INFLUENCE OF SMASSE INSET ON CHEMISTRY TEACHERS' CLASSROOM PRACTICES, STUDENTS' ATTITUDE AND ACHIEVEMENT IN PUBLIC SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, KENYA

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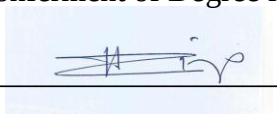
DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been submitted for examination or any award of Diploma or conferment of Degree in this or any other university

Signature  Date 02/07/2023

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Recommendation

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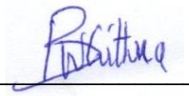
Signature  Date 05/07/2023

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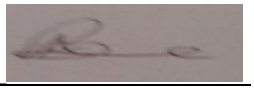
Signature  Date 05/07/2023

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This work is dedicated to the Almighty God and my family members for their love and understanding during the entire study period

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ABSTRACT

The quality of science graduates largely depends on the quality of teachers and their classroom practices during secondary school training period. Strengthening of Mathematics and Science in Secondary School Education (SMASSE) is an in-service course for mathematics and science teachers aimed at improving their classroom approaches and students' achievement. The focus of this study was to establish if the aims of SMASSE INSET were achieved. The study sought to find out the influence of SMASSE INSET on chemistry teachers' classroom practices, students' attitude and achievement in chemistry subject in Nandi East Sub-County, Kenya. The study targeted 98 Chemistry teachers and 13620 Chemistry students. A sample size of 19 Chemistry teachers and 160 chemistry students were purposively selected. Questionnaire for both chemistry teachers and students were administered. The instruments were piloted in one public secondary school in Nandi Central Sub County Nandi County to ensure they were of acceptable reliability and validity. To test reliability of instruments the Cronbach's alpha of coefficient was used. Cronbach's alpha coefficient value of 0.931 for chemistry teachers` classroom practices questionnaire and 0.885 for students' attitude towards chemistry subject questionnaire were obtained from pilot. Instruments were considered reliable since the coefficients were within the acceptable threshold of 0.7 and above. Data collected was organized and entered into SPSS program version 21 for analysis. Descriptive data was presented in terms of frequency tables, mean, standard deviation and percentages. Inferential data was analyzed using Pearson correlation, linear regression Analysis and t-test statistic at a significant level of 0.05. Descriptive data was presented in form of tables and figures. The findings of the study indicate that SMASSE INSET had a positive and statistically significant influence on chemistry teachers` classroom practices and students' attitude towards chemistry subject in public secondary schools in Nandi East Sub-County, Kenya. However, the findings showed that SMASSE INSET had no statistically significant influence on students' chemistry achievement in public secondary schools in Nandi East Sub-County, Kenya. In conclusion, despite the positive changes on the chemistry teachers' classroom practice and students' attitude towards chemistry, achievement has not improved as expected. The study recommends that chemistry teachers should be given chance to attend SMASSE INSET since it brings positive impact on student's attitude towards chemistry subject. Finally, the ministry of education should invest more on new interventions that will improve students' chemistry achievement at Kenya Certificate of Secondary Education.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASEI: Activity-focused, Students-centered learning with Experiment and Improvisation

CEMASTEA: Centre for Mathematics, Science and Technology Education in Africa

FSE: Free Secondary Education

H.O.D Head of Department

INSET: In-Service Education and Training

JICA: Japanese International Cooperation Agency

JODA: Japanese Official Development Assistance

KCSE: Kenya Certificate of Secondary Education

KESSP: Kenya Education Sector Support Programme

KICD: Kenya Institute of Curriculum Development

KNEC: Kenya National Examinations Council

MoE Ministry of Education

MPET: Master Plan on Education and Training

OER: Open Educational Resources

PCK Pedagogical Content Knowledge

PDSI: Plan, Do, See, Improve

SMASSE: Strengthening of Mathematics and Science in Secondary Education

STEM: Science, Technology, Engineering and Mathematics

TESSA: Teacher Education in Sub-Saharan Africa

TIQET: Totally Integrated Quality Education and Training

UNESCO: United Nations Educational Scientific and Cultural Organizations

WECSA: Western, Eastern, Central and South Africa

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Education, particularly science and technical education, is a contributory factor for the production of the needed technologists and craftsmen as well as skilled artisans who are required to turnaround the nations' economy and usher in the desired technological advancement (Agola, 2016). Science and technology are requirement for the elevation of economies of countries from a "consumer nation" to a "producer nation" from a developing nation to a developed nation, all these being pillars to realization of vision 2030 and Sustainable Development Goals (SDG's) (Nderitu, 2014). Acquisition of appropriate scientific and technological skills is necessary to cope with the challenges presented by the evolving needs of modern work place in our industries and ever growing non-formal sector (National Planning Commission, 2013).

Education and training systems that respond adequately to these demands therefore contributed to the efforts to overcome the growing unemployment and marginalization of majority of the populace, by providing access to appropriate learning experience designed to broaden skills and knowledge that can increase productivity and significantly improve the fortunes of the employment amongst our youth (Botkin *et al.,* 2014). Science education has been accorded a prime position worldwide and chemistry particularly has been identified as a very important science subject and its contribution to scientific and technological development of any nation has been widely reported (Veblen, 2017).

The contributions of chemistry to society are vast and almost numerous. They include: production of vaccines, food safety practices, treatment programs for diseases, diagnostic tools in healthcare, plastics, synthetic fibers, an understanding of oil, cosmetics and cleaners. Vaccines and immunization were first popularized in the 1770s by Edward Jenner, who took pus from the hand of a victim of cowpox, and used it to protect people from the much more serious smallpox. Jenner was hailed as having stumbled onto something amazing, and the era of modern vaccines began. Without exactly understanding the chemistry - or indeed the biology - behind his discovery, Jenner had helped launch a revolution in chemistry that continues today with the development of vaccines for the deadly diseases of our age like Swine Flu (Chartier, 2014).

It was as a result of this recognition given to chemistry in the development of an individual and the nation that it was made a core-subject among the natural sciences and other science related courses in Kenya's education system (Ekwam, 2014). It has been a pre-requisite subject for offering most sciences-oriented courses in the tertiary institution and these calls for the need of teaching it effectively (Elmoge, 2018)

Chemistry teaching is supposed to be results oriented and students centered, this can only be achieved when students are willing and teachers are favorably disposed using the appropriate methods and resources in teaching the students (Brookfield, 2017). Students by nature are curious, they need to be actively involved in the learning process in which they are continuously equipping, testing, speculating and building their own personal construct and knowledge. It is only by personalizing such knowledge that it becomes valid, meaningful and useful to them. In chemistry, students need to construct their own personal awareness and meaningful information. To substantiate the argument, Best and Kahn (2016) remarked that the brain is not a passive consumer of information, and to learn with understanding, a learner must actively construct meaning of what to be learned.

Despite the prime position chemistry occupies in our educational system and the efforts made by researchers to enhance performance, students' achievements in chemistry and science in general are still low in Kenya (Ahmed, 2018). In Nandi East Sub-County chemistry subject is normally ranked second last after mathematics every year when KCSE results are analyzed (Chemeli, 2019). Though teachers with high motivation and mastery of knowledge are needed, learning difficulties and capacity to facilitate learning are important (Dewey, 2013). This calls for correct use of an appropriate teaching and learning method. It is not enough for students to learn names and definitions of chemicals and observe subsequent reactions, they need also to mix the chemicals and observe subsequent reactions. Knowledge of how teaching methods affects students learning may help educators to select methods that improve teaching quality, effectiveness and accountability to learners and the public, it may also help them keep up with information technology and globalization to avoid the status quo (Richards & Rodgers, 2014).

According to KNEC Report (2018), the performance of science subjects, chemistry included at secondary school education in Kenya is low. The Kenya government has made attempts to enhance the subject mastery and pedagogical skills of teachers at all levels under Kenya

Education Sector Strategic Plain (KESSP). Under this strategy competitive training programs for in-servicing both primary and secondary school teachers have been put in place to enhance teachers' effectiveness so as to improve quality. The strengthening of science and mathematics in Secondary Education (SMASSE) project, which was partnership between the government of Kenya and the government of Japan through Japan International Cooperation Agency (JICA) is part of this effort. SMASSE project was implemented in July 1998 and was to run up to the year 2003 (Mwangi, 2014). The SMASSE project focuses on improving mathematics and science education by promoting quality classroom practices. The project targeted science teachers, principals and education officers with the realization that students are the ultimate beneficiaries of the whole process. According to Githua and Ng'eno(2016) incorporation of teachers' attitudinal statements in the value and belief systems of the learners influence their attitude towards the subjects. However, performance of chemistry is still low in secondary schools.

SMASSE baseline studies indicated that there were numerous problems in Mathematics and science education (Cheruiyot *et al.,* 2017). This included attitudes towards mathematics and science, inappropriate teaching methods and low content mastery. During teacher training suitable benchmarks that stipulate both the content and pedagogical developments and growth should be earmarked (McLaren, 2015). SMASSE project targeted teacher attitudes first because of the time they spent with the students. Teachers' negative attitudes can be impacted on the learners' attitudes towards mathematics and sciences (Gibson *et al.,* 2014). SMASSE came up with an Activity, Student, Experiment and Improvisation (ASEI) movement which were geared at making learning student centered as opposed to teacher centered. To achieve the ASEI condition, SMASSE came up with the plan, Do, See and Improve (PDSI) approach to teaching and learning which has to do with planning lessons with hands-on and minds-on activities for the learners which are then assessed to see the successes and failures of the lesson and hence improve on it (Entwistle & Ramsden, 2015). Changeiywo *et al.* (2014) noted that improving performance in mathematics and science education is a great societal need in Kenya, not only for industrialization but also for producing scientifically empowered citizens. The challenge has been how to make mathematics and science more "alive" more "real" and more accessible. Gibson *et al.* (2014) therefore strongly felt that students' involvement during lessons must be enhanced to increase learners' motivation, create effective teaching/learning environment and more interesting lessons.

Conventional methods of teaching that are normally used seem to have not changed the achievement in chemistry. The conventional methods or teacher-centered teaching and lecture methods are the most common teaching behaviour found in schools worldwide (Riga *et al.*, 2017). Teacher-centered teaching can be very effective, particularly for: Sharing information that is not easily found elsewhere, presenting information in a quick manner, generating interest in the information and teaching learners who learn best by listening. However, there is need for teachers to use more interactive teaching approaches in order to improve learners' achievement. SMASSE a teacher professional development project introduces ASEI-PDSI teaching approach with the objective of improving the students' achievement in science and mathematics. This study sought to determine whether this new teaching approach has an influence on chemistry teachers' classroom practice, students' attitude and achievements in secondary schools.

According to Romina (2016), there is significant relationship between chemistry in-service training of teachers and students' academic performance. Lucenario *et al.* (2016) observed that Pedagogical Content Knowledge (PCK) guided lesson is an effective method to develop the teachers' PCK competencies and student achievement in terms of conceptual understanding and problem solving.

In Nandi East Sub-County reports show that performance in chemistry has remained low when compared to the other subjects offered in secondary schools (Jepketer *et al.,* 2015). In 2017 Chemistry as a subject was not performed well at KCSE since the mean score stood at 24.08 nationally (KNEC 2018). In Nandi east chemistry performance were also not appealing since the mean score stood at 26.54 in 2017 KCSE (County & Nandi County, 2018). This prompted the researcher to investigate the influence of SMASSE INSET on Chemistry Teachers' Classroom Practices, Students' Attitude and Achievements in Public Secondary Schools in Nandi East Sub-County, Nandi County, Kenya.

1.2 Statement of the problem

Chemistry is a central subject of science that is closely related to daily life. Chemistry being a prerequisite subject for offering sciences-oriented courses like pharmacy, nursing and medical engineering in the tertiary institutions it is necessary for students to get good grades in secondary education. However, poor grades in chemistry in KCSE have been attributed to several factors which include: -students negative attitude towards chemistry, inappropriate teaching approach, over enrolment, poor syllabus coverage, poor laboratory structures or unavailability of enough practical tools and few chemistry teachers. The Ministry of Education, Science and Technology in Kenya through its various organs has made considerable efforts to curb the above problems, key among them being introduction of SMASSE INSET. The in-service program was meant to equip chemistry teachers with skills in designing relevant teaching and learning activities that promote student interest and understanding that improve chemistry performance of the students. However, it has been noted that despite the introduction of the SMASSE INSET, students' achievement in chemistry subject is still ranked low all over the country implying the problem is persistent and wanting. This indicates that there could be yet other critical factors that contribute to poor performance in the subject. The study thus seeks to investigate the influence of SMASSE INSET on Chemistry Teachers' Classroom Practices, Students' Attitude and Achievements in Public Secondary Schools in Nandi East Sub-County, Nandi County, Kenya.

1.3 Purpose of the study

The main purpose of this study was to find out the influence of SMASSE INSET on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools in Nandi East Sub-County, Kenya.

1.4 Objectives of the study

The study was guided by the following objectives:

i. To find out the influence of SMASSE INSET on chemistry teachers` classroom practices.

ii. To find out the influence of SMASSE INSET on students' attitude towards chemistry subject.

iii. To find out the difference in chemistry achievement before and after SMASSE INSET.

1.5 Hypotheses of the study

The study was tested by using the following hypotheses: the hypotheses were tested at 5% level of significance.

$H_0$1: SMASSE INSET has no statistically significant influence on chemistry teachers` classroom practices.

$H_0$2: SMASSE INSET has no statistically significant influence on students' attitude towards chemistry subject.

$H_0$3: SMASSE INSET has no statistically significant difference in chemistry achievement before and after.

1.6 Significance of the study

The findings of this study may assist the Ministry of Education, Science and Technology to improve the ASEI-PDSI Teaching Approach. The findings may also be utilized by the Kenya Institute of Curriculum Development (KICD) in making decisions regarding what areas covered in the SMASSE INSET could be included in the pre-service teacher curriculum of all institutions training teachers. Further, teachers and school principals can use the findings to improve implementation of the ASEI-PDSI approach. Finally, the study findings form baseline information to be used for further studies.

1.7 Scope of the study

This study focused on the influence of SMASSE INSET on chemistry teachers' classroom practices, students' attitude and chemistry achievements in secondary schools in Kenya. The study was conducted in public secondary schools in Nandi East Sub-County, Nandi County. The study targeted chemistry teachers and forms two, three and four students in secondary schools within Nandi East Sub-County, Nandi County.

1.8 Assumptions of the study

According to Sureiman (2013), assumption in any particular study is unique facts presumed to be true but have not been verified. In the study the following assumptions were made:

i. All the respondents were honest in responding to the items in the questionnaire

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

1.9 Limitation of the study

Limitations of the study as Bell *et al.* (2017) observed constitute the aspects of study that the researcher knows and may negatively affect the results generalizability. The study had the following limitation: Due to poor record keeping, some science head of department didn't have all the KCSE chemistry records. The information in such instances was sourced from specific heads of subjects and subject teachers.

1.10 Definition of terms

Attitude: A relatively stable organization of beliefs, feelings and behavior tendencies that could be negative or positive towards something (Chandler & Munday, 2016). In this study, it was indicated by students' change of feelings towards chemistry. These are also shown by students' opinions, feelings and certain inclinations towards chemistry. This was measured using chemistry student questionnaire.

Influence: An action or process of producing effects on the actions, behavior, opinions etc. of others (Obe, 2018). In this study, influence is on chemistry teachers' classroom practices and students' attitude towards chemistry. i.e., the action that produced effects was SMASSE and the effects were chemistry teachers' classroom practices, students' attitude and chemistry achievements

INSET: This is the In-service Education and Training of teachers which is meant to extend their personal education and develop professional competence. In this study, this is the SMASSE In-service education of chemistry teachers.

