IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 6, Issue 6 Ver. VIII (Nov. - Dec. 2016), PP 60-77
www.iosrjournals.org

Influence of Strengthening of Mathematics and Science in Secondary Education (SMASSE) Project: Performance and Trend in the Mean Score of Biology in Kakamega North Sub County, Kenya.

Florence M. Sikolia[1] and Stephen F. Sikolia[2]
[1]*Department of Mathematics and Science Education, Masinde Muliro University of Science and Technology, Kenya*
[2]*School of Physical Sciences and Biological Sciences, Maseno University, Kenya*

Abstract: *Biology as a Science has enormous practical applications on our daily lives. However, just like mathematics and other science subjects, performance in biology in the national examinations has been relatively low. As a result, the Kenyan government in collaboration with Japan International Co-operation Agency (JICA) launched Strengthening of Mathematics and Science in Secondary Education (SMASSE) project in July 1998. SMASSE embarked on in-service training of serving teachers of mathematics and science with an aim of making them better teachers. The purpose of this study was to determine the relationship between the level of implementation of SMASSE initiative and biology performance at K.C.S.E in public secondary schools in Kakamega North Sub County, Kenya. The study spells out the relationship between the level of implementation of SMASSE initiatives and biology achievement at Kenya Certificate of Secondary Education (K.C.S.E). The research was carried out in Kakamega North Sub County of Kakamega County in Kenya, an area where the pilot phase of SMASSE had been conducted since the year 2000 by the Ministry of Education. Twenty-five public secondary schools in the area which presented candidates to the examination council in the year 2014 were used in the study. The K.C.S.E results for 2014 were used as a measure of achievement. The target population of this study was all secondary school biology students, head teachers and form four biology teachers from the 25 schools. Since SMASSE is an ongoing project, views of how the biology teachers implement initiatives of SMASSE was collected from form two and form three biology students of 2015. To be specific, the views were collected from students taught by the 2014 K.C.S.E biology teachers. The data was collected using a student questionnaire designed by the researcher. Simple random sampling of a specific class was used to select 12 students from sampled classes to complete the questionnaires. Another tool used in data collection was the biology teachers' questionnaire, which was administered to the biology teachers who taught the 2014 K.C.S.E biology classes. The other tool used in data collection was observation checklist and head teachers' questionnaire, which was administered to the head teachers of the sampled schools. Interview schedules were also used to gather more information from the science teachers and laboratory technicians. Purposive sampling was used to select biology teachers who prepared the 2014 K.C.S.E biology class and were SMASSE compliant for further observation. Regression analysis at 95% confidence level and descriptive statistics was used for data analysis. The data show a positive trend between K.C.S.E. results and the years of SMASSE training. A positive gradient was established and a steady improvement in K.S.C.E. determined. This study provides data to form a basis to inform the education policy makers to improve the structure of instructional strategies for efficient and effective teaching and learning to strengthen the science performance in secondary schools in the country.*

Keywords: *Biology, Japan International Co-operation Agency, Kenya Certificate Secondary Education Strengthening of Mathematics and Science in Secondary Education*

I. Introduction

The Strengthening of Mathematics and Science in Secondary Education (SMASSE) project was launched in Kenya on first of July 1998 in 9 districts (Kajiado, Gucha, Kakamega, Lugari, Butere-Mumias, Kisii, Murang'a, Maragua and Makueni) out of 72 districts in the country. The programme was implemented for 5 years to 2003. Then the project underwent three phases with the third and final phase coming to an end in May, 2014 (Waititu and Orado, 2009) [1]. It became an integral and critical component of the education system in the Kenya's future because of its relevance to the economy and the need for a citizenry ability to make wise decisions on issues affecting them by the dynamics of the modern society. The Mathematics and Science Education broad aim was to play major role in the socio-economic drivers through relevance in supporting and securing a transformative shift in Kenya and the whole of Africa's development Agenda (Bethell, 2016) [2]. The

21st century is a century of hope for Africa, but whether or not the youth of Africa can contribute and benefit from the opportunities that economic and technological growth presents, depends very much on the kind of scientific and mathematics skills that young people experience in their education (Akyeampong, 2016) [3].This calls for diversity of models simulating SMASSE in Kenya focused on the skills acquired being relevant for self-sufficient and to the changing dynamics in the modern society. Similar initiatives have been adopted in different parts of the world, for example, the STEM in the United States of America (Wieman, 2012[4]; Wieman and Sarah, 2014[5]) and SME in most of theSMASSE-WECSA Member Countries of Africa (SMASSE PROJECT, 2005: URL:http://www.jica.go.jp/) [6].

