear to view Physics as valuable in itself and are pleased if there is internal coherence within the Physics concepts learned (Mondoh, 2003).

A good supply of well qualified and enthusiastic Physics teachers is vital, because girls, who often lack familiarity with the situations and activities that are common in Physics, require more support to negotiate meaning and are therefore more sensitive to poor teaching than boys (Changeiywo, 2001). The Physics curriculum must develop students' understanding of how the Physics they are learning relates to them, impacts on the modern world and opens up a range of professional and technical careers. The whole assessment process must not introduce barriers to the participation of girls in Physics. It is easier to shape girls' interest, behavior, attitude and curiosity towards science at an early age and sustain the same to adult hood (Mwangi *et al*., 2001).

Women and girls, who account for over 51 percent of Kenya's population, are significantly underrepresented in the scientific and technological fields, and are unable to contribute to economic development to an extent proportional to their numbers (Fennema and Sherman, 1978). The knowledge about gender perceptions in Physics education made it easier for schools and educators in Kenya and Konoinin particular to understand why boys and girls perform differently in Physics. This could also help them understand why boys achieve higher grades in tests and are interested in learning Physics than girls and this would help them develop a Physics curriculum that must develop students' understanding of how the Physics they are learning relates to them. This is an in-service education for a teacher that is conducted in the absence of particular curricular changes (SMASSE, 2004). This is a continuous update of skills and abilities by the teachers. This helps teachers update themselves to effectively play their roles in a dynamic education system.

2.5 Secondary School Teacher's In-Service Professional Development Programme (TIPDP)

This In-service Education and Training INSET provide a potential benefit to teachers' professional growth. Teachers' In-Service Professional Development Programme (TIPDP) provides teachers with knowledge and skills to effectively teach science using the current curricular content. The degree of success for this INSET is judged by the competencies in the teachers' improvement of classroom practices but not in terms of its contribution to some overall instructional direction established for the schools (Mulumbe,2017). Collete and Chiapetta (1989) pointed out that for teachers to be effective in promoting scientific literacy, they must be well prepared in their science subjects. In addition, science teachers must have firm understanding of the nature of science and be updated with the current technological advances affecting our society every day. To ensure that teachers are constantly updated, focus should be directed to the change of approaches, methodologies, in-service training and conferences at all levels (Ng'ang'a, 1999).

2.6 SMASSE Approach and Students' Achievement

Klug (2016) noted that school leaders have direct and indirect impact on the level of achievement of the students. The same study also noted that although personal factors, differences in ability levels and personalities of every individual student usually fall outside the school leadership domain of influence, situational and motivational factors are to some degree within a school leaders' power to control (Kahare, 2011). The study put forward a measurement-based approach for analyzing the effectiveness of school leaders and provides a convenient model for understanding the schools' influence on students' achievement.Athman and Monroe (2004) stated that an increase in student engagement by leaders can in turn improve academic achievement.Barchok (2006) found that all students irrespective of their class level, school type, or amount of school support received from significant others have the potential of developing favorable achievement towards science achievement. Kuria in his study of the influence of SMASSE on learning and teaching of Physics among Naivasha sub-county secondary school students found that both were impacted positively by the project (Kuria, 2016).

Teachers have been teaching using a 3-part format lesson plans which consists of introduction, the body and the summary or conclusion. The introduction is where the teacher introduces the new concept and tries to connect with previously learned concepts. The body of the lesson plan is where the teacher expounds on the concept fully followed by the summary of the lesson topic as the conclusion of the lesson. The SMASSE lesson plan consists of an introduction part just like any lesson but the body of lesson has an activity to be done by the students through Activity Student-centered, Experiments and Improvisation (ASEI) and Plan, Do, See and Improve (PDSI) for the teacher. The teacher therefore summarizes the lesson as the conclusion. The difference between the two teaching approaches is the activities in a lesson and the use of handouts. The study therefore had set out to investigate the impact of the approach on achievement by students in Konoin sub-county before and after exposure of the SMASSE approach.

2.7 Theoretical Framework of the Study

This study was based on Keller's ARCS model of achievement and motivation design. Among the proponents of this theory were Alekyan and Kishore (2018) and it advocates states four steps for promoting and sustaining the learning process, these are: Attention, Relevance, Confidence and Satisfaction (ARCS) model. The theory illustrates two ways of gaining attention of the learners. These are: perceptual arousal and inquiry arousal. The theory also gives methods of getting the attention of learners. This theory was used by Mutai (2018) in his study of the motivation to learn Biology and SMASSE teaching approach and found a positive correlation between motivation and SMASSE teaching approach. Kinzi (2017) also used this theory to relate selected personality factors and academic achievement in science. The learner must be actively involved by use of hands-on methods, this is to better reinforce materials and account for individual differences in learning and there must be humor in learning. Hands-on activities form the core reasons for improvisation and performance of many small-scale experiments (SMASSE, 2004)

The second aspect of Keller's theory is relevance. He stated that in order to establish relevance of learning, learners must be motivated by use of concrete language and examples which learners are familiar with. The SMASSE lesson plans contained the section of prerequisite knowledge. Here the learners were expected to have some prior information about the topic to be introduced. The learners then used the existing knowledge to build up the present knowledge and skills. The third aspect of Keller's design is confidence which states that students must be allowed to understand their likelihood of success in the learning process. Learners must be aware of performance requirements and evaluation criteria. The fourth aspect of Keller's model is satisfaction (Keller, 1983) The learners must feel that the skill is useful by providing opportunities to use newly acquired skills in real setting.

Schein (2015) stated the Lewin's Three Stage Theory of Change commonly referred to as unfreezes, change (transition) and freeze (refreeze). The more we feel that change is necessary the more urgent we are motivated to change. Unfreezing and getting motivated to change is all about weighing up the advantages and disadvantages and deciding if the advantages outnumber the disadvantages before you take any action. Students become motivated to change when the teaching approaches are relevant to their present and future needs. This theory relates with the present study in that change is required in the teaching approach that enhances achievement in Physics.

2.7.1 Conceptual Framework of the Study

The conceptual framework of the study was based on Keller's Attention, Relevance, Confidence and Satisfaction (ARCS) model of motivation design for the dependent variables. For this study, the model was adopted since the variables studied were related to each other. The factors within the SMASSE approaches are; improvisation of laboratory equipment and materials, performance of many small-scale experiments, use of worksheets in practical and peer teaching as opposed to the regular teaching methods.

In conceptualizing the study, the researcher attempted to point out how the independent (SMASSE teaching approach) interacts with the dependent variable. The study hypothesized that for high educational achievement the SMASSE teaching approach has to be adopted by teachers. The SMASSE approach is hypothesized to be intervened by the following variables: the school factors, teacher factors, student factors and the conventional teaching approach. The impact of intervening variables especially those related to students was contributed by the sampling procedure which ensured that schools which are similarly endowed in resources, age and size were sampled. For the teacher factors it was controlled by sampling teachers who had undergone all the INSET training programmes from the selected schools. The researcher ensured that those schools sampled were similar in size and other facilities. This was done to ensure that these variables did not interfere with the dependent variables. The independent variable was hypothesized to impact positively the achievement of the students in the KCSE physics. In the model below, the SMASSE approach was generally hypothesized to influence students' achievements as shown in figure1.

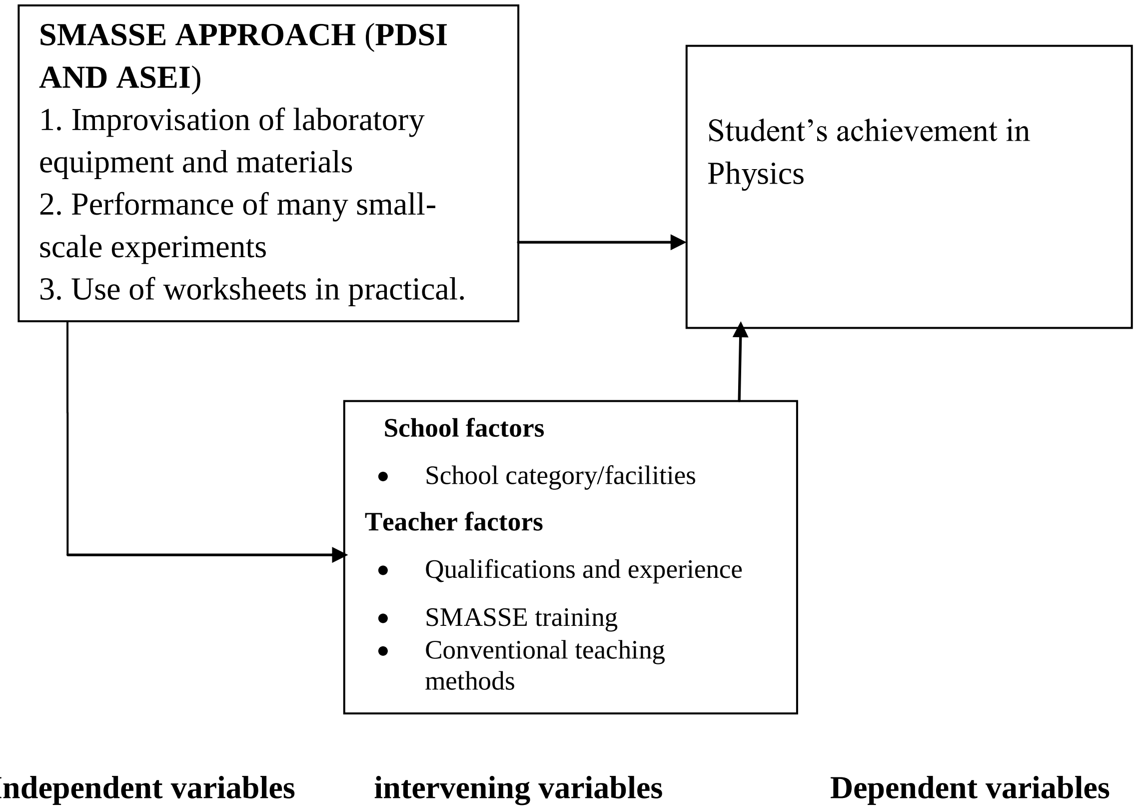

Figure 1. Diagrammatic representation of the variables and their interaction in the study