Professional development: This is used to refer to the individualistic and personal process of continuing professional education (Obe, 2018). In this study professional development is the ability of chemistry teachers to apply ASEI/PDSI approach to teaching as learnt in the INSET, change attitude and improve classroom practices**.**

Staff development: This is the activity of staff training to improve their capacity (Likert, 2017). In this study, staff development means the development of an individual teacher as a member of a particular school.

Students' achievement: Students' success in learning which is portrayed by good performance (Jumonville-Graf, 2012). In this study, it has bees be shown by the students' chemistry KCSE grades. In this study, students' chemistry K.C.S.E scores were used to indicate their achievement.

Teachers' classroom practice: These are the methods that promote the teaching and learning of chemistry in the classroom (Dictionary, 2014). In this study it refers to the teaching procedures, methodology and classroom management.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on variables relevant to this study. The subsections under discussion include; the importance of Chemistry in Society, Goals and Objectives of Teaching Chemistry in Kenya, Students Chemistry Achievement in Kenya at KCSE, Methods of Teaching Chemistry in Secondary Schools, The Impact of SMASSE INSET on students achievement in chemistry, Attitudes towards Chemistry, Teachers' Understanding of the ASEI-PDSI Approach and its Implementation, School principals' Supervision of Implementation of ASEI-PDSI Approach, Teachers' Usage of the ASEI-PDSI Approach, comparison of ASEI-PDSI with conventional or regular teaching methods, Theoretical framework and the Conceptual framework.

2.2 Importance of chemistry in society

Chemistry as a subject has a significant importance in our daily lives and the society in general. Everything on the earth is made of chemicals. Chemistry helps us understand how items around us are made e. g cooking gas. In our daily life, we fall sick and consequently need drugs which are made by scientists through chemistry. This helps to know what drugs to take by showing their contents and their impacts on our body (Hofstein *et al.,* 2011).

Through chemistry, we get to understand how food gives energy to our bodies; this enables us to be careful regarding contaminations and also their consequences afterwards such as diseases. Chemistry helps to understand and observe the changes around us since such changes are caused by chemistry, for example, changes of the colors of leaves. It helps in day-to-day decisions that affect our lives e.g., mixing the household chemicals such as tealeaves and sugar. It also describes various chemical elements preset in the environment, their reactions, and effects on the environment. It illustrates environment segments, their interrelationships, and significances (Hofstein *et al.,* 2011).

In our daily lives, we wear clothes that are made of fabrics such as nylon which is learned in chemistry. It also boosts the industry sector through extraction of valuable metallic such as copper, zinc, and magnesium and also helps in understanding the chemical reactions of such

metals. We use soaps that are made through a process called saponification in chemistry, these soaps help in carrying out daily activities such as laundry (Ary *et al.,* 2018).

Everyone can and should understand basic chemistry, but it may be important to take a course in chemistry or even make a career out of it. It's important to understand chemistry if you are studying any of the sciences because all of the sciences involve matter and the interactions between types of matter. Students wanting to become doctors, nurses, physicists, nutritionists, geologists, pharmacists, and (of course) chemists all study chemistry. A student might want to make a career of chemistry because chemistry-related jobs are plentiful and high-paying. The importance of chemistry won't be diminished over time, so it remained a promising career path (Abelev *et al.,* 2014).

2.3 Goals and objectives of teaching chemistry in Kenya

Chemistry as a subject is introduced to the learners for the first time at secondary school level. The knowledge of chemistry is necessary in the understanding of the composition, properties and behaviour changes of matter that form the environment around us. This syllabus presents chemistry as a practical subject where scientific concepts, principles and skills are developed through experimental investigations. The learning of scientific knowledge by discovery method is encouraged. The topics and content have been carefully selected and logically organized to facilitate step by step realization of the expected behavioural changes. The specific objectives in every topic guided the teacher and the learner on the depth of treatment of content. The learning/teaching experiences have been appropriately chosen to ensure proper development of the cognitive, psychomotor and affective skills (Ary *et al.,* 2018).

The Goals of teaching Chemistry in Kenya is;

i. To provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
ii. To provide students with the skills required to succeed in graduate school, the chemical industry, or professional school.
iii. To expose the students to a breadth of experimental techniques using modern instrumentation.

The objectives of teaching Chemistry in Kenya show that the general objective of teaching Chemistry is to acquire knowledge, conceptual understanding, and skills to solve problems and make informed decisions in scientific contexts. Based on Gultepe (2016) stated the following objectives;

i. Use Chemistry to Address Scientific Inquiries.

Students must develop questions and use chemistry to determine the answers. This process is achieved by planning and implementing controlled experiments in which students make educated guesses, or hypotheses, about how chemicals will interact. When the experiments are complete, students must analyze and record their findings

ii. Connect Chemistry with Physical Science

Students must understand the structure of atoms and chemical reactions. Students may meet these objectives by creating and labeling models of atoms and writing and balancing chemical equations that show the new substances were created as a result of blending specific elements identified on the Periodic Table of Elements. Achieving this objective also means that students should familiarize themselves with key vocabulary words such as "catalyst," "proton," "neutron" and "electron."

iii. Connect Chemistry with Life Science

Students must investigate the relationship between chemical signals and cellular development. They also must study the way that body chemistry keeps humans alive and well. This objective may be met in part by creating models of neurons and analyzing the effects that specific behaviors have on humans' neurological development.

iv. Connect Chemistry with Earth Science

Students should identify and describe geochemical reactions, or chemical changes in the Earth. They may meet this objective by writing specific geochemical equations and investigating how geochemical reactions create natural phenomena such as mountain ranges and volcanoes.

They also may meet this standard by researching chemical reactions that occur in outer space.

v. Use Technology to Promote Scientific Understanding

Students must consciously integrate technology when conducting experiments. Students may use certain computer technology to simulate certain chemical reactions.

vi. Connect Chemistry and Contemporary Concerns

Students should investigate and demonstrate knowledge about the significance of chemistry to contemporary concerns. This study includes man-made and natural disasters. Lessons may meet this requirement by focusing on the chemical components of alternative energy, chemical creation of environmentally friendly products, effects of efforts to clean up the 2010 Deep Water Horizon oil spill, effects of the 2011 Fukushima meltdown and controversy surrounding the chemical components of vaccines.

vii. Connect Chemistry with History

Students must demonstrate knowledge of chemistry's effect on history by studying famous chemists. They also may identify and analyze the ways that specific chemical innovations have changed the way society functions and had a global effect on the world.

The syllabus emphasizes the use of International Units for Physical and Applied Chemistry (IUPAC) system of nomenclature, correct use of chemical terminologies and equations. There are applications and projects at the end of most of the topics to enable the learners link the subject with the physical environment around them. The learners would use the opportunities to interact with the physical and chemical processes, which take place within the local environment. The projects are meant to enhance creativity, critical thinking and ability to make logical decisions. The projects also make the learners aware of the effect of scientific knowledge in everyday life and thus able to appreciate their responsibility to the society (Carraher Jr, 2017).

The projects given are only examples. Teachers can come up with their own objectives; the learners are also encouraged to initiate their own projects based on the scientific principles so far learnt. This creates interest, curiosity and fun in the learning of the subject. Most of the apparatus, chemicals and equipment required for carrying out experiments are basic in most secondary schools. Improvisation and use of local materials is encouraged where necessary to cut down on costs. The suggested time is only a guide on how long each topic is expected to take (Lykknes & Suay-Matallana, 2017).

Further the main purpose of the teaching chemistry is: to encourage students to develop curiosity and a spirit of enterprise; to teach students to be aware of the safety of oneself and others in the laboratory and be committed to safe practices in daily life; to teach students to analyze data from experiments or from other sources; to acquire students a readiness in becoming responsible citizens in a changing world and to provide students with some insight into future career prospect in the fields related to Chemistry (doctor, teacher, engineer, nurse, dentist, pharmacist) (Thimmappa, 2017).

2.4 Students' achievement in chemistry at KCSE in Kenya

Chemistry as a subject is not performed well in national examination. According to KNEC 2018 report shows students achievement in Chemistry at KCSE for the years 2013 to 2017 as indicated on Table 1.

Table: 2.1: Students chemistry achievement in Kenya at KCSE (2013-2017)

Year	No of Candidates	Maximum Score	Mean Score (%)	Standard Deviation
2013	439,847	100	24.50	16.05
2014	478,582	100	32.15	17.82
2015	515,888	100	34.35	16.65
2016	566,836	100	23.71	16.74
2017	606,515	100	24.05	16.45

From Table 1 candidates doing chemistry increased from 566,836 in 2016 to 606,515 in 2017 an increment of about 7%. Chemistry performance improved between the years 2013 to 2015 with a mean score of 24.50 to mean of 34.35. Thereafter a drop from the 2015 to 2016 with means score falling from 34.35 to 23.71 respectively. Further there was a slight improvement in performance in the year 2017 to a mean score of 24.05 as reflected in the table. Low achievement is attributed to poor manipulative skills while performing practical work in chemistry classroom, poor mastery of chemistry concepts and lack of revision before sitting for the examination. KNEC 2018 recommended that good chemistry performance can be achieved by adopting the practical approach in teaching the subject (KNEC, 2018).

Students' low achievement in chemistry remain a matter of serious concern to the nation, despite education stakeholders investing heavily on new strategies such as introducing SMASSE INSET as one of the remedial measures to improve the achievement. One of the intentions of this study is to investigate the influence of SMASSE INSET on students' chemistry achievement.

2.5 Methods of teaching chemistry in secondary schools in Kenya

According to Gaitas and Martins (2017), the term teaching method refers to the general principles, pedagogy and management strategies used for classroom instruction. The principles and strategies used by teachers to help students to learn. Personal teaching philosophy and culture influence teaching methods. Andragogy and pedagogy are two teaching methods extensively considered in literature (Agonacs & Matos, 2019). The teaching methods of chemistry in secondary schools include; lecture method, Questioning method, Teacher Demonstrations method, Field work method and the project method.

a) Lecture method

The lecture method is a teaching method where the instructor acts as the primary information giver. The instructor typically stands in front of the students and may use a visual aid, such as a PowerPoint presentation, chalkboard or handout (Mong & Ruggiero, 2015).

Students are expected to listen and take notes during lectures, and there is limited interaction and exchange between teacher and student. The lecture method is common in college classes due to its convenience and ability to pass on information to a large group at once. Students who are not auditory learners or who lack note taking skills may struggle with the lecture method of teaching (Mong & Ruggiero, 2015).

In the lecture method, teacher is the only active participant and the pupils are the passive listeners. The teacher can deliver a lot of information to the pupils in a short time but the longer the lecture period, the less the pupils are able to retain. This is shown by the following data, when pupils are lectured to and then tested on their retention (Bhalli *et al.*, 2016).

Table 2.2: Lecture period and score

Time (Minutes)	% Score (Average)
15	41
30	25
45	22

The longer the lecture the more the mental fatigue leading to the loss of concentration. The lecture method would be appropriate in the following circumstances: When starting a new and difficult topic. When explaining certain difficult and theoretical points which cannot be shown practically when; summarizing and recapitulating certain generalizations and principles at the end of the lesson and when explaining some relevant background material of the topic (Oreovicz & Wankat, 2015).

Lecture methods can be broken into two types: Formal lecture where the teacher talks throughout with little response from the pupils. This teaching method should not be employed in chemistry teaching in secondary schools. Informal lecture; In this method, pupils give feedback through answering questions. The lecture is broken down into small bits and the teacher asks questions in order to offer stimulus variation, test what the pupils know, stimulate the pupils to think and enhance discipline (Oreovicz & Wankat, 2015).

Teachers should make their pupils active by basing the teaching on discussion. When pupils cannot make direct observations, they must be given the necessary information. A discussion can then be based on this information. In theory lessons, there should be frequent change of activity (stimulus variation). After a discussion, the teacher should have some individual work for the pupils. The teacher should then supervise the individual work and use it for further discussion (Pedroso *et al.,* 2016). Based on the current study teachers do not give close attention to supervision of students work after discussion.

b) Questioning Method

The questioning technique is a useful method in chemistry teaching because it can be used on its own, or as part of another method. It should always accompany the lecture method which then results to a class discussion. Questions have various aims, a few of which are listed as: Questions help to get feedback for the teacher as well as pupils; they help to understand the level of pupils that is their present level of learning and also help to promote interest. Change in activity helps to

sustain interest and the use of questions is a deviation from routine and to test comprehension, e.g., to find out how far the pupils understood the content (Catalan *et al.*, 2022).

c) Teacher Demonstrations

In a demonstration experiment, one person performs the experiment for the large group. These are performed when there is shortage of apparatus, safety is a priority and particular attention is needed in certain parts of the experiment which might be overlooked when the pupils do it alone (Catalan *et al.*, 2022).

Many schools have a shortage of equipment and chemicals hence teaching have to be based on demonstrations and not on class experiments. The danger in overdoing demonstrations is that pupils may become passive with time (Alemayehu & Zengele, 2016).

The planning of a Demonstration

The following are some hints to help the teacher in planning demonstration: Demonstrations must always be rehearsed before they are performed in front of the pupils before lesson starts, teacher should get the necessary apparatus and chemicals and arrange them in the order they are supposed to be used; the apparatus should be as long and simple as possible. This improves visibility of the demonstration; Mount the apparatus so that the pupils can watch the procedure from left to right; all pupils should be able to watch the demonstration. Remove anything that blocks their view. To increase visibility, the apparatus can be raised by placing them on a box placed on a desk. Pupils can be asked to get to the front for better visibility but they should not get too close to the demonstration table because of the safety risk. If the experiment is carried out in the laboratory, it can be done on the middle bench in order to increase visibility (Li *et al.*, 2019).

d) Field Work

Field work is part of good science teaching and is used in the study of chemistry. Its results from the need to illustrate the technical application of certain topics dealt with in the classroom. It provides the link between chemistry and technology. Fieldwork involves trips with the students to observe and investigate situations outside the laboratory (Nilson, 2016).

During the exploration phase, students analyze models to collect as much information as possible, looking for patterns and relationships. In the concept phase, students conceptualize the observed patterns and relationship and the name of the concept learned is revealed. Application phase is the last phase of the learning cycle and it is during this time that students apply concepts learned to new situations. Instructors guide to Process-Oriented Guided-Inquiry Learning (POGIL) breaks down the steps necessary to carry out a POGIL lesson. The teacher breaks the class into groups of four where each student had the job as a leader, recorder, presenter or evaluator. Groups are then given data, models, and/or information to analyze that is aimed to guide students learning. During this time, students answered guided questions that build off of the prior questions. Once the group had processed the information provided during the exploration phase, the students formulated their own hypothesis based on the patterns observed in the exploration phase. It was during this time the new learned concept was given a formal name. Both the exploration phase and the concept invention phase allow students to have a good working knowledge of the concepts process before a formal name is given. During the application phase, students newly learned concepts were tested by applying the material learned to new situations (Pedroso *et al.,* 2016).

e) The Project Method

The project work approach has a unique application in teaching-learning process. It provides a pupil with the opportunity to undertake investigations for the solution of problems. The application phase allows students to build confidence in what they have learned. Project-Based Learning is a method of teaching that facilitates learning though student engaged projects centered on concepts to be learned (Kirschner & Van-Merrienboer, 2017).

During the process of working on a project; students are creating, questioning, and revising knowledge, while developing their skills in critical thinking, collaboration, communication, reasoning, synthesis, and describes a successful project-based learning lesson with students More

efficient curriculum instruction, students learning skills outside of the required content, and relevance to student's life are a major reason why teachers choose project as a method of teaching. Today's chemistry teachers are faced with two main objectives when preparing lessons; (1) students' mastery of chemistry concepts and building 21st century skills for Science, Technology, Engineering and Mathematics (STEM) jobs. Chemistry teachers should focus on helping students build 21st century skills, such as critical thinking, creativity, meta-cognition or self-regulation, collaboration, information and technological literacy in an effort to make students more competitive in the workforce. Online blogging is an excellent way for chemistry teachers to teach chemistry concepts, build 21st century skills and keep students excited and focused about learning chemistry. While blogging can be done through discussion boards, using sites, such as a wiki, allows students to actually conduct group projects in class or at home while being able to monitor progress in real-time (Sharples *et al.*, 2016).