The SMASE-WECSA Association (SWA), an alliance of African countries was created as a part of the SMASE project for sharing and expanding Mathematics and Science Education (MSE) cooperation among 27 countries and became the main channel of JICA MSE regional cooperation. Through the activities of SWA, a variety of approaches modeled around the Kenyan project have been initiated in various countries. Apart from Kenya, Southern (Zambia and Malawi) and Western (Senegal and Burkina Faso) African countries have introduced their unique experience and accelerated multi-polarity of the MSE cooperation (Akyeampong, 2014) [7]. Besides the multinational activities of SWA, the "Working Group on Mathematics and Science Education" (WGMSE) of the Association for the Development of Education in Africa (ADEA) has also been a nexus of MSE initiatives of JICA since the project begun. In May 2014, around the same time that SMASE Project Phase 3 ended, WGMSE was converted to the "Inter-country Quality Node of Mathematics and Science Education" (ICQN-MSE) as an initiative of the Ministry of Education, Science and Technology of Kenya. JICA communicated to the Ministry its willingness to continue supporting the ICQN-MSE to provide peer learning environment of MSE among African countries. Currently, JICA assists a number of regional MSE activities in Kenya namely; dispatch of a Regional Cooperation Advisor, Third-Country Training Programme (TCTP) for MSE educators, and sharing of information on education cooperation in Africa.

The government of Kenya recognizes the important role science and mathematics play in the realization of vision 2030; to become a globally competitive and prosperous country by 2030. Based on data, largely from the Trends in International Mathematics and Science study (TIMSS) and data from UNESCO's GMR database it is possible to establish the following facts regarding young people's performance in mathematics and science at grades 4 and 8 even at grade 12. Generally, the data shows that student performance in mathematics and science has been persistently low [3]. This requires remedial action. This has been reflected in the amount of resources both human and otherwise that are channeled towards enhancing the teaching and learning of science and mathematics at all levels of the education system in different parts of the world and especially in Kenya. At secondary school level, there have been a number of intervention strategies that the government has put in place to ensure effectiveness in the teaching/learning of these subjects in Kenya [1]. Thus, the problems and challenges of science education including new opportunities in science education can tackled through research approaches (McFarlane, 2013) [8].

According to STEM, education is built on the assumption that students come to school with different brains and that education is the process of immersing these brains in knowledge, facts, and procedures, which those brains then absorb to varying degrees. The extent of absorption is largely determined by the inherent talent and interest of the brain. Thus, those with STEM "talent" will succeed, usually easily, whereas the others have no hope [4]. Research advances in cognitive psychology, brain physiology, and classroom practices are painting a very different picture of how learning works. That, more research is needed on how to accomplish the desired learning most effectively over the full range of STEM skills and potential learners in our classrooms, as well as how to best train teachers. According to different model, the SMASE intervention and relevance was derived from in-service aimed at enhancing the quality of teachers in terms of positive attitude, teaching methodology, mastery of content, resource mobilization and utilization of locally available teaching and learning materials in Nigeria (Shuaib, 2016) [9].

The SMASSE goal was to enhance the capability of young Kenyans in mathematics and science, biology included. This owed to the fact that the knowledge and skills gained in biology transverses all spheres of life. Apparently, biology helps to solve societal problems in health, agriculture, environmental conservation, and management. It prepares learners for careers in applied disciplines such as agriculture, medicine, biotechnology, agrochemical, and food industries among other areas of application (Maundu, Sambili and Mutwii, 1998) [10]. Despite its enormous practical value, the general trend in biology performance in Kenya Certificate of Secondary Education Examination (K.C.S.E) has been poor especially for girls (Odhiambo, 2000) [11]. Mwangi (2003) [12] notes that the general poor performance by students in K.C.S.E science exams (including biology) indicates that students lack adequate scientific skills. These skills are meant to be obtained through the learning of these subjects at secondary school level. Therefore, he notes that most school leavers at this level do not possess the knowledge and skills to be able to benefit from the opportunities for further training and education. Such skills could be applicable in the labor industries and other critical sectors of the economy. This is a major barrier to the Kenyan's quest for industrialization by the year 2030 (Kenya Vision, 2030) [13].

According to the United Nations report (2007) [14]:
"*It is urgent for Africa to develop a sense in science and technology which will spur industrial and Agricultural productivity, ensure food productivity, control diseases, provide clean water, and preserve the environment*." Pp. 76.The UN report also indicates that the quality of Science and Engineering Education in Africa, Kenya included, is also declining. This leads to the poor performance in Science-based subjects. It is not a secret that education is a key factor in promoting economic and national development. However, according to the United Nations report (Oct., 2007), the science and technology gap between Africa and rest of the world has grown over the years. To bridge this gap, African governments have pledged to promote the study of science and technology. At the summit of the continent's political body held on the January, 2007, at Addis Ababa (Ethiopia), the African Union heads of States and governments, pledged to revitalize African Universities and promote the study of science and technology by young people [14].