Figure 1 show the interaction of the variables in the study, the independent variable was SMASSE Approach of teaching physicsand this variable was hypothesized to impact students' achievement scores in KCSE Physics examinations. The extraneous variables include school category/facilities, teacher qualifications and experience, and SMASSE training. To ensure that influence by extraneous variables were minimized schools of similar size, history and facilities were selected in each category i.e., sub-county, county and extra-county schools

2.7.2 Research Gap

The study tried to explore the impact of SMASSE teaching approach on students' achievement in physics in Konoin Sub-County by comparing achievement in the four-year period (2000-2003) before the introduction of SMASSE with that of the period (2012-2015) when all the SMASSE cycles had been completed and implemented. The four SMASSE cycles were completed in 2008. The first students who got fully exposed to this programme from form one to form four did their KCSE in 2012.Therefore the first, second, third and four groups did their KCSE in 2012, 2013, 2014 and 2015respectively.

This area has not been studied and therefore necessary so as to enable students, teachers and education stakeholders to make informed decision on the future of the programme.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the research design, location of the study, target population, sampling procedures and sample size. It also presents the research instruments, data collection procedure, data analysis and presentation of the data analysis. .

3.2 Research Design

The study used *expost facto* research design. This design is used as an alternative to experimental design because sometimes the latter is expensive, non-feasible and difficult to conduct. While in experimental design the independent variables are manipulated, in causal-comparative design the predictors are not. *Ex post facto* studies gather data retrospectively (e.g. given the obvious effects of smoking, the researcher will look in the past to find the potential cause), the design gathers data from pre-formed groups and the independent variable is not manipulated in the experiment. For this, the researcher looked for a population on which the data were available, in an already existing appropriate group. Experimental research designs are meant to compare groups in a more natural way while an *ex post facto* research design attempts to identify causes or consequences of differences in a non-experimental setting. These differences already exist, and their impact on the outcome is identified by comparing groups. The *ex post facto* design can have different foci: (i) exploration of effects, (ii) exploration of causes, and (iii) exploration of consequence. *Ex post facto* design refers to studies that use secondary data (i.e., data that has already been collected) and the data are obtained from pre-formed groups, therefore the independent variable is not manipulated as it is done in experimental studies (Laura &O'dwyer, 2013).This type of design has some similarities with the correlation design. Both designs are suitable when conducting a research which is either impossible or unethical. Both try to establish relationships among variables, but the main difference is that *ex post facto* compares two or more groups after one of the groups has been exposed to some treatment and/or condition (e.g., new training or intervention) and the design will be used to compare the grades and in two or more groups. In *ex post facto*, we compare groups, while in correlation design we attempt to explain one variable by the other (Brewer & Kuhn, 2010)

The expost facto research design often uses the document analysis tool to review and evaluate documents. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge(Corbin & Strauss, 2008).In this particular study it looked at the Physics achievement in KCSE before the inception of SMASSE (2000-2003) and after (2012-2015).For this study it was hypothesized that any improvement in Physics achievement would be due to the students' exposure to SMASSE approach after its inception in 2004. Document analysis was used in combination with cross-section survey research method as a means of triangulation of the combination of methodologies in the study of the same phenomenon' (Denzin, 1970). By triangulating data, the researcher attempts to provide 'a confluence of evidence that breeds credibility' (Eisner,1991). By examining information collected through different methods, the researcher can corroborate findings across data sets and thus reduce the impact of potential biases that can exist in a single study. In this study the researcher used the teacher's questionnaire to collect data from teachers currently in service. According to Patton (1990), triangulation helps the researcher guard against the accusation that a study's findings are simply an artifact of a single method, a single source, or a single investigator's bias.

3.3 Study Location

This study was carried out in Konoin a sub-county in Bomet County in the former Rift Valley province. It is bordered byBureti, Bomet Central, Bomet East and Sotik Sub-counties. The sub-county was selected for the study due to the fact that the achievement in physics at KCSE level was low as compared to the other sub-counties in Bomet County (Education Insight May-June 2017, Issue 12). Furthermore, there was no SMASSE INSET centre within the sub-county where the teachers can access the SMASSE resource Centre.

3.4 Target Population and Accessible population

The target population for the study was the secondary school students who did Physics in Konoin Sub-County before and after SMASSE was introduced. The accessible population was the 5017 Form four students who did KCSE before the inception of SMASSE (2000-2003) and the 5204 students that did their KCSE after SMASSE inception (2012-2015) in Konoin Sub-County. SMASSE was introduced in the whole country which was undertaken in four INSET Cycles in the years from 2004 to 2008.SMASSE training is an annual event done in every county and is still ongoing. The reason we chose four years before and four years after inception of SMASSE was to give us an understanding of the impact of the programme on students' physics achievement. The four SMASSE cycles were completed in 2008. The first students who got fully exposed to this programme from form one to form four did their KCSE in 2012.Therefore the first, second, third and four groups did their KCSE in 2012, 2013, 2014 and 2015 respectively. The INSET cycles took four years to complete

3.5 Sampling Procedures and Sample Size

The sample consists of all the physics students before the introduction of SMASSE (2000-2003) and after (2008-2012) in Konoin sub-county which was 5017 and 5204 respectively. The study used stratified, systematic and proportionate sampling techniques to select the participating schools and physics students from the different categories of schools in the sub-county. There were 55 established secondary schools in Konoin Sub-County within 3 divisions. These divisions are Konoin with 21 schools, Kimulot with 17 schools and Cheptalal with 17 schools. The sampling procedure ensured that every division was to be represented by a proportionate number of schools. The schools were further categorized as extra-county, county and sub-county. To ensure that the characteristic of the sample reflect the characteristics of the population, the sampling ensured students were picked from each category of schools in the sub-county. Nassiuma (2000) recommend the formula shown below for determining sample size for a finite population. This formula was used to obtain the number of the sampled schools.

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where: -

n=required number of schools

N=the given number of schools

C= Coefficient of variation in this case 20%=0.2

e=Margin error in this case 0.05

$$n = \frac{56 \times (0.2)^2}{(0.2)^2 + (56-1)(0.05)^2} = 12$$

From the above expression 12 schools were selected to form the sample size.

The sub-county has three categories of schools' extra-county, county and sub-county schools. There were 4 extra county schools, 4 county schools and 47 sub-county mixed schools. The Stratum of schools in the sub-county is shown in Table 5.

Table 5:The stratum of schools in Konoin sub-county

Division	Extra County School		County Schools		Sub-County Schools
	Boys	Girls	Boys	Girls	Mixed
Konoin	1	1	0	0	19
Kimulot	1	0	0	1	15
Cheptalal	0	1	2	1	13
Total	2	2	2	2	47

The numbers of schools sampled were 12 as shown in Table 6. There were two extra county boys and two girls schools in the sub-county both were selected to participate in the study. There were also two county boys and two girls schools in the sub-County, purposive sampling was used to select the four extra and the four county schools for the study. Another four were four sub-county mixed schools which had KCSE Physics candidates by the year 2000 were selected using proportionate and systematic sample to select a total of 12 schools for the study.

Table 6:Sample Size per school Type.

Category of school	School type	Number of schools
Exra-County	Boys	2
Exra-County	Girls	2
County	Boys	2
County	Girls	2
Sub-County	Mixed	4
Total		12

All the physics students' results in the sampled schools were analyzed and the physics teachers in the sampled schools who had undergone SMASSE INSET training were handed the questionnaire to fill. The total population of physics teachers in the sub-county was 107; only teachers who had undergone the four SMASSE cycles from the sampled schools filled the TQSAP.UsingNassiuma (2000) formula shown below to determine the sample size for a finite population. The formula was used to obtain the number of physics teachers from the sampled schools.

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where: -

n=required number of teachers

N=the given number of teachers

C= Coefficient of variation in this case 20%=0.2

e=Margin error in this case 0.05

$$n = \frac{107 \times (0.2)^2}{(0.2)^2 + (107-1)(0.05)^2} = 14$$

From the above expression at least 14 teachers were sufficient to form the sample size.