2.6 The impact of SMASSE INSET on students' achievements in mathematics and sciences

SMASSE Kenya personnel conducted Monitoring and Evaluation of application and impact of the principles of ASEI movement and PDSI approach in the classroom in Malawi, Rwanda, Zambia and Zimbabwe. The project observed positive impacts in terms of teachers" attitudes and classroom teaching and learning (Wafubwa, 2014). Teachers who had consistently undergone SMASSE training had shown positive attitudinal change towards their profession and improved on their lesson delivery. Students also had improved participation in the lessons (Koosimile & Suping, 2015). SMASSE is thus evaluated positively by WECSA member countries. The net impact on teachers showed that teachers planned better and more consistently; attended to students needs more; were more confident to carry out practical activities; tried out new methods; faced the challenges arising from lack of resources as well as the challenge arising from large classes as a follow up on the impact of SMASSE INSET (Wafubwa, 2014).

The net impact on students showed that, students: were actively involved in the learning process; showed great interest and responsiveness; attended the lesson more punctually and regularly; did their assignments more neatly and promptly; carried out discussions beyond class time; interest and curiosity was aroused and sustained as they related mathematics to the real life experiences; encouraged teamwork and allowed individual participation of the students; were provided with opportunities to develop key competencies such as problem solving, synthesis and application of

information (Glatthorn *et al.,* 2018). Midterm and end term evaluation conducted by JICA and GoK based on Development Assistant Committee criteria rated SMASSE INSET highly successful. Technical cooperation with JICA has expanded with primary mathematics and science teachers INSET launched in January 2009 for a period of five years. It is clear from the foregoing literature that SMASSE INSET has impacted positively on the teaching and learning of chemistry in the member countries (Glatthorn *et al.,* 2018). In this study the influence of SMASSE INSET on chemistry teachers' classroom practices, students' attitude and achievements was investigated.

2.7 Teachers' and students' attitudes towards chemistry in secondary schools

The SMASSE baseline survey of 1998/99 established that negative attitudes of students, teachers, parents and society in general contributed a lot to the poor performance in sciences. Kirikkaya (2011) defines attitude as favourable or unfavourable responses to things, places, people, events or ideas. Kahare (2012) sees attitude as simply the extent of liking or disliking of something. According to him attitudes are internal states that influence the individual choice of action. Mutai (2011) observes that attitude is a tendency, a state of readiness to act or react in a certain manner when confronted with a certain stimulus. Attitudes are reinforced by beliefs and often attract strong feeling that led to particular form of behaviour. The way people view situations in life depends on the attitude they hold and these attitudes compel them to react to objects, situation or propositions in ways that can be called favourable or unfavourable.

According to Czerniak and Krajcik (2018), behaviour is better predicted from an individual belief and that beliefs are the best indicators of decision individual makes throughout their lives. They stress the connection between teachers' attitudes and students" beliefs about science. When attitude is negative or unfavourable students take little or no interest in education and perform poorly in exams as Kirikkaya (2011) observes. Tseng *et al.* (2013) in their research on teachers' beliefs about the nature of science, students learning and the role of the teacher suggested that these beliefs do affect teachers" planning teaching and assessment. A teacher's belief about learning and knowledge strongly impacts the classroom climate enabling students to explore articulate and analyze their beliefs on topics. Maza and Niaz (2011) admitted that students have traditionally considered chemistry as being one of the most difficult areas of science. One of the reasons that make students shy away from chemistry is quantitative nature, also socio-cultural

factors where difficult tasks are seen as a male domain and also the contribution of the chemistry teacher in instilling negative attitude. Some students form negative attitudes towards chemistry long before they enroll in secondary school. This is due to the opinions they get from their parents, elder siblings, friends and sometimes teachers in their primary schools.

Negative attitudes are displayed through verbal expression such as "I hate Chemistry", "Chemistry is difficult" or can also be expressed through acted tendencies like: sleeping during the lesson, yawning in class and looking bored, absentmindedness during the lesson, refusing to participate in the practical activity and obtaining poor results that do not bother the student

According to Langat (2017) the SMASSE report noted that teachers' negative attitudes affected performance. Teachers" attitude determine the direction and action the students are likely to take. Teachers' positive attitudes have been shown to attract more interest in their class and students' attitudes are a reflection of teachers' attitudes. Though the teacher's negative attitudes may be due to the problems they encounter in their schools, their effect goes down to the classroom where it may be noted that teachers put little or no effort into preparation and performance of activities pertaining to effective teaching and learning. Further Bridges (2013) observes that unless the teacher has the attitude s/he desires to foster; it is unlikely that s/he has success in communicating to his/her students.

Attitudes once formed may be resistant to change since they are wrapped up within a persons' feelings, needs and the self-concept. To let them go therefore requires a change in the self and this requires much effort. 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 map-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. Some of the indicators of positive attitude were the levels of enjoyment of both teachers and students during the teaching and learning process, levels to which teachers engage student in practical work and the extent to which the teacher makes the learning environment friendly to the learner (Reeve, 2014). However, one of the intentions of this study is to find out whether SMASSE INSET can influence students' attitude towards chemistry as a subject.

2.8 Teachers' understanding of the ASEI-PDSI approach and its implementation in secondary schools in Kenya

It has been pointed out that the ASEI-PDSI approach is an innovative approach of teaching championed by the SMASSE INSET programme. Ater and No (2013) observed that innovation is one major type of change in which something new is added to an existing phenomenon; it means introducing something new that deviates from the standard practice. They stress that an innovation must be simple enough to be understood and utilized. Innovation is a deliberate attempt to improve practice in relation to certain desired objectives; it is a form of change (www.amazon.com). Innovation as a form of change should be technically sound; require change in structure of a traditional school; must be manageable; must be flexible; and must be focused on efforts, timing and resources according to the stated objectives (Costa *et al.,* 2015).

The implementation of change is often the most difficult part of the change process. Until people use the new idea, he observes, no change would have actually taken place. Innovations are sometimes not implemented as planned due to resistance to change. One of the factors that can lead to resistance to change is a lack of adequate resources. The study observes that implementation and institutionalization of new practices typically demand more resources that are used to support the existing practice (Onchong'a, 2013).

Further the study by Onchong'a (2013) noted that innovations are also impeded by a multiplicity and a lack of specificity of objectives; systemic implications, whereby an innovation in one part of a system has implications for the rest of the system; obsolete incentive structure, whereby an obsolete incentive structure may have negative influence on an innovation; lack of knowledge, whereby those who have to implement ban innovation are generally faced with a lack of knowledge about effective practices or the consequences of alternative plans; time constraint, whereby unrealistic demands are placed upon institutions due to pressure for change within a short period of time; and psychological barriers, whereby people tend to continue with activities which are known and which provide a certain security, rather than enter into activities with unknown consequences.

Ginsberg and Wlodkowski (2017) add that creativity enhances learning and makes teaching more effective. Teaching for creativity requires practitioners to be creative themselves and to foster a culture among learners, that values creativity. Implementation of the ASEI-PDSI approach

means putting the approach which is an innovation into practice. The implementation means taking the innovation to schools after the try-out has been completed. It involves among other things, persuading a variety of people to accept the innovation, keeping the general public informed, training the teachers, provision of necessary facilities, supply of materials and equipment, actual practice of the innovation, and providing continuous support for teachers (Onchong'a, 2013).

In order for the ASEI-PDSI approach to be effectively implemented, teachers require an adequate understanding of the approach and its components. The approach entails Activity focused teaching and learning, which calls for use of varied, appropriate and interesting teaching and learning activities by teachers, as well as having students conduct practical work; Student-centered teaching and learning, which calls for greater involvement of the learner in the learning process-this is done through effectively encouraging students to give their prior experiences and explaining their ideas related to the content; effectively encouraging students to give their own hypotheses/predictions and helped to discuss how they differed from those held by others and to verify them through experiments; effectively encouraging students to give their own observations and results in experiments and to discuss how they differed from those of others; and encouraging students to evaluate the lesson;

In experiments students should be given opportunities to perform experiments which enhance understanding of concepts in chemistry and science- this is evidenced by the ability of students to solve related problems; ability of students to make deductions from practical work; and the ability of students to verify hypotheses and predictions; and Improvisation: this calls for innovativeness and creativity on the part of the teacher and it involves improvising using materials available in the immediate environment of the students to give experiments and also arouse interest and curiosity in the learners-this is evidenced by the conduct of modified/simplified experiments; utilization of materials available in the students' immediate environment; teacher producing and or utilizing improvised materials; ability of the students to effectively use improvised materials; and enhanced students‟ participation (Ndirangu, 2018).

The following are the principles of ASEI: Knowledge-based teaching to be replaced by activity-based teaching; Student-centered learning to prevail over teacher-centered teaching; Experiment and research-based approaches to replace the traditional lecture approach; and Improvisation and

small-scale experiments to replace large-scale experiments. For the principles of ASEI to be put into effective use, the PDSI (Plan, Do, See, and Improve) approach is recommended. This entails:

Planning: this involves proper planning of the lesson based on the ASEI principles- lessons should cater for learners‟ background, needs, interests, misconceptions and prior knowledge related to the lesson content; work plan should be appropriate and realistic in light of the lesson content and students‟ abilities, skills and interests; and the teacher should prepare appropriate and adequate materials for students‟ use;

Doing: this is concerned with lesson delivery; the instructional process based on the plan- introduction of the lesson should incorporate previous knowledge, skills and everyday experience and linked the topic; the introduction should be clear on what the teacher wants the students to learn besides being stimulating enough to arouse the interest and curiosity of the students; the lesson should encourage students to express their prior experiences and explain their ideas related to the content; students should be encouraged to give their own hypotheses and predictions and helped to discuss how they differ from those held by others and to verify them through experiments; students should be encouraged to give their own observations and results in experiments and to discuss how they differ from those of others; teacher should deal with students‟ questions, misconceptions and reinforce learning at each step; lesson should encourage active participation of students as much as possible in the main teaching steps; lesson should encourage students to draw conclusions; teacher should summarize the lesson and give follow-up activities; teacher should check the accuracy, correctness, depth and appropriateness of the content through question and answer techniques; teacher should organize and conduct the lesson taking into account the individual differences in student capability; and the teacher should make effective use of the teaching and learning materials and media;

Seeing: this involves evaluation of the lesson at all stages of its development- teacher should supervise class work; teacher should be attentive to the needs of students; teacher should keep eye contact on students to monitor their feelings; teacher should invite questions from students; and the teacher should ask questions to check quality of understanding;

Improvement: this involves making appropriate improvements during the development of the lesson and/or in the subsequent lessons based on the feedback obtained in the See component of this approach. This is evidenced by the teacher rephrasing questions or instructional statements as necessary; teacher interjecting rightly and calling to attention inattentive students; teacher giving further guidance to students on lesson activities; and the teacher making appropriate adjustments in the conduct of the lesson (Onchong'a, 2013).

A study by Perrott (2014) showed that teachers who have a sound understanding of an innovative teaching approach implement it effectively. In their study to measure the extent and ability to which the Teaching English for Life Learning (TELL) strategies and methods were being implemented in Ethiopian schools. Tom (2017) established that the TELL strategies and methods were being effectively implemented as a result of a high understanding of the strategies and methods by teachers who had undergone the TELL training.

In a related study, Kallery (2018) found out that teachers who had undergone an In-Service education and training programme in languages, social sciences and chemistry were not able to effectively implement the programme procedures. This was attributed to failure to understand the new procedures of teaching the above subject areas. In addition, the study established that the new teaching procedures could not be implemented within the teaching time allocated to the respective learning areas. Teachers also felt that the paperwork involved in the implementation of the new procedures had increased their workload unnecessarily.

The training was organized by the Department of Education, Republic of South Africa. It was also aimed at determining whether the training contributed to meeting the intellectual and professional challenges facing South Africans in the 21st century. The study followed a qualitative approach. Data was collected from Grade Nine Teachers responsible for teaching languages, social sciences and chemistry in three rural schools. ASEI-PDSI being a teaching approach introduced by SMASSE was investigated if it has had an influence on chemistry teacher's classroom practices, students' attitude and chemistry achievement.

2.9 School principals' supervision of implementation of ASEI-PDSI approach in secondary school in Kenya

Modern school supervision can be defined as a positive action aimed at the improvement of classroom instruction through the continual growth of all concerned- the child, the teacher, the

supervisor, the administrator, and the parent or other interested lay person. The study adds that the major purpose of instructional supervision can be said to be to oversee the implementation of educational policies and to ascertain whether the implementation is being done effectively (Zepeda, 2013).

According to Nyongesa (2014), the head-teacher is the leader in a school, the pivot around which many aspects of the school revolve, and the person in charge of every detail of the running of the school, be it academic or administrative. One of the roles of the head teacher as an instructional supervisor is to supply learning-teaching materials. Teachers as well as students need to be supplied with the materials necessary for the effective teaching-learning process. The materials should not only be available but must be of good quality. The head teacher should make sure that such materials and any other are in the school before teachers and students require utilizing them. A good system for prompt delivery is therefore essential.

According to Moyo (2014), effective management of curriculum implementation depends on the availability, control and monitoring of human, financial and physical resources. These resources include learners, staff members, supplies, timetables, textbooks, teaching aids, facilities and so forth. Ajibade and Rembe (2018) further emphasize the importance of adequate financial resources as a crucial implementation indicator in curriculum implementation management. The study highlights the importance of management of physical resources, as the nature and availability of these resources directly affect the teachers‟ and the learners‟ ability to engage in effective teaching and learning.

Carrying out classroom visits to observe lessons is another role of the head teacher. According to Mbae (2016), the Manual of Heads of Secondary Schools in Kenya stresses this role by noting that in particular, the head teacher must check the teaching standards by reference to the schemes of work, lesson notes, pupils‟ exercise books, records of work done; and by actual visits to the classroom to see the work of individual teachers. Rhodes and Fletcher (2013) also promote classroom observation as a form of performance management. However, these authors strongly believe that this should be done by trained mentors who are able to provide support regarding teaching, learning and classroom management to the observed teachers before, during and after the observation session. In this regard, Lyons and Pastore (2016) stress the importance of regular and constructive feedback to the monitored and evaluated parties.

Another role of the head teacher in instructional supervision is to hold individual discussions with teachers. These are usually held after classroom visits or at the request of the teacher or supervisor. They can be most valuable in providing for an exchange of ideas, and in identifying possible areas for curriculum study or for the teachers‟ professional growth. It is also the role of the head teacher to carry out evaluation of curriculum implementation. Through evaluation, the supervisor enabled the educational process within the organization to be more effective in achievement of set goals and objectives. A good programme is not complete without an evaluation report (Campbell, 2014).

According to Onchong'a (2013), the specific roles of school principals in the SMASSE programme include: utilizing scarce resources at their disposal more rationally towards academic activities for the benefit of the learners; mobilize all available resources, both human and physical, for enhancement of teaching and learning activities; conduct regular school-based supervision of teaching and learning activities; and organize regular seminars and workshops for chemistry and science teachers through science congress.

Studies conducted reveal that school principals indeed have a significant role to play in a teacher's teaching practices. In her study, Wambui (2015) found that school principals had a significant effect on teachers‟ teaching practices. Though the roles of the school principals are clearly spelt out, it has been revealed that some school principals never carry them out as required, with the result being poor curriculum implementation as reflected in performance in national examinations. Studies show that head-teachers who focus on other issues rather than internal supervision record poor results in examinations.

According to Aguttu (2013) many head-teachers of schools spend more time with finance management than with the curriculum and instruction, and student personnel. School principals seem to believe that they are only accountable for financial management of their schools because they are liable for prosecution if financial mismanagement is discovered. Competency of the head teacher is essential for proper supervision. Some studies have established that school principals' lack of effective training in educational administration, hence lacking the competency to effectively carry out effective supervision of exams.