According to Bishop (1985) [15], many countries are strengthening and modernizing their mathematics and science courses in order to produce more and better-qualified candidates for higher-level technical and scientific studies. Kenya responded by launching the SMASSE project, a joint venture with Japan International Agency (JICA). The project aimed at addressing the quality of teaching and learning of secondary school mathematics and science with a hope of improving students' academic achievement in these subjects. Therefore, it was necessary to find out the level to which the projects' goal had been realized especially, with respect to students' academic achievements in biology.In an attempt to counter problems of poor performance in biology and other sciences in secondary schools, Kenyan Ministry of Education Science and Technology (MOEST) in conjunction with Japan International Co-operation Agency (JICA) launched the SMASSE project on 1 July 1998. The initiative was in line with global thinking on the need to enhance acquisition of requisite scientific and numeracy skills among the youth as a means of increasing their participation in improving the quality of human life.The SMASSE initiative was prompted by the consistently poor performance in K.S.CE. in science and mathematics. Following the launching of the project, teachers were frequently in serviced in innovative ways of teaching biology. It is not clear many years later if the project has had an impact on the way biology is taught in school or not, and whether performance in the subject has improved accordingly. This data would be informative to the policy makers.

1.1 Statement of the Problem

An analysis of the pattern and trends of performance in K.C.S.E biology by the Kenya National Examination Council(KNEC) between 2002 and 2014 (K.N.E.C. Reports, 2002[16],2003[17],2004[18],2005[19],2006[20],2007[21],2008[22],2009[23],2010[24],2011[25],2012[26],2013[27],2014[28],2015[29]) is as shown in Table 1. From the table 1, it is clear that performance in the subject has remained poor with an overall mean score of below 50% throughout the years. Further, there was an increase in the number of candidate who sat for K.C.S.E while there was a general drop in the percentage mean score from 2007 to 2012 (K.N.E.C. Report, 2013) [27]. This is despite the enormous efforts and initiatives by the government of Kenya and her development partners to improve the quality of teaching and learning in biology and the allied subjects. Themost notable initiative has been SMASSE in-service training through which thousands of biology teachers have been in-serviced in terms of preparation and use of low-cost resources in teaching.

Table 1: Candidates overall K.S.C.E. performance in Biology 2002 to 2014

Year	Paper	Candidature	Maximum Score	Mean Score	Percentage Score
2002	1	177,251	100	24.10	22.65
	2		60	13.12	
	overall		160	36.24	
2003	1	184, 438	100	25.54	25.70
	2		60	15.56	
	overall		160	41.11	
2004	1	200,797	100	31.77	30.69
	2		60	17.31	
	overall		160	49.07	
2005	1	234,975	100	28.22	25.99
	2		60	13.38	
	overall		160	41.54	
2006	1	217,677	80	19.83	27.45
	2		80	25.20	
	3		40	11.63	
	overall		200	54.89	
2007	1	248,519	80	27.10	41.95
	2		80	35.01	
	3		40	21.81	
	overall		200	83.90	

2008	1	274,215	80	22.24	30.32
	2		80	21.09	
	3		40	17.30	
	overall		200	60.64	
2009	1	299,302	80	20.14	27.15
	2		80	18.41	
	3		40	15.86	
	overall		200	54.29	
2010	1	317,135	80	21.39	29.20
	2		80	18.67	
	3		40	18.42	
	overall		200	58.39	
2011	1	363,817	80	22.74	32.44
	2		80	23.31	
	3		40	18.84	
	overall		200	64.87	
2012	1	389,523	80	19.77	26.21
	2		80	-20.70	
	3		40	11.97	
	overall		200	52.41	
2013	1	445,896	80	28.91	31.63
	2		80	22.36	
	3		40	12.88	
	overall		200	63.26	
2014	1	445,896	80	23.91	31.83
	2		80	18.92	
	3		40	20.82	
	overall		200	63.65	

Source: Kenya National Examination Council Report 2002 to 2015

The recommended instructional strategy by SMASSE is Activity, Student Experimentation and Improvisation (ASEI) and Plan, Do, See, Improve (PDSI) approach. The strategy focuses on student-centered learning that involves many student activities that include experiments and use of improvised material (ASEI) where necessary. To achieve these, formulation and implementation of work plans, evaluation of the results, and improving the work plans are encouraged. This constitutes PDSI, which stands for plan, do, see and improve. Nui and Wahome (2006) [30] reporting on "SMASSE project impact assessment survey of September 2004" in the 2005 SMASSE internal report indicated that through these approaches, there is a positive impact on achievement of skills, knowledge and attitude by the learners. This has led to significant improvement in internal performance in mathematics and sciences in districts where SMASSE has been operating during the project period. Despite the effort, low performance is still persistent as shown by the mean scores in biology in Kakamega North Sub County (Table 2).