3.6 Instrumentation

The study used document analysis tool to extract the physics results from KCSE score sheets from the sampled schools for the two periods. The Teachers' Questionnaire on Students' Achievement in Physics (TQSAP) was also used to collect data on the teachers' views on SMASSE.

i. Document Analysis Tool

The document analysis tool was the instrument which had the period as the heading under study with five columns. These were the type of school, gender of the students, number of students, the mean per gender, the overall mean of the school and the fifth column had the remarks. The document analysis tool enabled the researcher to get specific information from the school records for the two periods under study. The student's physics KCSE results for the period (2000-2003) before the INSET as shown by Appendix A, Part I and after the INSET (2012-2015) as shown in Appendix A, Part II. This instrument was used to collect the data for each period and separate the data per gender for further analysis.

ii. Teachers' Questionnaire on Students' Achievement in Physics (TQSAP)

The researcher used one questionnaire; the Teachers' Questionnaire on Students' Achievement in Physics (TQSAP). It consisted of 4 questions that covered data on teacher's age, educational level, length of service and 8 questions on teaching methods in terms of preference, information on Teachers' In-service Professional Development Programme (TIPDP) and teachers' opinion on SMASSE approach in teaching of Physics as per attached appendix B.

3.6.1 Pilot study

Piloting involved the administration of research instruments to subjects that were similar in all aspects, to the subjects that were eventually studied. The pilot subjects were within the similar environment as the actual study subjects. Roll (1986) notes that a pilot study is necessary because a researcher embarking on classroom research will find it valuable to spend some time in the classroom using one or more established systems and looking at the kind of issues which will arise in turning their own research questions into a set of criteria and definition for use in the classroom. Peter (1994) states that even the most carefully constructed instrument cannot guarantee a hundred percent data reliability. The Pilot study was meant to assess reliability by checking for consistency of the instrument. This helped in ensuring that the data which was expected to be produced was in line with the study objectives. Research instruments may be pre-tested on a small sample of respondents (Mulusa,1990).The correlation coefficient between the scores of the responses from the questionnaire administered on the two different occasions was used to calculate the reliability coefficient using the Pearson product moment correlation coefficient formula.The TQSAP correlation coefficient was found to be 0.7231.According to Kerlinger (1973) and Koul (1984), a positive correlation coefficient r of 0.5 and above is a strong on and hence the research instrument was deemed reliable. The research instruments were then adjusted according to how the subjects responded in relation to the study objectives. The instruments that were used in this study were piloted in four schools in the neighboring Buret Sub-County, one school per Division, which were not involved in the final study. Piloting assisted in determining ambiguities in the items in the questionnaire and also determined whether the instrument would elicit the type of data anticipated as well as to lead to a meaningful analysis of the final data to be collected. Piloting therefore is carried out to enable necessary adjustments to be done on the parts of the questionnaire that appeared ambiguous to the respondents. Ambiguous questions was revisited and adjusted accordingly. The researcher used the results of the pilot test to adjust the questionnaire items and make them appropriate and understandable, thereby increasing their validity.

3.6.2 Validity of the Research Instruments.

Validity is defined as the ability of the research instrument to measure what it intended to measure (Welman& Kruger,2001). Validity is to find out whether the instrument meets the following validity tests; the content, construct and criterion validity. Content validity is used to establish the extent the instrument covers the various objectives that are required.

The criterion validity measures whether the instrument is able to establish a rule or a standard in which a judgment is based (Kasomo,2006). The findings from Teachers' Questionnaire on Students' Achievement in Physics (TQSAP) and the data analysis tool instrument provided accurate information in which future decisions could be made concerning SMASSE approach in relation to its impact on achievement in Physics. To ensure that the two research tools measure what they intended to measure, they were scrutinized by the supervisors and colleagues from the Department of Curriculum Instruction and Educational Management of Egerton University. The feedback was used to make the necessary adjustments on the tools.

3.6.3 Reliability of the Research Instruments.

Frankel and Wallen (2009) defines reliability as the consistency of the measurement or the degree to which an instrument measures the same way each time it is used under the same conditions with the same subjects. The Teachers' Questionnaire on Students' Achievement in Physics (TQSAP) was piloted in four schools at Buret Sub-County. The schools used in the pilot were not involved in the actual study and the number of schools for the pilot study was arrived at after consultations with my supervisors. The collected information was analyzed to come up with numerical data and codes that facilitated determination of the reliability of the instrument. The collected information was subjected to the internal consistency reliability test. Key (2014) stated that internal consistency method provides a unique estimate of reliability for the given test administration. The study used Cronbach's alpha to estimate reliability co-efficient of the teacher's questionnaire (TQSAP) which was found to be 0.7231. According to Fraenkel and Wallen (2000) the minimum coefficient of 0.700 and above is considered reliable.

3.7 Data Collection Procedures

The permission to carry out this study was sought from the National Commission for Science, Technology and Innovation (NACOSTI) through Graduate School of Egerton University after getting a written consent from Egerton research ethics committee. A copy of the research proposal was submitted to both NACOSTI and the University research ethics committee before the permission was granted. After obtaining the permission to carry out the research, the researcher visited the County commissioner and the Director of Education of Bomet to get permission and informed the heads of schools. The researcher then visited the schools to collect the data from school records using the document analysis tool and the teachers' questionnaire.

3.9 Data Analysis

Data collected using the document analysis tool was analyzed in order to obtain the information required in the study. Data analysis was based on the objectives and the hypotheses of the study. These data were analyzed using the Statistical Package for Social Sciences (SPSS) version 28.0. Descriptive statistics like the means and standard deviations were used to describe scores on items on the collection tool. The t-test and ANOVA were used to analyze scores on achievement in Physics at a significance alpha level of 0.05 which determined whether to accept or reject the null hypotheses of the study. The hypotheses were tested at 95% level of significance and the data presented in form of tables. The t-test in this study was used to test if there was any significant difference in the means before and after exposure to SMASSE while the ANOVA was to test if there was any significant difference in the achievement between the boys and girls before and after exposure to SMASSE in the sub-county.

Table 7: Summary of Variables and Statistical Tests of the Study

Hypothesis	**Independent Variable**	**Dependent variable**	**Analysis**
Ho1 There is no significant difference in students' Achievement in Physics before (2000-03) and after (2012-15) exposure to SMASSE	SMASSE approach	Mean score/ Achievement	t-test,
Ho2 There is no significant difference in students' Achievement in Physics before (2000-2003) and after (2012-2015) exposure to SMASSE in terms of gender	SMASSE approach	Mean score/ Achievement	ANOVA

3.10 Ethical Considerations

The research was based on established ethical consideration that governs research. Frankel and Wallen (2000) recommend that a researcher should strive to control bias, prejudice and conflict of interest when conducting research. The main ethical issue in this study was confidentiality of the school and education office records and respondents. Confidentiality was maintained at all times and all respondents were asked to participate voluntarily and without disclosing their identity by not writing their names on the questionnaire. This helped them to be honest and open while giving out information because they knew that nobody would know who gave out certain responses. The information collected was under the full responsibility of the researcher as an individual. This ensured that the information given was safely kept and used only for the purposes of the study. The collected data was stored on paper for short-term and for purposes of long-term use, it was stored using electronic storage. All these were aimed at guaranteeing confidentiality of data collected. The researcher further assigned numbers to the participants' responses instead of names to protect the participants and since there was no writing of names of schools, codes were used to identify the schools in case of follow up for particular information.

At the same time, the researcher sought the teacher's consent and permission of school principals to ensure that the study did not infringe on their rights. This informed consent was sought by explaining the purpose of the study, guarantee of anonymity, confidentially and identification of the researcher (Creswell & Clark, 2007). The respondents were informed that their giving of information was out of their willingness and that they were free to terminate their participation at any time and were not coerced to give information they felt they should not.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and their discussions. It has three sections; the first part gives summary results of the analysis of the characteristics of the respondents**.** The next two sections are the analyzed results on the impact of SMASSE programme on achievement in physics.

4.2. Results from Piloting

To ensure validity and reliability of the questionnaires developed, a pilot study was carried out on them. Piloting involved the administration of research instruments to subjects that were similar in all aspects, to the subjects that were eventually studied. The pilot subjects were within the same environment as the actual study subjects. The instruments that were used in this study were piloted in four schools in Bureti Sub-County, one school per Division, which were not involved in the final study. The instruments were administered personally by the researcher himself. Piloting assisted in determining ambiguities in the questionnaire items and also determined whether the instrument would elicit the type of data anticipated as well as to lead to a meaningful analysis of the final data to be collected. Piloting was therefore carried out to enable necessary adjustments to be done on the parts of the questionnaires that appeared ambiguous to the respondents. Reliability is a measure of how accurate outcomes or information are produced by a study instrument after repeated testing (Creswell, 2014).The research instruments were then adjusted according to how the pilot subjects responded in relation to the study objectives.

Reliability was established through use of test-retest method. The same instrument was administered to the same group of respondents after a period of two weeks and the responses in the first and second obtained. The questionnaires that were used during the actual study were administered on respondents in four schools in the sub-county that did not participate in the actual study. The responses from this first test were analyzed and kept. After two weeks, the same questionnaires were administered to the same respondents and the responses were analyzed. The items on the questionnaire for the second testing were re-arranged to take care of recall effect by the respondents. Table 8 shows the rate of return of TQSAP from teachers in the pilot study

Table 8: Questionnaire Return Rate of Piloting.