Alabu (2013) studied competencies needed by school principals and implications for pre-service and in-service teacher education in Nairobi and Kakamega Districts. The study found that school heads lack effective training in educational administration, thus lacking the expertise to carry out effective supervision and evaluation of the curriculum practice in the schools. The study recommended the need to train educational principals at school level in management knowledge and skills which will enable them to carry out effective supervision and evaluation of the curriculum. Implementation of SMASSE being an in-service training funded by the government of Kenya and teachers attend without paying a fee its supervision is crucial. This study investigated if the approaches learnt at SMASSE INSET influence chemistry teachers' classroom practices, students' attitude and achievement.

2.10 Teachers' usage of the ASEI-PDSI approach in secondary schools in Kenya

Evaluation relating to the extent of usage of an innovative teaching approach is critical in any programme or training. Evaluation facilitates informed decision-making that led to improvement. They also observe that evaluation attempts to show the cause-effect relationships between programme activities, and the change they may have observed; is important for accountability; and is an educational process that assesses the extent of people's participation, how well participants are doing, and what effect the programme is having on the intended beneficiaries (Costa *et al.*, 2015).

The SMASSE INSET conducts monitoring and evaluation to improve the quality of programme activities and also to provide justification for continued allocation of resources into the programme. The monitoring and evaluation instruments developed by SMASSE are aimed at: measuring change of attitudes among INSET participants; measuring the extent to which content mastery and pedagogical skills have been upgraded; measuring upgrading in quality of teaching and learning; determining the quality of INSET sessions; and monitoring prudent financial practices (Bett, 2016).

According to Owuor (2014), the nationwide SMASSE INSET impact assessment survey conducted in 2009 established that teachers who had been exposed to the ASEI-PDSI approach planned better and more consistently, attended to students' needs better, were more open to teamwork, were more confident, tried out new methods of teaching, and were better equipped to face the challenge of large classes and lack of resources. Equally, it was established that students

being handled by such teachers were actively involved in the learning process, and showed great interest and did their assignments more readily and promptly, carried discussions beyond class time, had an improved relationship with the teacher, developed teamwork, and their attitude towards mathematics had changed for the better. In the study, quantitative data was collected using questionnaires for students, teachers and school principals.

In addition, students wrote an achievement test based on chemistry and science subjects. It was found out that there was a statistically significant positive effect on students‟ achievement (as measured by the achievement tests) as a result of implementation of the SMASSE INSET. Equally, it was found out that the students' ability was significantly predicted by the students' attitude towards the subject. In addition, it was found out that school principals had significant effect on teachers‟ teaching practices. It should be noted that this kind of evaluation is internal. Evaluation for funded programmes is carried out for two reasons. Firstly, it is done to fulfill a contract or grant commitment. And secondly, it may be a kind of delaying tactic or a way to shift responsibility or get favourable publicity for the programme. For the case of SMASSE, the evaluation was possibly done to justify the continued allocation of resources into the programme. This calls for independent studies to verify the evaluation results obtained by SMASSE‟s internal evaluators. Some external studies relating to the usage of the ASEI-PDSI approach have also been carried out (Tom, 2017).

A study by Onchong'a (2013) found out that while teachers perceived the SMASSE INSET programme as having been effective in exposing them to a student-centered approach, this was not reflected in their classroom practices which were largely teacher-dominated. This was partly attributed to large classes, the use of English as second language, and pressure to cover the syllabuses in preparation of the national examinations. The study, whose purpose was to assess the effectiveness of the SMASSE and School-based Teacher Development programmes in the Kenyan primary and secondary schools sampled four districts and held interviews with 185 teachers. The researchers equally observed lessons and held focus group discussions with pupils and students. The study recommended that the Ministry of Education should mainstream INSET programmes in its policy for teacher development.

Studies whose focus includes the use of the ASEI-PDSI approach have been conducted by some researchers. According to Rammiki (2016) majority of the physics teachers (over 80%) in

Murang'a District were using the ASEI-PDSI approach in the teaching and learning of physics. Besides, the instructional materials used by physics teachers who had undergone the SMASSE training differ from those used by physics teachers who had not attended the SMASSE INSET.

Rammiki (2016) studied the impact of SMASSE Programme on teaching of physics in Selected Schools in Murang'a district, Kenya. The study identified lack of adequate time and materials for improvisation as the cardinal challenges in the implementation of the ASEI principle and PDSI approach. The study had employed proportional sampling to obtain a sample of 49 physics teachers who filled out questionnaires, and purposive sampling to select 10 teachers whose lessons were observed. An observation schedule was used to collect the observed data. Similar findings emerged from studies conducted by Wafubwa (2014). SMASSE advocate for the use of ASEI-PDSI as a teaching approach therefore this study seeks to investigate the influence of SMASSE INSET on chemistry teachers' classroom practices as one of the objectives of the study. Table 3 shows the comparison of Conventional Methods to ASEI-PDSI Teaching approach.

Table 2.3 : Comparison of ASEI-PDSI with conventional teaching methods

Dimension	**Conventional Methods**	**ASEI-PDSI teaching approach**
View of learning	Transmission of knowledge	Transformation of knowledge
Power relation	Emphasize on teachers' authority	Teachers as learner among learners
Teachers' role	Providing mainly frontal instruction	Facilitating learning
View of knowledge	Presented as certain application problem solving	Construction of personal knowledge; identification of problems
Learning experiences	Knowledge of facts, concepts and skills, focus on content and product	Emphasize on process learning skills, self-inquiry, social and communicative skills.
Control of process	Mainly teacher structured learning	Emphasis on learner self-directed learning.
Motivation	Mainly extrinsic	Mainly intrinsic
Evaluation	Product oriented, achievement testing, criterion referencing	Process oriented; reflection on process; self-assessment; criterion referencing.
Learners' role	Relatively passive recipient of information	Active participation

2.11 Theoretical framework

This study was based on Jean Piaget constructivist theory of learning (Rannikmae *et al.*, 2020). Constructivist theory states that learning is an active process where the learner creates meaning from different experiences (Bada & Olusegun, 2015). The facets of the process include selection and transformation of information, decision making, generating hypothesis and making meaning from information and experiences while relying on cognitive structure to do so. Cognitive

structure (i.e., schema or mental models) provides meaning and organization to experiences and allows the individual to "to go beyond the information given". According to Bruner, learners construct new ideas based upon their current and past knowledge. Instruction can be made more effective by providing a careful sequencing of materials to allow learners build upon what they already know in order to discover the key principles by themselves.

Brooks (2015) notes means that a teacher cannot "pour" information into a student's brain and expect them to process it and apply it correctly later. The teacher facilitates moderates and suggests while allowing the students to experiment asks questions or perform activities that require the student's full participation. The teacher may also provide tools such as problem solving and inquiry-based activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge collaboratively. Constructivist learning is a personal endeavor, whereby internalized concepts, rules and general principles may be consequently applied in a practical real-world context. It gives students ownership of what they learn and by grounding it in an authentic the real-world context, constructivism stimulates and engages them. Constructivist posits that knowledge is constructed when individual engages in talk and activity about a problem or task. Learning is seen as a process by which individuals are introduced to a culture by more skilled members.

Constructivist theory of learning is relevant to this study because it has many variations such as active learning upon which SMASSE is based and discovery and knowledge building. It promotes a student free explanation within a given framework or structure. The teacher acts as a facilitator who encourages students to discover principles for themselves and construct knowledge by working to solve realistic problem. Constructivist learning has wide ranging impact on teaching methods in education and is an underlying theme of many education reform movements like the SMASSE programme. The ASEI/PDSI paradigms advocated by SMASSE become powerful in ensuring meaningful teaching and learning of chemistry in secondary schools.

2.12 Conceptual framework

A conceptual framework is a diagrammatic presentation of the theory which is presented as a model where research variables and the relationship between them are translated into visual picture to illustrate the interconnections between the independent and dependent variables (Onen, 2016). The study was discussed based on the relationship between the independent variables (SMASSE INSET), extraneous variable (Teaching experience, Professional Training of Chemistry Teachers and Teaching & learning resources) and the dependent variable (Students' attitudes towards chemistry, teachers' classroom practices and Students' KCSE chemistry achievements). Figure 1 is a conceptual framework showing the relationship between the independent, extraneous and dependent variables.

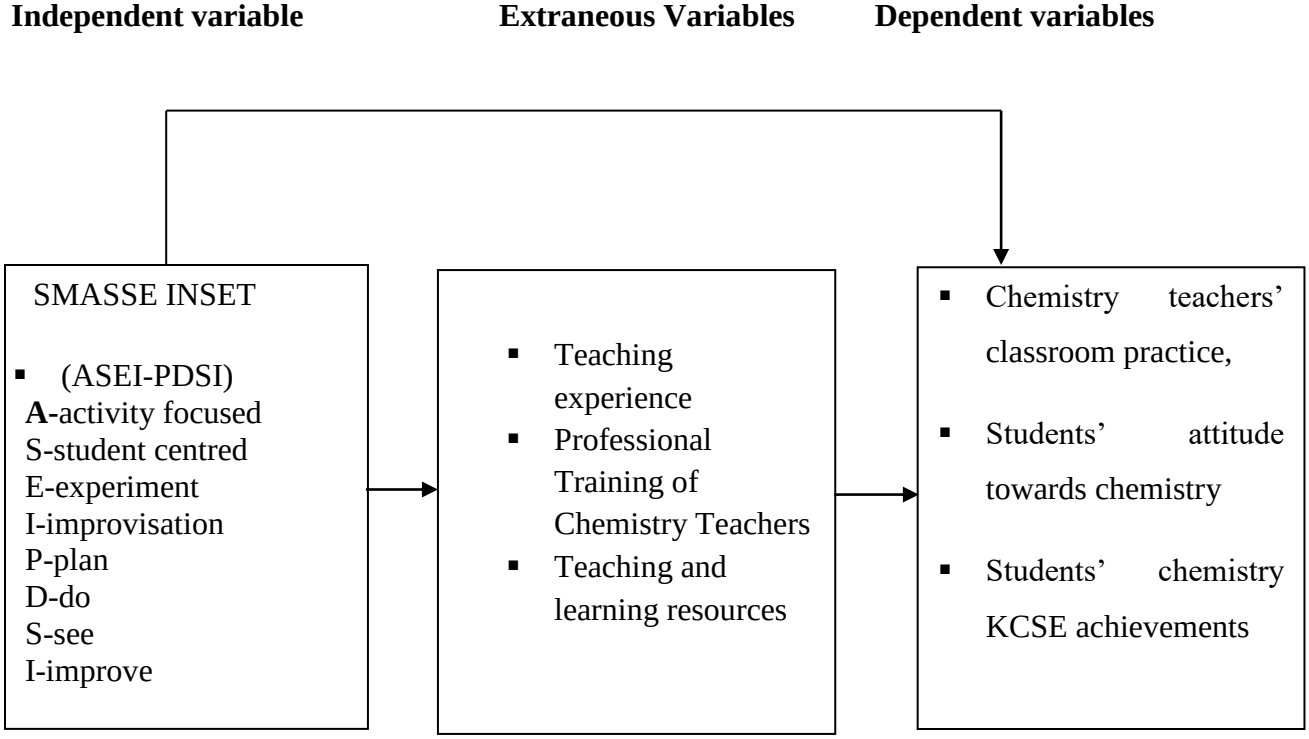

Figure 2.1: Conceptual framework

In conceptualizing the study, the study sought to point out how the independent variable SMASSE INSET interacts with the dependent variables: (chemistry teachers' classroom practice, students' attitude towards chemistry and Students' Chemistry KCSE achievement) as shown in Figure1. The study hypothesized that for high educational output (achievement) to be realized, the SMASSE INSET has to succeed in positively impacting on improving chemistry teacher's classroom practices and changing positively students' attitudes towards chemistry. The influence

of the extraneous variables such as teaching experience, was controlled by purposively selecting teachers who had attended SMASSE INSET, Professional Training of Chemistry Teachers was controlled by involving teachers with minimum professional qualification of Diploma and learning resources was controlled by purposely selecting schools of different categories depending on their frequency in the sub county.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents procedures that were followed in carrying out the study. It presents research design, study area, study populations, sample and sampling procedures, study variables, research instruments, validity and reliability of the research instruments and analysis techniques.

3.2 Research design

The study adopted a cross-sectional study which is descriptive research design. According to Flick (2014) descriptive research is a process of collecting data in order to test hypothesis or to answer questions concerning the current status of the subject in the study. Cross-sectional studies are usually relatively inexpensive and allow researchers to collect a great deal of information quite quickly. Data is often obtained using self-report assessments and researchers are then able to amass large amounts of information from a large pool of participants. Creswell and Creswell (2017) stated that descriptive study designs are used in preliminary and exploratory studies to allow researchers to gather information, summarize, present and interpret for the purpose of clarification. The descriptive research is useful because of the economy of taking a sample of the population to generalize results for the whole population. Descriptive study design was employed because it guarantees breadth of information and accurate descriptive analysis of characteristics of a sample which can be used to make inferences about population (Rubin & Babbie, 2016). Mwihaki (2019) explains descriptive survey as a method of collecting information by administering a questionnaire to a sample of individuals. It can be used when collecting information about peoples' attitudes, opinions, habits or any of the variety of education or social issues. This study design is most appropriate for this study because the data was collected from teachers and students directly, then the sample was used to generalize results for the whole population.

3.3 Study location

The location of the study was Nandi East Sub-County, one of the six sub counties of Nandi County. The sub county is located in Eastern part of Nandi County, The Sub-County has 2 extra county schools, 6 county and 22 Sub-County schools totaling to 30 schools, with a teaching work force of 98 chemistry teachers, both employed by government and school board of management. The Sub-County was purposely selected because majority of the chemistry teachers had

participated in SMASSE INSET by the time the study was conducted. Furthermore, performance of students in chemistry subject was poor despite being taught by SMASSE INSET in-service trained teachers.

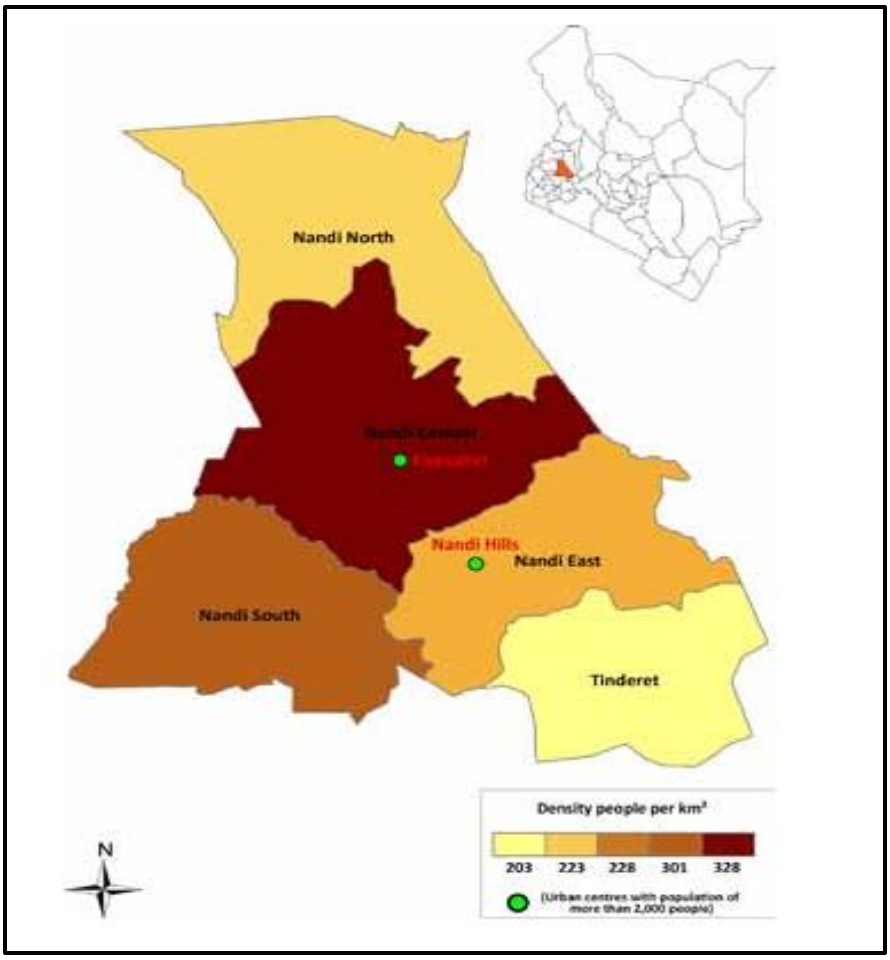

Figure 3.1: Nandi County map

3.4 Target population

Bell *et al.* (2017) describes population as entire group of individuals and objects with common observable characteristics. It is the larger population from which sample is selected. The study targeted 98 chemistry teachers who have participated in SMASSE INSET and 13620 chemistry students of the 30 public secondary schools in Nandi East Sub-County, Nandi County. Table 4 shows the target population of chemistry teachers and chemistry students. The accessible population of the students is 1574.