Respondents	Sampled	Returned	Return Rate (%)
Teachers	7	7	100

The pilot study involved seven teachers in four schools and all them filled and returned the questionnaires which were administered by the researcher. The scores of the two tests were then correlated by use of Pearson Product moment to obtain a correlation coefficient that established the extent to which the contents of the instruments are consistent in yielding the same responses every time the instrument is administered. The study obtained correlation coefficients of Alpha $\alpha = 0.7231$ for the Physics teachers' questionnaire. Thus, the study instrument was considered reliable as their reliability coefficients $\alpha > 0.70$ (Creswell *et al.*,2018)

4.3 The Response Rate

The study used a sample of 12 secondary schools drawn from a target of 55 schools and from the sampled schools before and after exposure to SMASSE. The sampled schools provided between 1 and 3 teachers selecting only those who had undergone INSET training. Table 9 shows a summary of the Questionnaire returns rate from the teachers of the sampled schools.

Table 9: Questionnaire Return Rate.

Respondents	Sampled	Returned	Return Rate (%)
Teachers	25	21	84

According to Edward *et al*. (2018) a questionnaire return rate of 84 % and above is absolutely satisfactory, while 60% to 80% return rate is barely acceptable. This questionnaire return rate was therefore acceptable.

4.4 Characteristics of Respondents

This section gives an analysis of Bio-data of the respondents. The first section gives analysis of the characteristics of the teachers who were the respondents. The second part gives an analysis of the students' numbers in each of the category of schools.

4.4.1 Teachers Bio-data

The questionnaire provided space where teachers were to indicate their gender, age, and highest education level. Those teachers who participated in the study were currently teaching in the sampled schools. At least one teacher from the sampled schools filled the questionnaires though others did not provide all the information required. A total of 21 out of 25 teachers filled the questionnaires correctly, translating to 84 percent return rate. The results are shown in Table 10

Table 10: Teachers 'Bio data from the sampled schools

Characteristic n =21	Scale	Frequency	Percentage
Gender	Male	15	71.43
	Female	6	28.57
Age	30 – 40 years	11	52.3
	31 -40 years	7	33.3
	41 -50 years	3	14.3
Highest education level	Diploma	3	14.3
	Degree	16	72.2
	Postgraduate	2	9.5

The results in Table 10 show that 52.5 percent of the sampled teachers were below 40 years. The results also show that 9.5 percent had attained postgraduate degrees. There were more male teachers as compared to females in the sampled schools. Table 11 gives the frequencies in which teachers use the various teaching approaches in teaching the subject during the period of study. The teachers were to indicate the frequency in which they employed a particular approach when teaching Physics.

Table 11: Frequency of use of the various Teaching Approaches

Teaching approach n =21	Very often	Often	Occasionally	Rarely	Never
SMASSE	6.3	50.0	12.5	31.3	-
Didactic	6.3	25.0	-	68.8	-
Heuristic	18.8	12.5	18.8	50.0	
Constructivist	68.8	31.3	-	-	-
Empiricist/	25.0	56.3	12.5	6.3	-
Observation			-		
Expository	31.3	18.8		31.3	18.8

Table 11 shows that 56.3 percent of the respondents often used SMASSE approach and less than half used expository approach in content delivery in the subject. Didactic approach seemed unfamiliar with the teachers as there was no rating on the lower scale. Constructivist approach scored highly though the respondents did not rate it on the lower scale. Empiricist and heuristic approaches were also regularly used per the response by teachers.

The first two teaching approaches are student centered with minimal input from the teacher but they consume a lot of time. The SMASSE approach is a student centered with the teacher acting as a facilitator with lots of improvisation approaches while didactic and expository approaches are dominated by teacher talk with very little student involvement. While the next three teaching approaches were heuristic, inquiry and constructivist these are more hands on or discovery methods. Table 12 shows the frequencies with which teachers use SMASSE teaching approach when teaching physics content. The combinations of the teaching approaches were as follows; combination 1 is SMASSE, lecture, constructivist and expository approaches: combination 2 was lecture, discovery and constructivist: combination 3 was SMASSE, discovery, constructivist, observation, expository.

Table 12: Various combinations of Preferred Teaching Approaches

Combination n=21	Teaching approach	Frequency	Percentage
Combination1	SMASSE	6	38.4
	Lecture	5	23.2
	Constructivist	2	9.5
	Expository	8	38.4
Combination 2	Lecture	4	19.2
	Discovery	6	28.3
	Constructivist	11	53.5
Combination 3	SMASSE	4	18.2
	Discovery	2	9.5
	Constructivist	4	19.0
	Observation	10	47.6
	Expository	1	4.7

From Table 12 combination 3 seems suitable for teaching Physics since SMASSE, constructivist and observation approaches are considered suitable for teaching and learning of Physics in secondary schools as evidenced by Table12, the combinations are over 95 percent student centred approach. The table also shows the combinations of teaching approaches 1 and 2 are not suitable for the teaching and learning of physics because it is dominated by the lecture teaching approach with no observation approach component at all (SMASSE, 2007).

Teachers were required in the questionnaire to indicate how often they are using the SMASSE approach in the teaching of the various topics in the secondary school physics. There are total of 20 topics in form three and four Kenya secondary school Physics syllabus. These topics were chosen because students at this level have chosen physics subject as it is optional in majority of the schools. Teachers were to indicate their responses using the following range of frequencies in the TQSAP and are summarized in Table 13

Table 13: The Frequency of the use of SMASSE Teaching approach in the teaching of Physics

Most often= 5, Often= 4, Uncertain= 3, rarely= 2 and Never= 1.

Topic n= 21	Frequency	SD
Linear motion	3.31	1.25
Refraction I	4.44	0.81
Newton's laws of motion	4.81	0.75
Work, Power, Energy & Machines	4.50	0.63
Waves	3.56	1.03
Current electricity	4.13	0.50
Heating effect of an electric current	3.63	1.09
Electrostatics	3.56	1.03
Quantity of heat	4.06	1.24
Gas laws	3.87	0.96
Thin lenses	3.81	1.22
Circular motion	2.88	0.89
Electromagnetic induction	3.38	1.59
Mains electricity	3.25	1.18
Cathode rays	3.04	1.11
X-rays	3.76	0.45
Photo electric impact	3.82	0.56
Radioactivity	4.02	0.34
Electronics		
SMASSE adoption index	3.31	1.25

Table 13 Shows that the adoption index of SMASSE was 3.31 on the likert scale and the Standard Deviation (SD) of 1.25. The SMASSE recommendations refer to the activities and experiments recommended to be done in the course of teaching the physics topics. The frequencies in the table illustrate its use and ranges from 4.81 which is very often to 2.88 which is uncertain. The table shows teachers often use SMASSE to teach 13 physics topics out of 20 topics in form 3 and 4 which represents 65%. The adoption index of 3.31 reflects a 66.2 percent use of the SMASSE approach in the teaching of Physics by teachers in Konoin sub-county. This shows that teachers in the sub-county are using the SMASSE teaching method to teach Physics and therefore it is one of the preferred approaches in the teaching of the Physics topics in secondary schools in the sub-county.

4.5 SMASSE approach and Students Achievement in KCSE Physics Examinations.

The Data collected for the periods before the introduction of SMASSE in the sub-county (2000-2003) and after (2012- 2015) was analyzed. The aim of collecting the data was to investigate the impact of SMASSE approach on students' achievement four years after it had been fully implemented in the sub-county. The data on student performance was obtained from KNEC mark sheets from the sampled schools.

The overall students' achievement in physics before the introduction of SMASSE (2000-2003) in the sub-county is shown in Table 13. These mean scores were used to asses the overall achievement. The table shows only the schools before the introduction of SMASSE in the sub-county.

Table 14: KCSE Physics results before SMASSE was introduced for the sampled schools (2000-03)

Year	Gender	Entry	Mean Score
2000	Boys	180	5.37
	Girls	59	4.91
2001	Boys	208	4.95
	Girls	70	4.84
2002	Boys	102	5.67
	Girls	85	5.42
2003	Boys	195	4.91
	Girls	114	3.86
Overall mean			Boys = 5.22 Girls = 4.88

Table 14, show the physics results of the four years for the sampled schools before SMASSE programme was introduced. The overall boys and girls mean score for the 12 schools was 5.22 and 4.88 respectively which represents a below average performance in the KCSE examinations. The total sample consisted of 685 boys and 328 girls showing that boys were twice the enrolment of girls.

Table 15 shows the results of the sampled schools after the four SMASSE INSET cycles were completed. The boys and girls mean scores were obtained from the same 12 sampled schools in the sub-county.

Table 15: KCSE Physics result after SMASSE was introduced (2012-2015)

Year	Gender	Entry	Mean Score
2012	Boys	253	5.93
	Girls	96	5.29
2013	Boys	248	5.18
	Girls	103	5.02
2014	Boys	225	5.01
	Girls	81	4.75
2015	Boys	283	4,40
	Girls	101	4.49
			Boys=5.13
Overall			Girls=4.79

Table 15 shows the achievement four years after the SMASSE approach was introduced, the mean grades of students from the schools were 5.13 and 4.76 for boys and girls respectively again this achievement is below average achievement in the sub-county. The total sample of boys were 1009 which is higher the 381 girls showing the disparity in enrolment still persisted.

Table 16 is the descriptive statistics analyzing the data from the two periods, showing the minimum, maximum mean, the range and the standard deviation

Table 16: Descriptive Statistics of results before and after the introduction of SMASSE

	N	Minimum Mean	Maximum Mean	Range	Std. Deviation
2000	239	2.83	8.81	5.705	1.832
2001	278	2.87	8.08	5.464	1.611
2002	187	3.24	6.65	4.490	1.196
2003	309	2.23	7.56	4.462	1.621
2012	349	3.77	7.59	5.235	1.116
2013	261	2.78	7.82	4.879	1.385
2014	306	4.11	7.18	5.544	0.894
2015	384	1.7	7.95	4.599	1.636
Average grade before SMASSE	1013	2.79	7.395	5.092	1.560
Average grade after SMASSE	1390	3.99	7.460	5.064	1.487
Valid N (list wise)	2403				

Table 16 shows the schools under the study before the introduction of SMASSE (2000-2003) and after and its introduction (2012-2015). The list shows the descriptive statistics of the sampled schools. The range between the highest and the lowest means before the introduction of SMASSE was 5.705 in 2000, the least range in the period was 4.462 in the year 2003.The spread of the mean (standard deviation) in the period was 1.560 while the mean for the period (2000-2003) was 5.092. The standard deviation for the period (2012-2015) was 1.487 while the average mean was 5.064. The table shows the entries from the 12 sampled schools which are shows overall mean grades of the schools.

The first objective of the study was to assess the impact of SMASSE on the students' Physics achievement after its introduction (2012-2015) in Konoin sub-county. Table 17 is the paired samples of the schools of the two periods in the study.

Table 17*: Paired Samples Statistics*

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Average after SMASSE	5.0035	1013	1.50971	.37743
	Average before SMASSE	5.1436	1390	1.12401	.28100

The table 17 shows the paired samples of the schools for the two periods. The mean score of the students before SMASSE (2000-2003) was introduced was 5.1436 and the mean score after SMASSE (2012-2015) was introduced was 5.0035. These average mean scores before (2000-2003) and after exposure (2012-15) differ by a 0.1401. The standard deviation shows the spread of the mean before and after the exposure to SMASSE. The standard deviation before and after the exposure to SMASSE was 1.12407 and 1.509 respectively. This shows (the spread of the mean) after exposure to SMASSE (2012-2015) was bigger compared to before the exposure to SMASSE (2000-2003). This could be attributed to the larger number of students taking up the subject in the period 2012-2015 compared to the period 2000-2003.The variance could also be due to the SMASSE teaching approach. The average mean score after exposure to SMASSE was 5.0035 which is lower than the mean before the exposure to SMASSE of 5.1436.This could also be attributed to higher interest by the students for the subject which resulted in a higher enrollment.

Table 18 shows the paired samples of the average mean scores before (2000-2003)and after exposure (2012-2015) to SMASSE.The pair of the average two mean scores was subjected to a t-test to see if the difference between the two means was significant or not and the results are as shown in Table 18.

Table 18*: Paired Samples t-Test comparing the means the two periods*

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Average after SMASSE Average before SMASSE	-.14006	.7580	.1895	-.54398	.26386	-.739	15	.471

Critical values (t = ±2.228, α =0.05), calculated values (t =-0.739, p =0.471)

The critical values were t =2.28 which is significant at 5% while the calculated values are t = 0.739 and p =0.471. The table shows p is greater α or 0.471 > 0.05 which implies the difference in the average means before and after exposure to SMASSE was not significant.

The first objective of the study was to find out if there was an impact of SMASSE on the students' physics achievement after the introduction of the SMASSE programme (2012-2015) by KCSE students in Konoin sub-county.

The first hypothesis of the study stated that there was no statistically significant difference in students' achievement in Physics before the introduction of SMASSE (2000-2003) and after its introduction (2012-2015) in Konoin Sub-County. Since there is no sufficient evidence to show that there is a significant difference in the achievement by physics students before the introduction (2000-2003) of SMASSE and after (2012-2015) it was introduced in KonoinSub-county, therefore the introduction of SMASSE teaching approach in the sub-county did not improve the achievement of the physics students in Konoin Sub- County and so the hypothesis was accepted.

The findings of this study agree with findings of Langat (2009), Ndiku (2011), and Sifuna and Kaime (2007) who established that the SMASSE INSET had not improved student's performance in mathematics in some secondary schools in Kenya. Similarly, Keitany (2014) in his study on the impact of SMASSE INSET on student's performance in Physics, teaching approaches and methodologies and teachers and student's attitude towards Physics found out that despite improvements in the student's attitude and teacher's teaching instructional practices, performance was still poor.Lelei*et al.*(2023)observed that despite the positive changes brought about by SMASSE on the chemistry teachers' classroom practices, chemistry achievement had not improved as expected.

4.6 SMASSE Approach and Students Achievement in KCSE Physics Examinations by Gender.

The second objective was to assess the impact of SMASSE students' achievement in physics in terms of gender before and after its introduction (2012-2015) in Konoin sub-county. The achievement by students in physics in the 12 schools across the two periods has been listed in Table 19 separated into boys and girls in the sub-county.

Table 19*: The Means per year for the sampled schools in terms of gender before and after the introduction of SMASSE*

Year		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
2000	Boys	180	5.5912	1.43428	4.3921	6.7903	4.02	8.06
	Girls	59	4.9861	1.29270	3.9054	6.0668	3.11	7.11
	Total	239	5.2886	1.35554	4.5663	6.0110	3.11	8.06
2001	Boys	208	5.2018	1.61251	3.8537	6.5499	2.78	8.21
	Girls	70	4.8283	1.45308	3.6135	6.0431	2.92	7.42
	Total	278	5.0151	1.49531	4.2183	5.8119	2.78	8.21
2002	Boys	102	5.7554	.96457	4.9490	6.5618	4.78	7.44
	Girls	85	5.3721	.89300	4.6255	6.1187	4.11	7.18
	Total	187	5.5638	.91951	5.0738	6.0537	4.11	7.44
2003	Boys	195	4.9940	2.26466	3.1007	6.8873	1.70	8.80
	Girls	114	4.4199	1.20721	3.4106	5.4291	3.11	7.09
	Total	309	4.7069	1.77802	3.7595	5.6544	1.70	8.80
2012	Boys	253	6.0833	2.04817	4.3709	7.7956	3.22	9.52
	Girls	96	5.2767	1.91405	3.6765	6.8769	2.44	8.11
	Total	349	5.6800	1.95980	4.6357	6.7243	2.44	9.52
2013	Boys	248	5.6654	1.77772	4.1792	7.1517	3.18	8.51
	Girls	81	5.2615	1.73285	3.8128	6.7102	2.55	7.64
	Total	261	5.4635	1.70868	4.5530	6.3740	2.55	8.51
2014	Boys	225	4.6874	1.03362	3.8233	5.5515	3.63	6.24
	Girls	81	4.1774	1.35210	3.0470	5.3078	2.84	6.65
	Total	306	4.4324	1.19209	3.7972	5.0676	2.84	6.65
2015	Boys	283	4.4504	1.58435	3.1259	5.7750	2.58	7.37
	Girls	101	4.4263	1.86402	2.8679	5.9846	1.88	7.56
	Total	384	4.4383	1.67123	3.5478	5.3289	1.88	7.56

Table 19 shows the minimum mean score before the introduction of SMASSE was 3.1007 for boys and 3.4106 for girls in 2003 while the maximum mean score in the same period was 6.8873 for boys and 6.1187 for the girls. The table also shows that the minimum mean grade in the period after the introduction of SMASSE was 3.1259 for boys and 2.8679 for girls in 2015 while the maximum mean grade after the introduction of SMASSE was 7.7956 and 6.8769 for boys and girls respectively in 2012.The total sample for each year is indicated for each of the 8 years under study.

Table 20 shows the means, standard deviation and the range for the two periods before the exposure to SMASSE (2000-2003) and after exposure (2012-2015).

Table 20*: Table of the means for the period before the introduction of SMASSE and after by Gender*

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Average before SMASSE	Boys	685	5.386	1.251	4.340	6.431	3.99	8.13
	Girls	328	4.902	1.004	4.062	5.741	4.00	6.79
	Total	1013	5.144	1.124	4.545	5.743	3.99	8.13
Average after SMASSE	Boys	1009	5.222	1.534	3.939	6.504	3.15	7.91
	Girls	381	4.785	1.556	3.485	6.086	2.43	6.93
	Total	1390	5.004	1.510	4.199	5.808	2.43	7.91

Table 20 shows the average mean score for boys and girls before the introduction of SMASSE was 5.386 and 4.902 respectively. The average mean after the introduction SMASSE for boys and girls was 5.22 and 4.785 respectively. The standard deviation for the boy's achievement was 1.251 while that for the girls is 1.004 which shows that the spread of the means of the boys is larger than that of the girls before the introduction of SMASSE. The standard deviation for boys and girls was 1.543 before and 1.556 respectively after the exposure to SMASSE.