Table 3.1: Target population

Groups	Target population
Chemistry teachers	98
Chemistry students	13620

3.5 Sampling procedures and sample size

The study employed purposive sampling to select one extra county, two county and three sub-county secondary schools. The order of selection is based on their availability since extra county are very few, county was moderately available and sub-county are mostly available. The sampling unit for the study was individual chemistry teachers and individual chemistry students. Kahare (2017) observes that a sample size of 10-20% of population is acceptable in a descriptive survey. Purposive sampling was used in sampling 19 chemistry teachers in the sampled schools. The students were selected through systematic sampling by use of chemistry teacher's progressive record book to ensure equal and fair representation of all students in the class. Form ones were left out, since they had not covered substantial work in chemistry course.

The total numbers of accessible students sampled were 1574 from the sampled schools (6) and the study sampled 10.2% of the accessible population which was 160 chemistry students. Simple random sampling was employed to pick five chemistry students in each participating class. Table 3.2 show the accessible population and sample size of chemistry teachers and chemistry students.

Table 3.2: Sample size

Groups	Accessible population	Sample size
Chemistry teachers	19	19
Chemistry students	1574	160

3.6 Instrumentation

The data for this study was generated using chemistry teachers' questionnaires (CTQ), chemistry students' questionnaires (CSQ) and Head of Science department data sheet. The questionnaires were administered to 19 Chemistry teachers, 160 chemistry students and 6 Head of Science department data sheets.

According to Gold and Windscheid (2020), questionnaires are good in that standard instructions are given to all subjects and the personal appearance, mood or conduct of the researcher did not affect the results. Questionnaires as Vivian (2017) observe helps the researcher to obtain information from a large sample in diverse regions and it upholds confidentiality. The researcher developed two sets of questionnaires to be used to collect data: Chemistry teachers' questionnaire (CTQ) and Chemistry students' questionnaire (CSQ).

3.6.1 Chemistry teachers' questionnaire (CTQ)

Chemistry teachers' questionnaire (CTQ) had two sections; Section one collected demographic data on the background of the respondents, which included their school category, gender, professional qualification, years of teaching experience, teaching load and SMASSE INSET attendance. Section two sought to assess the influence of SMASSE INSET on teachers' classroom practices. The section had 13 items on the areas of a chemistry teacher focus on in the process of delivering ASEI-PDSI lesson. This section had a minimum score of 13 and a maximum score of 39. The responses were scored on a 3-point likert scale, which were i.e. 3(Very frequent), 2(Frequent) and 1(Not frequent).

3.6.2 Chemistry students' questionnaire (CSQ)

Chemistry Students' questionnaire (CSQ) had two main sections. Section one was used to gauge students' attitude. This section had 12 likert type items on students' interest towards chemistry subject and chemistry teacher. The responses were assigned scores between 1 to 5 where 5(Strongly Agree), 4(Agree), 3(Undecided), 2(Disagree), and 1(Strongly disagree) which was used to determine the measure of attributes using descriptive statistics. Students were required to indicate whether they Strongly Agree, Agree, Undecided, Disagree or Strongly disagree with the statements. Section one of the questionnaire had a minimum score of 12 and a maximum score of 60. Section two was used to assess students' level of participation during chemistry lessons. This section had also 10 likert type items on students' participation during chemistry lessons. The responses were assigned scores 1-3 where 1 represents No participation, 2 represents Passive participation and 3 represents Active participation which were used to determine students' participation level in chemistry lesson using descriptive statistics. Students were required to indicate whether they don't participate, passively participate or actively participate. This section had a minimum score of 10 and maximum score of 30.

3.6.3 Data sheet

The study used data sheet to collect information from Heads of Science Departments to measure the student's achievement in chemistry before and after SMASSE INSET. The data sheet showed the school code, school category and KCSE performance mean scores of boys and girls between the year 2010-2019.

3.7 Piloting of research instruments

The research instruments were pre-tested in one public secondary school in Nandi Central Sub-County. Piloting was done to refine the instruments before they were applied in actual research. Majid *et al.* (2017) observed that piloting ensures that research instruments are clearly stated and have the same meaning to all respondents. Since the actual study was done in 6 out of 30 schools in the Sub-County, pre-testing in one school constituted 20% coverage of the total sampled population. Pre-testing ensure that the instruments are of acceptable reliability and validity.

3.7.1 Validity of the research instruments

Validity is the degree to which the results obtained from the analysis of data actually represent the phenomenon under study. Validity has to do with how accurately the data obtained in the

study represent the variables of the study (Bell *et al.,* 2017). According to Setiawan and Sudiapermana (2022) validity is concerned with whether one is measuring what he intends to measure. The study used content and face validity whereby the study discussed with colleagues, consulted and got expert judgment on research instruments from the supervisors who validated and enhanced the value and content of research instruments.

3.7.2 Reliability of the research instruments

Reliability is a measure of how consistent the results from a test are. Reliability was ensured through piloting survey. Piloted data was used to test reliability using Cronbach's alpha. The Cronbach's alpha of coefficient value 0.7 and above is acceptable since it indicates reliable. According to George and Mallery (2016) if the value of alpha is equal or greater than 0.7 it is acceptable and reliable while a value less than 0.7 is unacceptable and therefore not reliable. The results of the piloted survey gave Cronbach's alpha of coefficient value of more than 0.8, where chemistry teachers` classroom practices had 0.931, and students' attitude towards chemistry subject had 0.885 as shown in Table 6. The study findings indicated that the research instruments were reliable. It therefore enabled the researcher to determine the consistency of responses and adjust items accordingly. This was in agreement with Weru (2013) who pointed that a Coefficient of 0.7 is a commonly accepted rule of thumb that indicates acceptable reliability and 0.8 or higher indicated good reliability.

Table 3.3: Reliability Test

Variables	Cronbach's Alpha
Chemistry teachers` classroom practices	.931
Students' attitude towards chemistry subject	.885

3.8 Data collection procedure

After getting introduction letter from Graduate school, Egerton University, the researcher obtained the research permit from The National Commission for Science, Technology and Innovation (NACOSTI). Then the researcher travelled to Nandi County offices to inform the offices of the intention to carry out the study. The researcher was granted permission by Nandi County commissioner to carry out research in the county for a period ending 30th July, 2022. Then Nandi East sub county director of education wrote to researcher the introductory letters

authorizing visits to the schools involved in the study and informed principals of the schools of the intended study. After acquiring the permission, the researcher proceeded to the targeted public secondary schools in Nandi East Sub-County and to collected data. Thereafter the researcher went to selected schools on different days of the month of May, 2022 and administered chemistry teachers' questionnaires (CTQ), chemistry student questionnaires (CSQ) and Data sheet. The school principal assisted the researcher in administration of the questionnaires and data sheet by identifying the chemistry teachers, chemistry students and Head of Science Department. Filled questionnaires and data sheets were collected the same day.

3.9 Data analysis

Before processing the data, the questionnaire was edited for completeness and consistency. This ensured the completeness of the questionnaire as required and coded to facilitate statistical analysis. Responses to the survey was catalogued by the number of responses to each question and entered in SPSS program version 21 for analysis. Data was analyzed using both descriptive and inferential statistics. Descriptive statistics such as frequency tables and percentages were used for the purpose of presentations and description in form of frequency distribution tables. Inferentially data was analyzed using Pearson correlation and linear regression model. Linear Regression model showed the relationship between the dependent and the independent variables. Table 7 shows summary of data analysis.

Statistical measurement model

$Y_1 = \beta 0 + \beta_1 X_1 + \varepsilon$

$Y_2 = \beta 0 + \beta_1 X_1 + \varepsilon$

Where

X_1 represents SMASSE INSET

β_0 represents Constant

β_1 represents the coefficient for Y_1 (Where i = 1, 2,3)

Y_1 represents Chemistry teachers` classroom practices

Y_2 represents Students' attitude towards chemistry subject

ε represents Error term

Table 3.4: Summary of data analysis

S.N	Research Hypotheses	Independent variable	Dependent variable	Statistical method of analysis
1	**$H_0$1:** SMASSE INSET has no statistically significant influence on chemistry teachers` classroom practices.	SMASSE INSET	Teachers' classroom practices	Descriptive statistics, Pearson correlation Linear regression model ($Y_1= \beta0 + \beta_1X_1 +\varepsilon$)
2	**$H_0$2:** SMASSE INSET has no statistically significant influence on students' attitude towards chemistry subject.	SMASSE INSET	Attitude of student toward chemistry	Descriptive statistics, Pearson correlation Linear regression model ($Y_2= \beta0 + \beta_1X_1 +\varepsilon$)
3	**$H_0$3:** SMASSE INSET has no statistically significant difference in chemistry achievement before and after.	SMASSE INSET	Students` chemistry achievement in KCSE	Descriptive statistics, t test

3.10 Ethical consideration

According to Harriss *et al.* (2017), ethical considerations in research are a set of principles that guide your research designs and practices. Scientists and researchers must always adhere to a certain code of conduct when collecting data from people. The following principles guided the study, voluntary participation of the respondents when collecting data; informed consent form was signed to allow students participate in data collection without violating their rights to either participating or not-participating. The study participants selected were at liberty to either participate in the study or not. All those participating was not coerced into participating in the study as the researcher wrote notifications in advance for any of the participant 's thus promoting informed consent for all those to be involved. The anonymity principle on participants was

adhered to, all the participants did not show their real names for identity but codes were used instead. In this regard, the names of the respondents were not disclosed. Further, confidentiality principle was adopted since all the information garnered in the study was kept confidential and protected for academic purpose only.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

Chapter four focuses on study results and discussions of the data findings collected on the influence of SMASSE INSET on chemistry teachers' classroom practices, students' attitude and achievements in public secondary schools in Nandi East Sub-County, Nandi County, Kenya. The guiding objectives of the study were;

i. To find out the influence of SMASSE INSET on chemistry teachers` classroom practices.
ii. To find out the influence of SMASSE INSET on students' attitude towards chemistry subject.
iii. To find out the difference in students' chemistry achievement before and after SMASSE INSET.

The chapter is divided into sections that include demographic characteristics of the respondents, influence of SMASSE INSET on chemistry teachers` classroom practices, influence of SMASSE INSET on students' attitude towards chemistry subject and the difference in chemistry achievement at KCSE before and after SMASSE INSET. The study results are analyzed using descriptive and inferential statistics.

4.2 Demographic characteristics of the respondents

Section 4.2 describes demographic characteristics of the sampled respondents that participated in the study. The following were discussed, response rate, category of the school, gender, professional qualification, teaching experience, teaching load and teacher - student ratio.

4.2.1 Distribution of response rate

The response rate of the study is shown in Table 8.

Table 4.1: Response rate

Category	Frequency	Percentage
Teachers Questionnaires Administered	19	100.0
Returned	18	94.7
Students Questionnaires Administered	160	100.0
Returned	145	90.6
Combined Questionnaires Administered	179	100.0
Returned	163	91.1

The researcher administered 179 questionnaires to the respondents (160 questionnaires to students and 19 to teachers). Out of the administered questionnaires 163 were dully filled and returned for data analysis (145 questionnaires to students and 18 to teachers). The remaining 10 questionnaires were incompletely filled therefore could not be analysed, while 6 did not return from the respondents, they misplaced it while some said theirs were torn accidentally. Therefore, the response rate of this research study was 91.1% (90.6% for students and 94.7% for teachers). The response rate of questionnaires was appropriate for the study analysis based on De Leeuw (2018) who asserted that the response rate of 70 percent and above is satisfactory to conduct adequate data analysis.

4.2.2 Distribution of teachers by school category

The study examined characteristics of the respondents. The first evaluation was on the distribution of teachers by their school category. The study categorized secondary schools into three major groups that exist in the region; extra-county, county and sub-county. The findings were illustrated in Table 9.

Table 4.2: Distribution of teachers by their school category

School category	Frequency	Percent
County	6	33.3
Extra-County	4	22.2
Sub-county	8	44.4
Total	**18**	**100.0**

Table 9 indicates that majority, 44.4 percent of the sampled teachers were drawn from the sub-county level, 33.3 percent came from county and the remaining 22.2 percent came from extra-county level secondary school. The variation in the number of teachers drawn from each category was based on the number of schools in each category and the number of Chemistry SMASSE INSET cycles. Sub-county secondary schools proved to be more than the county and the extra county schools in the region. The sub-county secondary schools are more because the ministry of education through Free Secondary Education rolled out a program that ensure each sub-county have built enough secondary schools that will enable all children to attend school as day scholars

4.2.3 Gender of the chemistry teachers

Secondly the study evaluated gender characteristics of the sampled chemistry teachers. The distribution of teachers by their gender was illustrated in Table 10.

Table 4.3: Distribution of teachers by gender

Gender	Frequency	Percent
Male	11	61.1
Female	7	38.9
Total	**18**	**100.0**

Table 10 indicates the distribution of the gender of the sampled teachers. Majority 61.1 percent of the sampled teachers were male while the 38.9 percent were female teachers. The gender distribution revealed that more teachers teaching chemistry were male compared to the female counterparts. In summary male teachers like chemistry subjects since their number is higher than the female chemistry teachers.

4.2.4 Distribution of teachers by professional qualification

Thirdly, the study also examined the distribution of professional qualification of chemistry teachers that were sampled. Table 11 illustrates teachers' professional qualification.

Table 4.4: Distribution of teachers by professional qualification

Professional qualification	Frequency	Percent
Diploma Education	2	11.1
Post Graduate Diploma	2	11.1
Bachelors of education	12	66.7
M.ED/MSC/MA	2	11.1
Total	**18**	**100.0**

Table 11 illustrates that majority of the sampled teacher's 66.7 percent had bachelor's degree in education, 11.1 percent had diploma in education, another 11.1 percent had post graduate in diploma and the remaining 11.1 percent had masters. The findings suggest that all teachers had adequate professional qualification to undertake chemistry teaching responsibilities and meet educational needs of the chemistry students. All teachers were competent and provided appropriate information during data collection period since they could read and understand the questionnaires administered.

4.2.5 Distribution of teachers by teaching experience

Fourthly, the study was interested to find out chemistry teachers teaching experience. The findings are presented on Table 12.

Table 4.5: Distribution of teachers by teaching experience

	Frequency	Percent
1-5 Years	2	11.1
6-10 Years	8	44.4
11-20 Years	5	27.8
Above 20 Years	3	16.7
Total	**18**	**100.0**

Table 12 illustrates that majority of the teachers, 44.4 percent had taught for a period of between 6-10 years, 27.8 percent had taught for a period of between 11-20 years, 16.7 percent had taught for more than 20 years and the remaining 11.1 percent had taught for a period of between 1 to 5 years. The findings suggest that there is a wide range of teaching experience in the schools both old and new teachers in the chemistry profession. The teaching experience may depict continuity of chemistry teaching and improvement on chemistry performance.