Table 21 is an analysis of the means for the difference in the means using ANOVA for boys compared to girls before and after the introduction of SMASSE and the overall mean before and after the introduction of SMASSE in Konoin sub-county.

Table 21*: ANOVA Analysis table for the means of boys and girls, the overall means for the period before the introduction of SMASSE and after*

		Sum of Squares	Df	Mean Square	F	Sig.
Average before SMASSE	Between Groups	.937	1	.937	.728	.408
	Within Groups	18.014	14	1.287		
	Total	18.951	15			
Average after SMASSE	Between Groups	0.761	1	.761	.319	.581
	Within Groups	33.427	14	2.388		
	Total	34.188	15			

Critical values ($F_{0.05:(1,14)}$ =4.60, α=0.05) calculated values (F =0.319, p=0.581)

Table 21 is an ANOVA test of the difference in the mean achievement of boys compared to girls before the introduction of SMASSE compared to boys and girls after. The test also analyzed the overall mean before and after the introduction of SMASSE in the sub-county. The ANOVA statistical analysis is significant at α=0.05, the computed value of the test F = 0.319 statistic while the critical value from F-distribution corresponding to 0.05 level of significance $F_{0.05(1,14})$ gave 4.60.Therefore the computed value of 0.319 is less than the critical valueof4.6 and so the difference within and between groups before the introduction of SMASSE and after is not significant implying the difference in the mean achievement of the boys and girls before and after exposure to SMASSE is not significant. It also implies the difference in the mean achievement for the boys and girls before exposure to SMASSE and after remain although it was not significant.

The second null hypothesis of the study stated that there was no significant difference in the means in physics achievement by students in terms of gender before (2000-2003) and after (2012-2015) exposure to SMASSE in Konoin Sub-County. The table of the means of the boys and girls before and after shows there was a difference in the means in the two periods as observed in Table 20. When these differences are tested for significance using ANOVA the results in Table 21 show the critical value is larger than computed value (4.6 is greater than 0.319)and therefore we accept the null hypothesis. Therefore, at α=0.05 level of significance, there is not enough evidence to conclude that the introduction of SMASSE impacted physics achievement in terms of gender by students in Koinon sub-county.

The findings of this study also show that males are performing better than females in physics in the sub-county. The results are in agreement with the findings of Barchok (2006) that the majority of the girls in Bomet were not as good as boys in science subjects. Some of the reasons given by students in the same sub-county are that science practical is problematic to girls; they lose hope easily in science subjects and that they will not become scientists in the future. This negative perception is perhaps what made females to perform poorly in the subject.Socio-cultural believes that difficult tasks as been male domain and that girls were associated with lighter duties(SMASSE, 2004).Langat (2009)also found out that teacher's teaching approaches and methodology had greatly improved as a result of SMASSE INSET. However, the attitude and teaching approaches did not translate to good performance. However Ndegwa (2023) in his study of physics students in Buuri sub-county,Meru County found that there was no statistically significant difference in the achievement between male and female students in physics, based on the results This perception has led to the girls performing poorly especially in mixed schools. Gender stereotyping has been a challenge in most schools where teachers expect boys to perform better than girls (SMASSE,2004).Early upbringing where societies restrict girls while boys are set free which in turn enhance more discoveries (SMASSE,2004).

Gender stereotyping arises from distinct divisions of tasks boys and girls are associated with but gender is dynamic and changes with time (KESI, 2011). The society has drastically changed; most girls' schools are performing better than boys' in the national examinations. In the KCSE of 2017, most of the top performing schools and students come from girls' schools. This therefore means that the society's dynamics have shifted towards gender equity and equality. Gender can be Constructed and deconstructed (SMASSE, 2009). Through the process of socialization, different societies assign different roles to boys and girl and men and women. Figure 2 shows a dichotomy of cultural and socio-cultural differences existing in human beings.

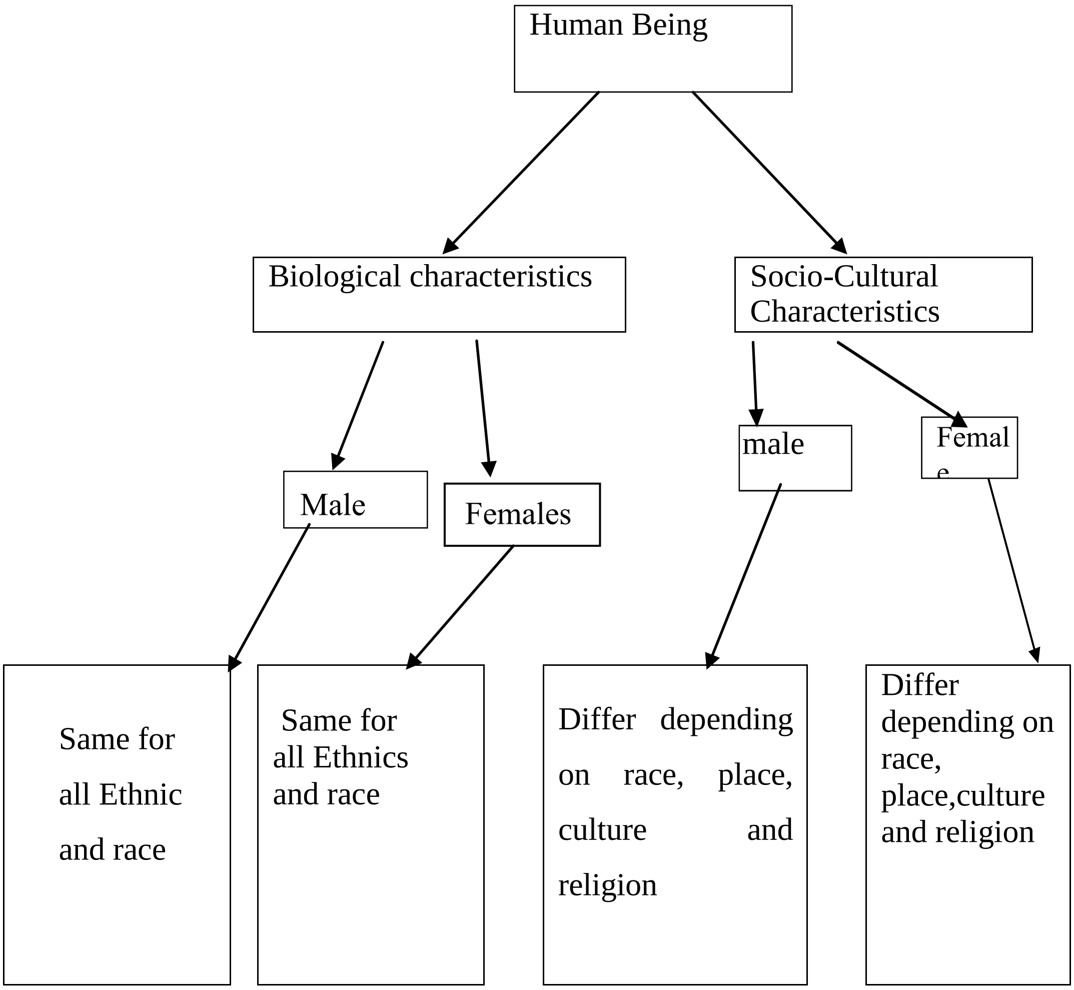

Figure2: Biological and Socio-Cultural Differences between Males and Females

Source: CEMASTEA (2015)

Figure 2 show that male biological characteristics are different from those of females in every respect. Socio-cultural difference exists depending on race, place, culture and religion. Biological differences are for instance differences in genitalia and the visible organs. The socio-cultural differences relate to tasks assigned at home and by the society. These tasks include construction of houses, household chores, and to some extend matters related to education. These biological and socio-cultural barriers have been deconstructed through socialization, education, gender equity and gender equality in all sectors of the society in line with the Kenyan constitution (CEMASTEA, 2011).

However these findings disagree with findings of Kwamboka (2012) who in her study on the application of the principles of Activity-Student-Experiment Improvisation/Plan-Do-See Improve (ASEI/PDSI) by mathematics teachers in secondary schools of Nakuru District, found that schools had adequate, professional and SMASSE trained teachers, school facilities and teaching-learning resources were adequate while Physics instructional sessions were teacher-dominated with little or no active involvement of students. Prevalent during lessons was the use of text books and the chalkboard, lessons lacked extensive student activities. Application of ASEI/PDSI principles was invisible, teachers' and students' attitude towards mathematics and ASEI/PDSI principles was relatively positive albeit factors that hinder their application. Similar findings were also found by Kisang (2009), who investigated the extent to which lessons in Japanese schools were interactive and student-centered for purposes of adaptation in the Kenyan situation. Findings revealed that learning at senior high school level was less interactive. Similarly, in his study, Yara and Otieno (2010) postulates that student achievement in mathematics depends on the way it is presented to learners, the way learners actively interact with the learning experiences presented and the environment within which these interactions are taking place.

The findings from this study are similar to the KNEC report (2016) which revealed that the achievement of students in KCSE physics examinations has been declining from 2012 up to 2015.The research findings revealed that this scenario adversely affects topics that appear at the end of the syllabus such topics are radioactivity-rays and photo electricity. From the research findings, it seems the implementation of SMASSE programme has not assisted in the adequate coverage of the physics syllabus. Poor syllabus coverage in physics could be one of the contributory factors to the poor achievement in this subject. The study also agrees with Langat (2016) who found out that there was no significant impact made by the introduction of SMASSE in the performance of boys and in mathematics though the programme impacted more positively on the attitude of girls more than the boys.

In the questionnaires that were administered to teachers who had undergone SMASSE approach, 45 percent of them pointed out that full implementation of PDSI/ASEI does not assist in syllabus coverage because of too many practical activities involved. Physics syllabus is at the same time very broad. Our curriculum is examination oriented whereas SMASSE approach is practical oriented while the examination papers are not practical oriented. It seems therefore that there is a contrast between the SMASSE approach and the examination council. The SMASSE approach does not emphasize the achievement in physics but its main emphasis is on student-centered teaching and ASEI/PDSI approach to teaching.

What is measured by the KNEC test papers is what matters. The general public, as well as those professionally involved in education, seems genuinely interested in finding out what cognitive skills and knowledge students have acquired in school. Since affective and manipulative outcomes of a school are never measured or tested, teachers' efforts are not directed to affective or manipulative domain teaching. Affective or manipulative domains have significant impact on academic achievement and should therefore be given attention and equal weight. The emphasis should be on the development of a whole person.

Physics teachers should encourage their students to have a positive self-image in physics. Negative self-image acts as a block to thinking even if a student has the ability to perform very well in physics. Success in physics requires a lot of practice and the right attitude. In physics, learners are expected to master the lower order skills before being introduced to the higher order ones. If the lower skills are not well mastered, then the hierarchical nature of physics makes the mastery of higher order skills difficult. It is for this reason that teachers need to diagnose the students' weakness early and monitor their progress as they move from one form to the other.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATONS AND RECOMMENDATIONS

5.1 Introduction

This chapter has five sections. The first part deals with the summary of the findings of the study. The second part gives the conclusions of the findings. The third section gives the implications of the findings and the next is the recommendations based on the findings of the study, followed in physics education and other areas for further research.

5.2 Summary ofthe Findings

The findings of the study can be summarized based on the objectives of the study. The first objective sought to find out whether SMASSE approach impacted the students' achievement in physics before (2000-2003) and after (2012-2015) exposure to SMASSE. The difference in the average means of the two periods were tested using t-test to see if the difference was significant and the findings showed that the difference was not significant as shown in Table 18. Therefore, there was no evidence of impact of the independent variable on the students' achievement in the subject in the period before and after exposure to SMASSE in the sub-county.

The second objective assessed whether there was a difference in physics achievement before (2000-2003) and after (2012-2015) exposure to SMASSE approach in terms of gender. The average mean score for boys and girls before the introduction of SMASSE was 5.386 and 4.902 respectively compared to the average means after the introduction of SMASSE which was 5.22 and 4.785 respectively. The findings showed that there was no statistically significant impact of the independent variable on student achievement by gender when the difference in the average means is tested using ANOVA as shown in Table 21.

5.3 Conclusions

On the basis of the findings of this study, the researcher made several conclusions which are related to the study. These are as follows;

i) Use of SMASSE teaching approach did not impact secondary school students' achievement in physics in the period under study.
ii) There was no impact on gender difference in terms of achievement when students are exposed to SMASSE approach.

5.4 Implications of the Study

The findings of this study have some implications to physics education and SMASSE program. The study shows that teachers have adopted the use of SMASSE teaching approach. The adoption has not impacted on the achievement in the subject in Konoin sub-county. Further the study also shows that students' achievement has not been impacted by the exposure to the approach at the school level. School programs together with the approach could have as well impacted on the students' performance but the teachers might not have resorted to SMASSE approach to teaching and used other methodologies due to time. The teachers might not have adopted fully the SMASSE approach due to the nature of examination system in Kenya which emphasizes the teaching to pass exams.

5.5 Recommendations

Based on the research findings, want to make the following recommendations.

i) The Quality Assurance and Standards Officers (QUASO) should design monitoring tools to ensure that the programme is actually implemented in the classroom.
ii) School managers should provide adequate resources for the SMASSE program.
iii) . The Ministry of Education could implement a compulsory policy of selecting Physics subject by students and Science teachers to attend SMASSE program

5.5.1 Recommendation for Further Research in Physics Education

Based on the findings of this study, the researcher made some recommendations that physics educators as well as education stakeholders can apply to improve achievement among secondary school students. Even though the results of this study could be generalized to secondary school students in Konoin sub-county, the recommendations however can be extended to cover other Sub-counties where SMASSE programme has been undertaken. These recommendations are;

i) Policy makers and education authorities as well as CEMASTEA need to increase efforts in identifying why the programme has not impacted the achievement of physics student and the challenges faced by teachers in implementing the SMASSE programme in their schools. The teachers should be encouraged to improvise on apparatus and resource used to assist in teaching of physics where the conventional resources are not available.

ii) Physics teachers should strive to make the subject a favorite in terms of instrumental value in advancing scientific careers as well as cultural aspects faced by the students.

iii) The study also recommends that teachers should strive to cover the whole syllabus within the allocated time and have ample time for revision so as to improve achievement in the subject.

5.5.2 Further Research.

The researcher identified some areas which require further investigation in order to have more insight in the relation between achievement and SMASSE approach as well as enriching the present knowledge. The suggested areas are:

i) Replication of the present study in other Sub-Counties in Kenya to find out whether the same trend will be observed.

ii) This study could also be replicated using other academic subjects such as Mathematics, Chemistry and Biology.

iii) Research should be done to establish the relationship between science preparation in primary schools on the subsequent study of physics in secondary and higher levels of education

iv) Further research is needed to investigate whether all the major steps of any innovation were considered before the SMASSE approach was implemented to cover the whole country

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Appendix A: Published Article

International Journal of Multidisciplinary Research and Growth Evaluation.

Impact of smasse programme on gender difference in the achievement of physics by secondary school students in Bomet County, Kenya

Paul K Yegon [1*], **J Changeiywo** [2], **Dr. William K Orora** [3]
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[2] Professor, Egerton University, Kenya
[3] Senior Lecturer, Egerton University, Kenya

* Corresponding Author: **Paul K Yegon**

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Abstract
Science subjects are the backbone of the scientific and technological advancements in the world. Achievement in science subjects in secondary schools in Kenya has been below average. The low achievement in the national examinations has been attributed mainly to teacher centered teaching approaches used by teachers. In an attempt to address the low achievement in Physics, the Strengthening of Mathematics and Science in Secondary Education (SMASSE) teaching program was introduced through In-service Education and Training INSET) in the whole of Kenya in 2004.Therefore, this study was an attempt to fill this gap. The objectives of the study were; to find out whether SMASSE approach had impacted the achievement in physics and whether there was a gender difference in the achievement in Physics among secondary school students in Konoin sub-county. The study used expost-facto research design as well as a survey research design. Stratified and systematic sampling was employed to select schools for this study. The population was the KCSE candidates in Konoin Sub- County and the accessible populations were the 2000-2003 candidates before SMASSE was introduced and 2012-2015 KCSE candidates immediately after. There was a total of 5017 candidates in this target class in 24 secondary schools in Konoin Sub-County in period 2000-03 and 5204 in the period 2012-15. The schools were in 3 categories, these were extra-County, county, and sub-county schools and both stratified, systematic sampling and purposive sampling were used to select 12 schools with a total of 1013(685 boys and 328 girls) students for the period 2000-2003 and 1390 (1009 boys and 381 girls) in the same 12 schools for the period 2012-2015 took part in this study. The research instruments used for the study were a Document analysis tools. Descriptive and inferential statistics were used in the analysis of data, a one-way ANOVA was used as inferential statistic to test the null hypothesis. All statistical tests were subjected to a test of significance at coefficient alpha (α) of 0.05. The study found out that there was no statistically significant difference between those students who were exposed to SMASSE and those who were not. The findings may inform decisions and action towards improving teaching and learning of Physics in Kenya. The study also may help to sensitize teachers, curriculum planners, policy makers and other education stake holders as far as SMASSE program is concerned on the areas that require improvement.

Keywords: SMASSE approach, Physics students' achievement

Appendix B: Document Analysis Tool

Part I
Period: 2000- 2003

Category of school e.g. County, Sub County	Gender		Number of students	Mean Mark		Overall Mean	Remarks
	MM A M	FB B BF		M	F F		

Period: 2012-2015Part II

Category of school e.g., County, Sub County	Gender		Number of students	Mean Mark		overall mean	Remarks
	M	F		M	F		

Appendix C: Teachers' Questionnaire on Students' Achievement in Physics (TQSAP)

Instructions

i This questionnaire contains a number of question statements. Read them and answer.

ii Your personal feelings or opinions on each question statement is required, please answer all the questions as quickly as you can.

iii Please do not write your name

Fill in the questionnaire in the spaces provided.

1. Gender

Male ☐

Female ☐

2. Age? ☐ 20-30 ☐ 31- 40 ☐ 41-50 ☐ 51-60

3. Educational Level? ☐ Diploma ☐ Degree ☐ Postgraduate

4. Length of service? less than 5 years ☐ more than 5 years ☐

5. a) Have you undertaken SMASSE training? Yes ☐ No ☐

b) If yes above when was the training undertaken? ----------------

6. a) The table below shows a list of approaches used by teachers in teaching Physics. Rate them as; **Most often**, **Often**, **Uncertain**, **Rarely**, **Never** for you by ticking in appropriate column of your choice. This is the frequency in which you use them.