4.2.6 Distribution of teachers by their teaching load per week

Fifthly, the researcher was interested on teachers teaching load per week. The findings are illustrated in Table 13.

Table 4.6: Distribution of teachers by their teaching load per week

Teaching load per week (number of lessons)	Frequency	Percent
10-15	1	5.6
16-20	2	11.1
21-27	13	72.2
28 lesson and above	2	11.1
Total	**18**	**100.0**

Table 13 indicated that majority, 72.2 percent of the sampled chemistry teachers had a work load of between 21 to 27 lessons per week. 11.1 percent had a workload of between 28 to 30 lessons per week, another 11.1 percent had a workload of between 16 to 20 lessons per week and the remaining 5.6 percent of the chemistry teachers had a workload of 10 to 15 lessons per week. This suggest that 72.2 percent of teachers had a recommended work load of between 21 to 27

lessons per week and the 16.7 percent of the teachers with less than 21 lessons workload per week had other administrative roles to cover. While the remaining 11.1 percent with a work load of 28 lessons and above per week were over-utilized due to scarcity of teachers in some schools. The later meant that chemistry performance will be negatively affected because of poor lesson preparation. However, 88.9 percent had appropriate workload per week.

4.2.7 Distribution of teachers attending chemistry SMASSE INSET

The researcher also asked chemistry teachers to indicate whether they had attended any chemistry SMASSE INSET cycle. The findings are illustrated in Table 14.

Table 4.7: Distribution of teachers attending chemistry SMASSE INSET

Attending chemistry SMASSE INSET	Frequency	Percent
Yes	18	100

The study findings on chemistry SMASSE INSET cycle attendance by chemistry teachers indicated that 100 percent of the teachers had attended the chemistry SMASSE INSET. The findings suggest that all sampled teachers had attested the importance of attending chemistry SMASSE INSET to the development of students' ability on chemistry subject. Teachers' response on attendance signifies need of chemistry SMASSE INSET in secondary schools. Chemistry SMASSE INSET is a positive event that helps chemistry students develop in preparation of their future careers fully.

4.2.8 Distribution of teacher-student ratio

Further, the researcher asked sampled chemistry teachers to indicate the teacher-student ratio in their classes. The findings are presented in Table 15.

Table 4.8: Distribution of teacher student ratio

Teacher student ratio	Frequency	Percent
Bellow 1:30	2	11.1
Between 1:31 to 1:40	7	38.9
Between 1:41 to 1:50	9	50
Total	**18**	**100**

Table 15 indicates that majority, 50 percent of the chemistry teachers had a teacher-student ratio of between 1:41 to 1:50, 38.9 percent had a teacher-student ratio of between 1:31 to 1:40 and the remaining 11.1 percent of chemistry teachers had a teacher-student ratio of below 1:30. The findings suggest that one teacher had a higher number of chemistry students as opposed to the recommended stands 1:40 (Sawyer, 2021) which is also ideal ratio set by UNESCO and other international standards.

4.2.9 Frequency distribution of continuous assessment test attempts

The study asked sampled chemistry teachers how often they give continuous assessment test to chemistry students. The study findings are illustrated in Table 16.

Table 4.9: Frequency distribution of continuous assessment test attempts

CAT frequency	Frequency	Percent
2 weeks	7	38.9
Monthly	5	27.8
After a topic	6	33.3
Total	**18**	**100**

Table 16 indicates that majority, 38.9 percent of the chemistry teachers give continuous assessment test to chemistry students after two weeks, 33.3 percent give continuous assessment test to chemistry students after end of the class topic and the remaining 27.8 percent give continuous assessment test to chemistry students every month. The varied ways of testing chemistry students through continuous assessment test gives opportunity teachers to understand the students' level of understanding in chemistry.

4.2.10 Frequency distribution of science laboratory in secondary schools

Further, the study asked teachers whether the school had science laboratory. The findings were illustrated in Table 17.

Table 4.10: Frequency distribution of science laboratory

Availability of science laboratory in secondary schools	Frequency	Percent
Yes	18	100
Well-equipped laboratory	Frequency	Percent
Yes	12	66.7
No	6	33.3
Total	**18**	**100**

The study findings in Table 17 showed that all the sampled chemistry teachers indicated that, extra-county schools, county schools and sub-county secondary schools had science laboratory. However, 66.7% of the secondary school science laboratory was well equipped while the remaining 33.3 percent of the secondary schools did not have well equipped science laboratories. This suggests that, the chemistry students still had challenges especially in the sub-county schools that had laboratory with no sufficient equipment to perform laboratory experiments. Low achievement of chemistry in students in schools with less equipped laboratory was recorded each year.

4.3 Influence of SMASSE INSET on chemistry teachers` classroom practices

The first objective of the study was to find out the influence of SMASSE INSET on chemistry teachers` classroom practices. The level of influence by Chemistry SMASSE INSET was assessed using a series of thirteen statements seeking respondents from teachers. The study used a scale ranging from 1 to 3 where; 3 represent Very Frequent, 2 represent Frequent and 1 represent Not Frequent when assessing the statements. The higher the score, the higher the influence of chemistry SMASSE INSET on chemistry teachers` classroom practices. Table 18 highlights the distribution of the teachers' responses on the statements provided.

Table 4.11: Influence of SMASSE INSET on chemistry teachers` classroom practices

Influence of SMASSE INSET on Chemistry Teachers` Classroom Practices	***Mean***	***Std. Deviation***
Engage students in group work in chemistry	2.00	0.594
Use appropriate question/answer technique with reinforcement of student response in chemistry	2.11	0.583
Assign student discussion work in chemistry	2.06	0.639
Assign student practical work in chemistry	1.94	0.416
Allow students to report the results of practical work in chemistry	2.11	0.676
Give students with difficulties more exercises and practice on observation in chemistry	2.33	0.686
Practice team teaching with your colleagues in teaching chemistry	2.39	0.698
Make ASEI/PDSI lesson plans for teaching chemistry	2.28	0.669
Use lesson notes instead of lesson plans in teaching chemistry	2.39	0.608
Use both lesson plans and lesson notes in teaching chemistry	2.44	0.616
Try out experiments or any other practical work before going to chemistry class	2.17	0.514
Give students take home chemistry assignments	2.39	0.608
Invite a colleague to sit in class during my chemistry lesson	2.22	0.732
Average mean	**2.22**	**0.618**

Valid N 18

Table 18 indicates that the chemistry teachers frequently utilized various aspects of chemistry teachers` classroom practices learnt in the SMASSE INSET. For the aspect of chemistry teachers` classroom practices, respondents rated all the 13 statements at about mean average=2.22 with mean scores of between mean=1.94 and mean=2.44. Majority of the respondents at mean=2.44 stated that they use both lesson plans and lesson notes in teaching chemistry, while minority of the respondents at mean=1.94 stated that they assign students practical work in chemistry. Another response at mean=2.39 stated that teachers practice team teaching with their colleagues in teaching chemistry, they also use lesson notes instead of lesson plans in teaching chemistry and further, chemistry teachers give students take home chemistry

assignments. In another response at mean=2.33 and standard deviation =0.686, teachers give students with difficulties more exercises and practice on observation in chemistry.

The respondents reported that SMASSE INSET positively influenced teachers to frequently use both lesson plans and lesson notes in teaching chemistry, it also positively influenced teachers to frequently use appropriate question/answer technique with reinforcement of student response in chemistry. Respondents also observed that SMASSE INSET programs positively influenced teachers in how to assign student discussion work in chemistry, assign student practical work in chemistry and allow students to report the results of practical work in chemistry

The study findings are in agreement with Glatthorn *et al.* (2018) who found that SMASSE INSET influence teachers to ensure students were actively involved in the learning process and showed great interest and responsiveness; attended the lesson more punctually and regularly; did their assignments more neatly and promptly; carried out discussions beyond class time; interest and curiosity was aroused and sustained as they related chemistry to the real life experiences; encouraged teamwork and allowed individual participation of the students; were provided with opportunities to develop key competencies such as problem solving, synthesis and application of information.

The study findings were contrary to Onchong'a (2013) who found out that while teachers perceived the SMASSE INSET programme as having been effective in exposing them to a student-centered approach, this was not reflected in their classroom practices which were largely teacher-dominated. This was partly attributed to large classes, the use of English as second language, and pressure to cover the syllabuses in preparation of the national examinations.

The study results showed that, chemistry SMASSE INSET programs has positively influence chemistry teachers to frequently give students with difficulties more exercises and practice on observation in chemistry, influenced chemistry teachers to frequently use lesson notes instead of lesson plans in teaching chemistry. Furthermore, chemistry SMASSE INSET programs guide chemistry teachers to frequently give students take home chemistry assignments and frequently invite colleague teachers to sit in their classes during chemistry lesson.

4.3.1 Hypothesis testing of SMASSE INSET on chemistry teachers` classroom practices

In this study, hypotheses were also tested, and the first hypothesis ($\mathbf{H_{01}}$) of the study stated that SMASSE INSET has no statistically significant influence on chemistry teachers` classroom practices. The findings are illustrated in Table 19.

Table 4.12: Hypothesis testing of SMASSE INSET on chemistry teachers` classroom practices

		Unstandardized Coefficients		**Standardized Coefficients**	**T**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	2.076	0.179		11.592	0.000
	SMASSE INSET	0.339	0.069	0.381	4.932	0.000

a. Dependent Variable: ***Chemistry teachers` classroom practices***

The first hypothesis was tested and a p value of less than 0.05 shows there was significant relationship between the variables and null hypotheses were rejected while p value of more than 0.05 shows there was no significant relationship between study variables and the study fails to reject the null hypothesis. The study results as shown in Table 19 indicates that SMASSE INSET has statistically significant influence on chemistry teachers` classroom practices ($\beta_1$=0.339; P=0.000<0.05). The β factor of 0.339 implies that SMASSE INSET has a significant influence on chemistry teachers` classroom practices by 33.9%. The p-value of 0.000 is less than the predictable value of 0.05 which indicates that the SMASSE INSET has a positive and statistically significant influence on chemistry teachers` classroom practices in secondary schools. Therefore, the study rejects the null hypothesis that SMASSE INSET has no statistical influence on chemistry teachers' classroom practices.

The findings are supported by Koosimile and Suping (2015) who observed a positive impact of SMASSE INSET in terms of teachers' attitudes and classroom teaching and learning practices. Teachers who had consistently undergone SMASSE training had shown positive attitudinal change towards their profession and improved on their lesson delivery. Students also had improved participation in the lessons. SMASSE is thus evaluated positively by WECSA member countries. Wafubwa (2014) also observed that the net impact on teachers showed that teachers planned better and more consistently; attended to students needs more; were more confident to

carry out practical activities; tried out new methods; faced the challenges arising from lack of resources as well as the challenge arising from large classes.

4.4 Influence of SMASSE INSET on students' attitude towards chemistry subject

The second objective of the study was to find out the influence of SMASSE INSET on students' attitude towards chemistry subject. The level of influence by Chemistry SMASSE INSET was assessed using a series of twelve statements seeking responses from students. The study used a Likert scale ranging from 1 to 5 where; 5 represent Strongly agree, 4 represent Agree, 3 represent Neutral, 2 represent Disagree and 1 represent Strongly disagree when assessing the statements. The higher the score, the higher the influence of Chemistry SMASSE INSET on students' attitude towards chemistry subject improvement. Table 20 highlights the distribution of the students' responses on the statements provided.

Table 4.13: Influence of SMASSE INSET on students' attitude towards chemistry subject

Influence of SMASSE INSET on Students' Attitude towards Chemistry Subject	Mean	Std. Deviation
Chemistry is a difficult subject	3.92	1.259
I enjoy studying chemistry	4.30	1.197
Chemistry is an important and necessary carrier subject	4.19	1.209
I know I can do well in chemistry	4.41	0.894
My teacher is interested in my chemistry performance	4.30	0.809
Both girls and boys can do well in chemistry	4.07	1.194
I like chemistry teacher	4.21	0.966
My teacher has made me feel that I can improve in chemistry	4.06	1.192
I often find myself studying chemistry during my free time	4.21	0.949
I like solving new problems in chemistry	4.21	0.952
I rarely skip chemistry lessons	4.26	0.831
I am satisfied with the way the teacher teaches chemistry	4.21	0.824
Average mean	**4.20**	**1.023**

Valid N 145

Table 20 indicates that Chemistry SMASSE INSET programs influenced positively students' attitude towards chemistry subject. The study related all the aspects on students' attitude to a mean of 4.20 with the least mean of mean=3.92 and highest mean=4.41. Majority of the students stated that they can do well in chemistry subject, while minority stated that chemistry is a difficult subject. Based on the findings in Table 20, most of the students enjoy studying chemistry, and also chemistry is an important and necessary career subject. Students also reported they can do well in chemistry when taught well; others supported the statement that their teacher is interested in their chemistry performance. Students' responses also showed a positive influence of Chemistry teachers on their attitude towards chemistry subject improvement. In addition, both girls and boys can do well in chemistry, students like chemistry teacher, chemistry teacher has made many students feel that they can improve in chemistry and also students often find themselves studying chemistry during their free time.

Table 20 further illustrated that Chemistry SMASSE INSET influence positively on students' attitude towards chemistry subject since majority of the students like solving new problems in

chemistry, students rarely skip chemistry lessons and also students are satisfied with the way the teacher teaches chemistry. This suggests that Chemistry SMASSE INSET has greatly influenced positively students' attitude towards chemistry subject. The subject has gain positive improvement despite its difficult nature to most students. When a positive attitude is developed towards chemistry subject then a significant improvement is always achieved.

The findings are in agreement with Czerniak and Krajcik (2018) who noted students' attitude and behaviour is better predicted from an individual belief and that beliefs are the best indicators of decision individual makes throughout their lives. They stress the connection between teachers' attitudes and students' beliefs about science. When attitude is negative or unfavourable students take little or no interest in education and perform poorly in exams. Students' attitude and belief about learning and knowledge strongly impact the student's ability to explore, articulate and analyze their beliefs on topics or subjects they cover. In this sense students' attitude toward love of chemistry is influenced by many factors and SMASSE INSET has brought positive impact.

Similarly, the findings Langat (2017) indicate that teachers' positive attitudes have been shown to attract more interest in their class and students' attitudes are a reflection of teachers' attitudes. Though the teacher's negative attitudes may be due to the problems they encounter in their schools, their effect goes down to the classroom where it may be noted that teachers put little or no effort into preparation and performance of activities pertaining to effective teaching and learning. Further Bridges (2013) observes that unless the teacher has the attitude s/he desires to foster; it is unlikely that s/he has success in communicating to his/her students

4.4.1 Student's participation attitude in a chemistry lesson

The study also assessed students' participation in a chemistry lesson as part of the influence of SMASSE INSET on students' attitude towards chemistry subject. The level of influence by Chemistry SMASSE INSET was assessed using a series of ten statements seeking responses from students. The study used a scale ranging from 1 to 3; key, 1 - No participation, 2 - Passive participation, 3 - Active participation when assessing the statements. The higher the score, the higher the influence of Chemistry SMASSE INSET on students' participation in a chemistry class lesson. Table 21 highlights the distribution of the students' responses on the statements provided.

Table 4.13: Student's participation in a chemistry lesson

Student's participation in a chemistry lesson	Mean	Std. Deviation
Asking question/answer question	2.49	0.636
Seeking clarification on areas not understood	2.45	0.600
Volunteer to perform a task during a lesson	2.50	0.567
Suggest outcome of an experiment	2.35	0.521
Make observation/take measurements/presentations/draw graphs, pictures e.t.c.	2.52	0.528
Record and analyzing observations and measurements	2.47	0.541
Draw conclusions from experiments	2.48	0.515
Carry out experiment outside normal class work	2.48	0.541
Improvising material to perform experiments	2.41	0.584
Participating in group work activity/discussion	2.29	0.600
Average mean	**2.44**	**0.563**

Valid N 145

Table 21 indicates that overall, Chemistry SMASSE INSET has influenced between passive and active student's participation in a chemistry lesson. On average mean score of 2.44 and a range of the least mean=2.29 and the highest mean=2.52 students show positive active participation in a chemistry lesson. The study findings show that students actively ask chemistry questions, and also actively answer chemistry question in class. Students also seek clarification on areas not understood, students volunteer to perform a task during a lesson, students suggest outcome of an experiment, and students make observation/take measurements/presentations/draw graphs, pictures e.t.c.

Similarly, Table 21 shows that students are actively participating in a chemistry lesson through recording and analyzing observations and measurements, drawing conclusions from experiments, carrying out experiment outside normal class work, improvising material to perform experiments and participating in group work activity/discussion. The findings are in agreement with Glatthorn *et al.* (2018) who observed that SMASSE INSET net impact on students showed that, students: were actively involved in the learning process; showed great interest and responsiveness;

attended the lesson more punctually and regularly; did their assignments more neatly and promptly; carried out discussions beyond class time; interest and curiosity was aroused and sustained as they related chemistry to the real life experiences; encouraged teamwork and allowed individual participation of the students; were provided with opportunities to develop key competencies such as problem solving, synthesis and application of information.

In addition, Koosimile and Suping (2015) supported that teacher who had consistently undergone SMASSE training had shown positive attitudinal change towards their profession and improved on their lesson delivery. Students also had improved participation in the lessons. Further, Ndirangu (2018) stated that students should be given opportunities to perform experiments which enhance understanding of concepts in chemistry and science this is evidenced by the ability of students to solve related problems; ability of students to make deductions from practical work; and the ability of students to verify hypotheses and predictions; utilization of materials available in the students' immediate environment; teacher producing and or utilizing improvised materials; ability of the students to effectively use improvised materials; and enhanced students' participation.

4.4.2 Hypothesis testing of SMASSE INSET on students' attitude towards chemistry subject

In this study, the second hypothesis was tested. The second hypotheses ($\mathbf{H_{02}}$) of the study stated that SMASSE INSET has no statistically significant influence on students' attitude towards chemistry subject. The study results are illustrated in Table 22.

Table 4.14: Hypothesis testing of SMASSE INSET on students' attitude towards chemistry subject

		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.788	0.503		3.559	0.001
	SMASSE INSET	0.306	0.135	0.187	2.273	0.025

a. Dependent Variable: Students' attitude towards chemistry subject

The second hypothesis was tested and a p value of less than 0.05 shows that there was a significant relationship between the variables and null hypotheses were rejected while p value of more than 0.05 shows there was no significant relationship between study variables and the study fails to reject the null hypothesis. The study results as shown in Table 22 indicates that SMASSE INSET has statistically significant influence on students' attitude towards chemistry subject (β_1=0.306; P=0.025<0.05). The β factor of 0.306 implies that SMASSE INSET has a significant influence on students' attitude towards chemistry subject by 30.6%. The p-value of 0.025 is less than the predictable value of 0.05 which indicates that the SMASSE INSET has a positive and statistically significant influence on students' attitude towards chemistry subject in secondary schools. Therefore, the study rejects the null hypothesis that SMASSE INSET has no statistical influence on students' attitude towards chemistry subject.

SMASSE INSET is a successful program that has been used to change attitude and perception of students towards chemistry subject. Positive attitude is packed with energy that can make great changes on chemistry achievement if only appropriate measures are used. The study is in agreement with Kahare (2017) that attitudes are internal states that influence the individual choice of action. Students' attitude on chemistry subject varies based on the extent of liking or disliking the set-up process from school, teachers and books.

Tseng *et al.* (2013) in their research on teachers' beliefs about the nature of science, students learning and the role of the teacher suggested that these beliefs do affect students' chemistry achievement. Further, another contribution by Mutai (2011) supports that attitude is reinforced by beliefs and often attract strong feeling that led to particular form of behaviour. The way

people view situations in life depends on the attitude they hold and these attitudes compel them to react to objects, situation or propositions in ways that can be called favourable or unfavourable

4.5 Chemistry achievement before and after SMASSE INSET

The third objective of the study was to find out the difference in chemistry achievement before and after SMASSE INSET. The study used secondary data to analyze the achievement of chemistry subject in KCSE between the year 2010 to 2014 before SMASSE INSET program and 2015 to 2019 after SMASSE INSET program. Table 23 shows the mean score of chemistry subjects for 6 schools before and after SMASSE INSET program.

Table 4.15: Students' KCSE chemistry mean scores before and after SMASSE INSET program

	BEFORE SMASSE INSET (CHEMISTRY MEAN) 2010-2014						**AFTER SMASSE INSET (CHEMISTRY MEAN) 2015-2019**					
SCH	2010	2011	2012	2013	2014	**MEAN**	2015	2016	2017	2018	2019	**MEAN**
SCH A	4.1327	3.2342	3.457	3.6487	3.9883	3.69218	4.0127	4.2432	3.8567	4.3458	4.5356	**4.19880**
SCH B	4.0862	2.5056	2.9221	3.9364	2.6000	3.21006	3.2354	3.8125	4.7433	3.9524	3.8333	**3.91538**
SCH C	2.5131	1.7833	2.5698	1.9521	2.3854	2.24074	2.5679	1.897	1.9003	3.0027	2.7382	**2.42122**
SCH D	7.1236	6.5432	6.4976	6.8765	7.5812	6.92442	7.1243	6.9854	6.4567	6.7543	7.3765	**6.93944**
SCH E	2.9928	3.6173	4.0045	3.7654	3.9944	3.67488	2.8876	3.2345	3.3981	3.6543	3.5123	**3.33736**
SCH F	4.6383	2.3621	2.7931	4.3815	4.1933	3.67366	3.8712	2.9733	3.7243	4.4831	4.1932	**3.84902**

Table 23 shows the trend of students' KCSE chemistry mean performance in the six sampled schools over two time period, before and after introduction of SMASSE.

4.5.1 Students' KCSE average mean scores in chemistry before and after SMASSE

Group statistics shows the mean deference on the achievement of chemistry between the two groups of learners before and after SMASSE INSET. The findings are presented in Table 24.

Table 4.16: KCSE average mean scores in chemistry before and after SMASSE

	Mean score before SMASSE	Mean score after SMASSE
N	6	6
Mean	3.9027	4.1102
Std. Deviation	1.58249	1.52109
Minimum	2.24	2.42
Maximum	6.92	6.94

Table 24 indicates the mean achievement of the chemistry subject in KCSE between the year 2010 to 2014 before SMASSE INSET program and 2015 to 2019 after SMASSE INSET program. In comparison the mean score of chemistry subject in KCSE between the years 2010 to 2014 before introduction of SMASSE INSET program was 3.9027 with a minimum of 2.24 and a maximum of 6.92 mean averages. The mean score of chemistry subject in KCSE between the years 2015 to 2019 after the introduction of SMASSE INSET program was 4.1102 with a minimum of 2.42 and a maximum of 6.94 mean averages. This suggests that introduction of SMASSE INSET program had a very small impact (negligible) on the achievement of chemistry subject to the learners. The findings are in agreement with Glatthorn *et al.* (2018) that SMASSE INSET has impacted positively on the teaching and learning of chemistry in the member countries.

4.5.2 T-Test results

The study also performed paired t-test which is used to compare two population means where with two samples in which observations in one sample can be paired with observations in the other sample. T-test findings are presented in Table 25.

Table 4.17: Comparison of students' chemistry achievement before and after SMASSE

Group	N	Mean	Std. Deviation	T	Df	Sig. (2-tailed)
Before SMASSE INSET (2010-2014)	6	3.9027	1.58249	-1.386	5	.225
After SMASSE INSET (2015-2019)	6	4.1102	1.52109			

Table 25 shows that the average mean score of chemistry after introduction of SMASSE as 4.1102 was slightly higher compared to that before SMASSE INSET of 3.9027 in the six sampled schools. This suggests that although below the expected average academic achievement in chemistry at KCSE after introduction of SMASSE INSET had slightly increased by 0.2075. The t-test results of -1.386 and p-value of 0.225 indicated that change in achievement was not statistically significant. Since the p-value was greater than the chosen significance level $\alpha = 0.05$, the study fails to reject the null hypothesis, and this concludes that SMASSE INSET has no statistically significant difference in chemistry achievement before and after.

Based on the findings there was no significant mean difference. SMASSE INSET did not change achievement aspect of the chemistry as desired since students' achievement level was not significant. The study results also showed that there was lack of consistency in students' chemistry achievement; the margins vary widely depending on the preparedness of the students. The findings are in consistent with KNEC, 2018) that students' low achievement in chemistry remain a matter of serious concern to the nation, despite education stakeholders investing heavily on new strategies such as introducing SMASSE INSET as one of the remedial measures to improve the achievement, students' achievement remain low.

The study findings are in agreement with Kenya National Examination Council Report (2018) which stated that chemistry performance improved between the years 2013 to 2015 with a mean score of 24.50 to mean of 34.35. Thereafter was a drop from the 2015 to 2016 with mean score falling from 34.35 to 23.71 respectively. Further there was a slight improvement in achievement in the year 2017 to a mean score of 24.05 as reflected in the table. Low achievement is attributed to poor manipulative skills while performing practical work in chemistry classroom, poor mastery of chemistry concepts and lack of revision before sitting for the examination.

The findings KNEC (2018) report also stated that low student chemistry achievement is attributed to poor manipulative skills while performing practical work in chemistry classroom, poor mastery of chemistry concepts and lack of revision before sitting for the examination. KNEC 2018 recommended that good chemistry performance can be achieved by adopting the practical approach in teaching the subject.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five presents summary of the findings, its conclusions, implications and the recommendations drawn from the conclusions. The study sought to find out the influence of SMASSE INSET on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools in Nandi East Sub-County, Nandi County, Kenya.

A response rate of 91.1% (94.7% for teachers and 90.6% for students) informed the study by fully completing questionnaires administered. Out of 19 teachers' questionnaires administered, 18 were completed and out of 160 students' questionnaires administered, 145 were completed. The study used both primary and secondary data in finding out the influence of SMASSE INSET on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools. The primary data was collected using, teachers' questionnaires and students' questionnaires while the secondary data was collected from documented information for example the chemistry KCSE performance recorded between the years 2010 to 2019. The collected data was analysed using both descriptive and inferential statistics with the aid of SPSS version 21 for windows program.

5.2 Summary of the findings

Based on the results of this study, the following major findings are presented.

i. SMASSE INSET has a positive and statistically significant influence on chemistry teachers` classroom practices in secondary schools. Therefore, the study rejected the null hypothesis one that SMASSE INSET has no statistical influence on chemistry teachers' classroom practices.
ii. SMASSE INSET has a positive and statistically significant influence on students' attitude towards chemistry subject in secondary schools. Therefore, the study rejected the null hypothesis two that SMASSE INSET has no statistical influence on students' attitude towards chemistry subject.
iii. SMASSE INSET has no positive and statistically significant influence in chemistry achievement before and after SMASSE INSET programs. Therefore, the study accepted

the null hypothesis three that SMASSE INSET has no statistical difference in chemistry achievement before and after.

5.3 Conclusions

In conclusion the SMASSE INSET had significant influence on chemistry teachers' classroom practice and students' attitude but also had very negligible impact on students' achievements in public secondary schools.

i. The use of SMASSE INSET had a positive influence on chemistry teachers` classroom practices in secondary schools. For instance, SMASSE INSET positively influenced teachers to frequently engage students in group work in chemistry and also positively influenced teachers to frequently use appropriate question/answer technique with reinforcement of student response in chemistry.
ii. The use of SMASSE INSET had a positive influence on students' attitude towards chemistry subject in secondary schools. For instance, both girls and boys can do well in chemistry, students like their chemistry teacher, chemistry teacher has made many students feel that they can improve in chemistry and also students often find themselves studying chemistry during their free time.
iii. Based on achievement, SMASSE INSET has no significant influence in chemistry achievement before and after SMASSE INSET programs. The mean difference before and after SMASSE program were similar.

5.4 Implications

The study established a positive influence of SMASSE INSET on chemistry teachers' classroom practice and students 'attitude in public secondary schools in Nandi East Sub-County, Nandi County, Kenya. The positive impact influenced chemistry teachers' classroom practice and students' attitude towards chemistry. This implies that scheduling teachers to attend SMASSE INSET brings a positive impact in teaching chemistry.

Students acknowledge that SMASSE INSET had a positive influence on their attitude towards chemistry subject in secondary schools. The program is beneficial to students since it in cooperates factors that help learners improve their performance in chemistry. The positive change of attitude and love of chemistry is significant.

Despite the positive changes on the chemistry teachers' classroom practice and students' attitude towards chemistry, achievement has not improved as expected. This implies that more inventions have to be put in place to improve chemistry students' achievement in Kenya certificate of secondary education.

5.5 Recommendations

In view of the stated conclusions, the following recommendations were made

i. The school management should come up with strategies that ensure chemistry teachers are given chance to attend SMASSE INSET since it brings positive influence on chemistry teachers classroom practices.
ii. Ministry of Education Science and Technology should invest more on SMASSE program to ensure that positive attitude towards learning chemistry brings students achievement in Kenya certificate of secondary education.
iii. Tertiary institutions like colleges and universities should incorporate SMASSE initiatives in their training programs for science teachers since it has positive significant influence on students' attitude towards science subjects and science teacher's classroom practices.

5.5.1 Suggestion for further research

Based on the conclusions of the study, the following are the suggestions for further research:

i. A study should be conducted to establish whether gender of the teacher affect the influence of SMASSE INSET in chemistry teachers` classroom practices.

ii. A study should be conducted to establish whether age of the teacher affect the influence of SMASSE INSET in chemistry teachers` classroom practices.

iii. A study should be conducted to establish whether teaching experience of the teacher affect the influence of SMASSE INSET in chemistry teachers` classroom practices.

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APPENDICES

Appendix A: Letter to the School Principal

HILLARY KOGOS LELEI

EGERTON UNIVERSITY

P.O. BOX 536

NJORO

THE PRINCIPAL

_____

_____ _____

_____

Dear sir/ Madam,

RE: REQUEST TO CARRY OUT RESEARCH IN YOUR SCHOOL

I am a student of Egerton University pursuing a Master Degree course in Curriculum and Instruction in Chemistry Education. As part of my course, I am required to carry out research on "THE INFLUENCE OF SMASSE INSET ON CHEMISTRY TEACHERS' CLASSROOM PRACTICES, STUDENTS'ATTITUDE AND ACHIEVEMENTS IN SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, NANDI COUNTY, KENYA**".** The purpose of this letter is to request you to allow me to collect the required information from teachers and students in your school. If allowed, I promise to abide by your rules. Attached are copies of my research abstract, questionnaires and a letter from the university. Thanking you in advance,

Yours faithfully,

HILLARY KOGOS LELEI

Appendix B: Consent Form
CONSENT TO PARTICIPATE IN THE STUDY SERIAL NUMBER ……

Background

You are being asked to participate in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Read the following information carefully and ask us if there is anything that is not clear or if you would like more information. Please take time to decide whether you want to take part in this study. The purpose of the study will be to investigate the influence of Strengthening of Mathematics and Science in Secondary Education In-service Education and Training (SMASSE INSET) on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools in Nandi East Sub-County, Nandi County, Kenya.