Coding: Never= 1Rarely=2 Uncertain=3 Often=4 Most often=5

Rating / **Approach**	**Most often**	**Often**	**Uncertain**	**Rarely**	**Never**
SMASSE					
Didactic (Lecturer)					
Heuristic (Discovery)					
Constructivist (Class discussion and Demonstration)					

Empiricist (Experimental)					
Expository (Teacher centered)					

5(b) From the list of the teaching approaches listed above, choose the best 3 in order of frequency in which you use them.

(i)...

(ii)...

(iii)..

c) Give reasons for your answers above:

(i)..

(ii)...

(iii)..

6. The list below shows topics covered in Secondary School Physics course. Indicate the extent in which you use the SMASSE approach in teaching them. Rate them as:

Coding: Never= 1rarely=2 Uncertain=3 Often=4 Most often=5

No	**Topic**	**Most often**	**Often**	**Uncertain**	**Rarely**	**Never**
A	Linear motion					
B	Refraction of light					
C	Newton's laws of motion					
D	Work, power, energy					
E	Waves ii					
F	Current electricity					
G	Heating effect of electric					

	current					
H	Electrostatics ii					
I	Quantity of heat					
J	Gas laws					
K	Thin lenses					
L	Circular motion					
M	Electromagnetic spectrum					
N	Electromagnetic induction					
O	Mains electricity					
P	Cathode rays					
Q	x-rays					
R	Photo electric effect					
S	Radio activity					
T	Electronics					

7.How do you describe the trend in students' enrollment in Physics for the last five years?

Improving ☐

Constant ☐

Declining ☐

8. To what extent do you attribute this performance to SMASSE approach?

To a large extent ☐

To a small extent ☐

Not at all ☐

9. Are your external exams results consistent with the internal exams?

Yes ☐ No ☐

If no, what factors contribute to this……………………………………...………

………………………………………………………………………………………..

……………………………………………………………………………………

10) Is your head teacher supportive whenever you require materials for teaching and learning Physics?

Yes ☐ No ☐

11) Comment on the areas which you feel should be improved in future on SMASSE program……………………………………………………………………...

…………………………………………………………………………………………

…

12) Give the areas you feel should be included in any future Teachers In-service Professional

Development Program……..........................……………………………………

Appendix D: Request for Research Permit

EGERTON UNIVERSITY

Tel: Pilot: 254-51-2217620
254-51-2217877
254-51-2217631
Dir.line/Fax: 254-51-2217847
Cell Phone

P.O. Box 536 - 20115
Egerton, Njoro, Kenya
Email: bpgs@egerton.ac.ke
www.egerton.ac.ke

OFFICE OF THE DIRECTOR GRADUATE SCHOOL

Ref: EM14/1657/06

Date: 10th December, 2021

The Director General
National Commission for Science Technology and Innovation,
P. O. Box 30623-00100
NAIROBI.

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – MR. PAUL KIPKURUI YEGON REG. NO. EM14/1657/06

This is to introduce and confirm to you that the above named student is in the Department of Curriculum, Instruction & Educational Management, Faculty of Education & Community Studies, Egerton University.

He is a bona-fide registered M.Sc student in this University. His research topic is **"Impact of SMASSE Programme on Secondary School Students' Achievement in Physics in Konoin, Sub-County, Boment County, Kenya."**

He is at the stage of collecting field data. Please issue him with a research permit to enable him undertake the studies.

Your kind assistance to him will be highly appreciated.

Yours faithfully,

DIRECTOR, BOARD OF POST GRADUATE STUDIES
10 DEC 2021
EGERTON UNIVERSITY, P.O. Box 536-20115 EGERTON

Prof. Nzula Kitaka
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

NK/vk

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Appendix E: Letter From NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **660466**

Date of Issue: **24/December/2021**

RESEARCH LICENSE

This is to Certify that Mr.. paul kipkurui yegon of Egerton University, has been licensed to conduct research in Bomet on the topic: IMPACT OF SMASSE PROGRAMME ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN PHYSICS IN KONOIN, SUB-COUNTY, BOMET COUNTY, KENYA for the period ending : 24/December/2022.

License No: **NACOSTI/P/21/15001**

660466

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix F: Research Authorization

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telegrams: "DISTRICTER", Bomet
Telephone: (052) 22004/22077 Fax 052-22490
When replying please quote

COUNTY COMMISSIONER
P.O BOX 71- 20400
BOMET

REF: EDU.12.1VOL.IV/(147)

4th January, 2022

The Deputy County Commissioner
Konoin Sub-County
MOGOGOSIEK

RE: RESEARCH AUTHORIZATION – MR. PAUL KIPKURUI YEGON

The above named person has been authorized to carry out research on **"Impact of SMASSE programme on Secondary School Students' Achievement in Physics"** in Konoin Sub-County, Bomet County for the period ending 24th December, 2022 by the National Commission for Science, Technology and Innovation vide their letter Ref. No.660466 dated 24th December, 2021.

Any assistance accorded would be appreciated.

COUNTY COMMISSIONER
BOMET COUNTY
04 JAN 2022
P. O. Box 71-20400, BOMET

Hesbon Kayesi
For: County Commissioner
BOMET

Appendix G: Research Authorization

REPUBLIC OF KENYA
MINISTRY OF EDUCATION
STATE DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

Telegrams: "ELIMU",
Telephone: 052-22265
When replying please quote
email:cdebometcounty@gmail.com
Ref/CDE/BMT/ED/AUTH/74/VOL.II/18

COUNTY EDUCATION OFFICE,
BOMET COUNTY,
P.O. BOX 3-20400,
BOMET.

4th January, 2022

Mr. Paul Kipkirui Yegon
Egerton University
P.o Box, 536-20115
NJORO.

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION.

Reference is made to the letter dated 24th December 2021, Ref: No. NACOSTI P/15001/660466 from NACOSTI requiring the above-mentioned person to conduct research on "**Impact of SMASSE Programme on Secondary Schools Students' Achievement in Physics in Konoin Sub County, Bomet County, Kenya"** for the period ending 24th December, 2022.

The purpose of this letter is to inform you that the authority has been granted for him to carry out the study in Bomet County, including learning Institutions among others.

Kindly accord him the assistance he require.

COUNTY DIRECTOR OF EDUCATION
BOMET
P.O. Box 3 - 20400, BOMET
P.P. 4/1/2022

INDIATSI MABALE
COUNTY DIRECTOR OF EDUCATION
BOMET COUNTY.

Copy

CEO- NACOSTI

SYSTEM CERTIFICATION ISO 9001 SGS

Appendix H: Ethics Authorization

EGERTON UNIVERSITY

TEL: (051) 2217808
FAX: 051-2217942

P. O. BOX 536
EGERTON

EGERTON UNIVERSITY RESEARCH ETHICS COMMITTEE

EU/RE/DVC/009
Approval No. EUREC/APP/161/2022 **7th February, 2022**

Paul Kipkurui Yegon
P.O. Box 62 Kimulot
Telephone:071012406
E-mail : pyegon85@gmail.com

Dear Paul,

RE: ETHICAL APPROVAL: IMPACT OF SMASSE PROGRAMME ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN PHYSICS IN KONOIN, SUB-COUNTY, BOMET COUNTY, KENYA.

This is to inform you that ***Egerton University Research Ethics Committee*** has reviewed and approved your above research proposal. Your application approval number is ***EUREC/APP/161/2022.*** The approval period is ***7th February, 2022 – 8th February, 2023.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***Egerton University Research Ethics Committee***.
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***Egerton University Research Ethics Committee*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***Egerton University Research Ethics Committee*** within 72 hours
v. Clearance for Material Transfer of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.

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APPENDIX G: Ethics Authorization

vii. Submission of an executive summary report within 90 days upon completion of the study to ***Egerton University Research Ethics Committee***.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely.

EGERTON UNIVERSITY
Date. 07/02/2022
RESEARCH ETHICS

Prof. R. Ngure

CHAIRMAN, EGERTON UNIVERSITY RESEARCH ETHICS CTTEE

RMN/BK/

EGERTON **UNIVERSITY**

TEL: (051) 2217808
FAX: 051-2217942

P. O. BOX 536
EGERTON

EGERTON UNIVERSITY RESEARCH ETHICS COMMITTEE

EU/RE/DVC/009
Approval No. EUREC/APP/161/2022 **7th February, 2022**

Paul Kipkurui Yegon
P.O. Box 62 Kimulot
Telephone:071012406
E-mail : pyegon85@gmail.com

Dear Paul,

RE: ETHICAL APPROVAL: IMPACT OF SMASSE PROGRAMME ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN PHYSICS IN KONOIN, SUB-COUNTY, BOMET COUNTY, KENYA.

This is to inform you that ***Egerton University Research Ethics Committee*** has reviewed and approved your above research proposal. Your application approval number is ***EUREC/APP/161/2022.*** The approval period is ***7th February, 2022 – 8th February, 2023.***

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"Transforming Lives through Quality Education"