Study Procedure

The respondents will be requested to fill the questionnaires and give them back to the researcher the same day. After distributing the questionnaires to the teachers, the researcher leaves them to fill. The researchers then engage students doing chemistry subject to fill in questionnaires. A different day will be set for analyzing the documents like the attendance register, the progress records and any other evaluation records in the same school. It is then the responsibility of the research to establish a rapport with the chemistry teachers. The study will employ participatory observation as the main tool for collecting data from the chemistry students. This will be used to gather data that will be observed directly from the subjects as they take part in the class activities. It will capture data on the influence of SMASSE INSET on chemistry teachers` classroom practices, influence of SMASSE INSET on students' attitude towards chemistry subject and difference in chemistry achievement before and after SMASSE INSET.

Risks

Participants may find participating in research stressful, especially if they are vulnerable, hidden or suppressed feelings or memories may be uncovered, additional concerns may come up and participants may worry about what they have shared. Therefore, it's essential for researcher to have clear procedures to follow if a child says anything that indicates they or another child may

be at risk of harm. The procedures should also include places where a researcher or child can access further support. If a researcher suspects that a child might be at risk of harm, then the research must be stopped until that child's safety is secured. Researcher can manage risk by providing counseling if the research subject is likely to become distressed; advice about services or help as a result of discussing needs which are not being met; offering the benefits of an intervention after completion of an intervention programme.

Benefits

There are no material goods benefits to your students for participating in this study. A potential benefit of the study will be improving participation of SMASSE INSET on students' performance in Chemistry in public secondary schools from the study recommendations.

Alternative Procedures

You may choose your students not to participate in this study

Confidentiality

This research will be conducted in accordance with all the Kenyan laws and regulations that protect rights of human research subjects. All records and other information obtained will be kept strictly confidential and your child's protected health information will not be used without permission. All data collection tools will be identified by number or otherwise coded to protect any information that could be used to identify your child. Results of this study may be published, but no names or other identifying information will be released.

Person to Contact

If you have questions, complaints or concerns about this study, you can contact the investigator from Egerton University, Faculty of Education and Community Studies in Curriculum and Instruction; Hillary K. Lelei +254726473057

Voluntary Participation

It is up to you to decide whether your students take part in this study. Refusal to participate or the decision to withdraw from this research will involve no penalty or loss of benefits to which your child is otherwise entitled. This will not affect your relationship with the investigators.

Right of investigator to withdraw

The investigator can withdraw your students from the research without your approval.

Costs and Compensation to participants

There is no cost to you, and there is no compensation to subjects for participation in this study.

Authorization for use of your protected health information

This study does not entail the use of your students' protected health information.

Thank you for your students' participation in this research and we truly appreciate your help.

CONSENT

By signing this consent form, I confirm I have read the information in this consent form and have had the opportunity to ask questions. I will be given a signed copy of this consent form. I voluntarily agree to take part in this study.

Name of Caregiver …… Signature…… Date……...

Name of Investigator ……Signature…… Date……...

Egerton University Secretary……Signature…… Date……...

Appendix C: Student assent form

INTRODUCTION

- In order to learn more about your participation in investigating the influence of Strengthening of Mathematics and Science in Secondary Education In-service Education and Training (SMASSE INSET) on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools, Hillary K. Lelei with other researchers are doing a "project" (some people call it a study). I am here to give you more information about this project and to ask you if you would like to be a part of it.

PURPOSE OF THE PROJECT

- The purpose of the project is to investigate the influence of Strengthening of Mathematics and Science in Secondary Education In-service Education and Training (SMASSE INSET) on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools
- You will be observed while participating in chemistry class lessons and also questionnaires will be given to students.

BENEFITS

- Being a part of the project may or may not help you and other students which have your same challenges of influencing Strengthening of Mathematics and Science in Secondary Education In-service Education and Training (SMASSE INSET) on chemistry teachers' classroom practice, students' attitude and their achievements in public secondary schools.

ASSENT

- I understand that my Mom or Dad, teacher, has said that it is okay for me to take part in this project (study) about my situation: influence of SMASSE INSET on chemistry performance
- I understand what this project (study) is about.
- I am going to be in this project (study) because I want to.
- I have been told that I can stop being a part of this project (study) anytime I want to. Nothing will happen to me if I want to stop. I will still be able to get learning in the school.

Name of Child/Parent……Signature…….....Date……

Principal Investigator……Signature……Date ……

Principal Investigator(s) contacts…….

Appendix D: Chemistry Teachers' Questionnaire (Ctq)
Dear respondent,

The following questionnaire is meant to elicit data on research entitle influence of SMASSE INSET on teacher classroom practices. Due to your position and duty as a chemistry teacher who has undergone the in-service training, you have been chosen to participate in this study. You are assured that the information you shall give will be treated with confidentiality, and it shall not be used for any other purpose other than the academic use for which it is intended. Please give honest information as required.

Thank you very much for your co-operation

SECTION I – BACKGROUND INFORMATION

Tick √ where appropriate. Measure of

1. Category of Your School
   Extra – county [ ] County [ ] Sub-County [ ]
2. Gender male [ ] female [ ]
3. What is your highest professional qualification?

Dip Ed [ ] PGDE [ ] B.ED [ ] M.ED/MSC/MA [ ]

4. How long have you been teaching chemistry?
   1 – 5 years [ ] 6 – 10 [ ] 11 – 20 [ ] above 20 [ ]
5. What is your teaching load per week?
   ……
6. Have you attended any chemistry SMASSE INSET cycle?
   Yes [ ] No [ ]

If yes, how many?

……

If no, why?

……

7. How many SMASSE training cycles have you attended? SMASSE Training

All the four cycles [ ] Three cycles [ ]

Two cycles [ ] One cycle [ ]

8. What is the teacher - student ratio in your class?

   …….....

9. How often do you give continuous assessment test?

   1 week [ ] 2 weeks [ ] monthly [ ] after a topic [ ]

10. Do you have a science laboratory in your school? Yes/ No

    If yes, is it well equipped? ……

SECTION II - CHEMISTRY TEACHERS` CLASSROOM PRACTICE

a) Below are activities the chemistry teachers engage their classes in while delivering ASEI-PDSI lesson. Please indicate how frequent you use each of them on a scale of 1-3.

Key; 3- Very Frequent, 2- Frequent and 1- Not Frequent

No		3	2	1
10	Engage students in group work in chemistry			
11	Use appropriate question/answer technique with reinforcement of student response in chemistry			
12	Assign student discussion work in chemistry			
13	Assign student practical work in chemistry			
14	Allow students to report the results of practical work in chemistry			
15	Give students with difficulties more exercises and practice on observation in chemistry			
16	Practice team teaching with your colleagues in teaching chemistry			
17	Make ASEI/PDSI lesson plans for teaching chemistry			
18	Use lesson notes instead of lesson plans in teaching chemistry			
19	Use both lesson plans and lesson notes in teaching chemistry			
20	Try out experiments or any other practical work before going to chemistry class			
21	Give students take home chemistry assignments			
22	Invite a colleague to sit in class during my chemistry lesson			

c). What factors in your opinion hinder implementation of SMASSE approaches in your teaching?

……..……
…….

d). Suggest ways in which SMASSE program may be improved in order to further improve teaching and learning of chemistry.

……

Thank you for participating

Appendix E: Chemistry students' questionnaire (CSQ)

SCHOOL……

CLASS……

GENDER MALE [ ] FEMALE [ ]

SECTION I

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

No		Strongly agree	agree	undecided	Disagree	Strongly disagree
1	Chemistry is a difficult subject					
2	I enjoy studying chemistry					
3	Chemistry is an important and necessary subject					
4	I know I can do well in chemistry					
5	My teacher is interested in my chemistry performance					
6	Both girls and boys can do well in chemistry					
7	I like chemistry teacher					
8	My teacher has made me feel that I can improve in chemistry					
9	I often find myself studying chemistry during my free time.					
10	I like solving new problems in chemistry					
11	I rarely skip chemistry lessons					
12	I am satisfied with the way the teacher teaches chemistry					

SECTION II

The following statements refer to your participation in a **chemistry lesson**. Read each statement carefully and evaluate your level of participation by placing a tick in the relev √ position.

Key

No participation [0]

Passive participation [1]

Active participation [2]

No		0	1	2
12	Asking question/answer question			
13	Seeking clarification on areas not understood			
14	Volunteer to perform a task during a lesson			
16	Suggest outcome of an experiment			
17	Make observation/take measurements/presentations/draw graphs, pictures e.t.c.			
18	Record and analyzing observations and measurements			
19	Draw conclusions from experiments			
20	Carry out experiment outside normal class work			
21	Improvising material to perform experiments			
22	Participating in group work activity/discussion			

What suggestions would you give that would help improve the teaching and learning of chemistry?

……

……

……

Thank you for participating

Appendix F: H.O.D science data sheet

School Code……

School Category Extra – county [ ] County [ ] Sub-County [ ]

Table 1 Chemistry KCSE Performance before SMASSE INSET

YEAR	ENROLMENT			MEAN
	BOYS	GIRLS	TOTAL	
2010				
2011				
2012				
2013				
2014				

Table 2 Chemistry KCSE Performance after SMASSE INSET

YEAR	ENROLMENT			MEAN
	BOYS	GIRLS	TOTAL	
2015				
2016				
2017				
2018				
2019				

1. Do you find the performance trend impressing? Yes [ ]. No [ ]

If Yes or No above, what do you think is the reason for the trend?

_____

_____

2. Are/have you participating (ed) in SMASSE? YES [ ], NO [ ]

3. In your opinion, do you think incorporation of SMASSE INSET is having any impact on the KCSE results? Give a reason.

_____

_____

Appendix G: Introductory letter

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

EM13/00047/10 **27th April, 2021**

Ref:..... **Date:**.....

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

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – MR. HILLARY KOGOS LELEI REG. NO. EM13/00047/10

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.Ed student in this University. His research topic is **"Influence of Smasse Inset on Chemistry Teachers' Classroom Practices, Students' Attitude and Achievements in Public Secondary Schools in Nandi East Sub-County, Nandi 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
28 MAY 2021

Prof. Nzula Kitaka
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

NK/vk

Appendix H: Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **711408**

Date of Issue: **30/July/2021**

RESEARCH LICENSE

This is to Certify that Mr.. Hillary k Lelei of Egerton University, has been licensed to conduct research in Nandi on the topic: INFLUENCE OF SMASSE INSET ON CHEMISTRY TEACHERS' CLASSROOM PRACTICES, STUDENTS' ATTITUDE AND ACHIEVEMENTS IN PUBLIC SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, NANDI COUNTY, KENYA for the period ending : 30/July/2022.

License No: **NACOSTI/P/21/11229**

711408

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 I: County commissioner research authorization

OFFICE OF THE PRESIDENT

MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Tel: 053 5252621, 5252003, Kapsabet
Fax No. 053 – 5252503
E-mail:
nandicountycommissioner@gmail.com
When replying, please quote

Ref: No. NC.EDU/4/3/VOL.I/(124)

County Commissioner's Office,
Nandi County
P.O. Box 30,
KAPSABET.

22nd February, 2022

Hillary K. Lelei
Egerton University
P.O. Box 536 – 20115,
EGERTON - NJORO.

RE: RESEARCH AUTHORIZATION

This is in reference to Research License No. NACOSTI/P/21/11229 dated 30th July, 2021 from the Director General/CEO, National Commission for Science, Technology and Innovation on the above subject matter.

You are hereby authorized to conduct a research on **"Influence of SMASSE inset on Chemistry Teacher's Classroom practices, students' attitude and achievement in public secondary schools in Nandi East Sub County, Nandi County"** for a period ending **30th July, 2022.**

Wishing you all the best.

PP

THE COUNTY COMMISSIONER NANDI.

H. M. SHAMBI ndc' (K)
COUNTY COMMISSIONER,
NANDI.

COVID-19 IS REAL GET VACCINATED

Appendix J: Sub-county education office authorization

MINISTRY OF EDUCATION
STATE DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

Telegrams: "EDUCATION",
Telephone: 053-643340/0208008149
Email; moenandieast@gmail.com
When replying please quote

SUB COUNTY EDUCATION OFFICE
NANDI EAST
P.O. Box 13
NANDI HILLS

7TH MARCH, 2022

REF: NED /ADM/R/267/VOLI/55

Hillary Kogos Lelei
Egerton University
Po Box 536-20115
EGERON NJORO

RE: AUTHORITY TO CARRY OUT RESEARCH :

Reference is made to your letter dated 22nd February 2022 requesting permission to carry out research in Public Secondary Schools in Nandi East Sub County.

I wish to inform that you have been granted permission to carry out your research entitled "Influence of Smasse Inset on Chemistry Teacher's Classroom Practices, Students' attitude and Achievements in public secondary schools", in Nandi East Sub County Nandi County.
You are further informed that you strictly conform to the research period ending 30th July,2022 and share a copy of your findings to this office.

Wishing you best of luck in your research.

Benard K. Manyasi
Sub County Director of Education
NANDI EAST.

SUB - COUNTY DIRECTOR OF EDUCATION
NANDI EAST SUB-COUNTY
18 MAR 2022
P. O. Box 13-30301,
NANDI HILLS

CC:
County Director of Education - Nandi County

Appendix K: Research publication

JRIIE Journal of Research Innovation and Implications in Education
Center for Research Implications & Practice

Website:www.jriiejournal.com ISSN 2520-7504 (Online) Vol.7, Iss.1, 2023 (pp. 157 - 165)

Influence of SMASSE INSET on Chemistry Teachers` Classroom Practices in Public Secondary Schools in Nandi East Sub-County, Nandi County, Kenya

Hillary Lelei Kogos, Bernard N. Githua & Ann C. Barmao
Egerton University, Njoro, Kenya
Email: hillaryleleik@gmail.com

Abstract: Strengthening of Mathematics and Science in Secondary School Education (SMASSE) is an In-Service Education and Training (INSET) course for mathematics and science teachers aimed at improving their classroom approaches and students' achievement. The study sought to find out the influence of SMASSE INSET on chemistry teachers' classroom practices on achievement of chemistry subject in Nandi East Sub-County, Nandi County, Kenya. The study targeted 98 Chemistry teachers. Simple random sampling was used to select 6 out of 30 schools. Chemistry teachers were purposively selected. Questionnaire for chemistry teachers was administered. Descriptive data was presented in terms of frequency tables, mean, standard deviation and percentages. Inferential data was analyzed using Pearson correlation, linear regression analysis statistic at a significant level of 0.05. The findings indicate that SMASSE INSET had a positive and statistically significant influence on chemistry teachers` classroom practices in public secondary schools in Nandi East Sub-County, Nandi County, Kenya. Despite the positive changes on the chemistry teachers' classroom practice, chemistry achievement has not improved as expected. This implies that more interventions have to be put in place to improve students' chemistry achievement.

Keywords: *SMASSE INSET, Chemistry, Teacher classroom practices, Achievement of chemistry subject*

How to cite this work (APA)

Lelei H. K., Githua, B. N. & Barmao, A. C. (2023). Influence of SMASSE INSET on chemistry teachers` classroom practices in public secondary schools in Nandi East Sub-County, Nandi County, Kenya. *Journal of Research Innovation and Implications in Education,* 7(1), 157 – 165.

1. Introduction

The contributions of chemistry to society are vast and almost numerous, production of vaccines, food safety practices, treatment programs for diseases, diagnostic tools in healthcare, plastics, synthetic fibers, an understanding of oil, cosmetics and cleaners. Vaccines and immunization were first popularized in the 1770s by Edward Jenner, who took pus from the hand of a victim of cowpox and used it to protect people from the much more serious smallpox (Chartier, 2014).

Chemistry teaching is supposed to be results oriented and students centered, this can only be achieved when students are willing and teachers are favorably disposed using the appropriate methods and resources in teaching the students (Brookfield, 2017). Students by nature are curious, they need to be actively involved in the learning process in which they are continuously equipping, testing, speculating and building their own personal construct and knowledge. It is only by personalizing such knowledge that it becomes valid, meaningful and useful to them. In chemistry, students need to construct their own personal awareness and