Table 2: Kakamega North Sub County 2008 to 2014 K.C.S.E Mean Scores in Biology

Year	2008	2009	2010	2011	2012	2013	2014
Mean Score in Biology	3.75	4.39	4.04	3.75	3.49	3.54	4.350

Source: Kakamega North Sub County Education Office, 2015.

The continued poor performance in K.C.S.E biology (an external examination) by the students raises a fundamental question: How effective is SMASSE project in influencing students' performance in K.C.S.E biology?

The 2006 August parliament report reinforces this question:

"*…….is the Minister aware that strengthening of Mathematics and Science in secondary schools (SMASSE) project training service has failed to meet the objective and not provide anything new to the teachers*?" (Mzalendo, 2006) [31].

The aforementioned question asked to the Minister of Education, Science and Technology in parliament in 2006, seven years after SMASSE project establishment, is a reflection of the concern on the continued poor performance in K.C.S.E biology by students in the country. Kakamega North Sub County was curved out of the larger Kakamega district and participated in the pilot phase of SMASSE since 2000. 2,517 candidates sat for K.C.S.E. biology in Kakamega North Sub County and the grades distribution is shown in table 3.

Table 3: Kakamega North Sub County K.C.S.E. biology grade distribution 2014.

Grades	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Total Candidates	35	49	55	76	92	142	207	271	277	767	474	72

Source: Kakamega North Sub County Education Office, 2015.

It can be seen from the Table 3, that in 2014 a proportion of 63.2% of the candidates scored D+ and below. It is notable that performance for other years shows a similar trend. This implies the attainment of SDG's, might not be possible for Kakamega North Sub County. Therefore, it became necessary to find out the influence of SMASSE initiative on K.C.S.E. biology performance in secondary schools in Kakamega North Sub County.

1.2 Purpose and Objectives of the Study

The purpose of this study was to determine the influence of SMASSE initiative on biology performance at K.C.S.E in public secondary schools in Kakamega North Sub County, Kenya. This was necessary in as much as policy regarding the SMASSE project implementation is concerned. The specific objectives of the study were: i) examine the relationship between the use of ASEI andPDSI instructional strategy and performance in K.C.S.E. biology; ii) to establish the trend in K.C.S.E biology performance in Kakamega North Sub County from the year 2008 to 2015.

1.3 Hypotheses

i)There is no relationship between the use of ASEI and PDSI instructional strategy and performance in K.C.S.E. biology in secondary schools in Kakamega North Sub County; ii) The null hypothesis was that there is no relationship between the trends in K.C.S.E biology performance and years of SMASSE in-service training in Kakamega North Sub County.

1.4 Significance of the Study

The findings of the study would be useful both to theory and to practice. In terms of theoretical value, the findings would put more light on the long-standing concepts and variables in the dynamic in-service process. In particular, the applicability of ASEI/PDSI approach to instruction in biology within limits of traditional orientation of teachers was critically examined. With regard to practice, the findings of the study would be useful in several ways:i) the Ministry of Education would realize the impact of SMASSE if any on small schools where resources and facilities are inadequate and would develop policies to help such schools excel in performance; ii) the ministry would realize the role played by SMASSE in academic achievement and thus streamline its policies in light of SMASSE objectives and principles; the biology teachers would plan and prepare their teaching and learning activities using ASEI/PDSI approach that will promote high achievement in the subject.

1.5 Scope of the Study

The study focused on the impact of SMASSE initiative. Specifically, the study examined the following aspects of ASEI: The use of activities in teaching biology, student-centered mode of teaching, use of experiments, and improvisation when materials required to conduct the experiments were absent. It also examined the following aspects of PDSI: plan where teachers are required to plan on how to teach, see where teachers are expected to evaluate their impact on students, and improve where teachers are required to improve on the areas students do not perform accordingly.

1.6 Limitations of the Study

The study was weighed down with the following limitations: i) the study findings may not be generalized to all schools in Kenya. This is because SMASSE in-service training was not initiated at the same time throughout the country. The findings however were useful to biology teachers in Kakamega North district; ii) due to limited time frame allocated for the post graduate program, the researcher relied on information collected using the questionnaire and group focus interviews to establish the teaching strategy in use and not in-depth interviews and direct observation in all schools sampled which was more demanding and time consuming; iii) in some instances, the SMASSE in-service trained teacher responsible for the 2013 K.C.S.E. biology results may have been transferred from their school. In such a situation, it was assumed that team teaching was being practiced so the research collected information from other biology teachers.

1.7 Assumption of the study

This study was guided by the following assumptions: that the K.C.S.E results in biology were a reflection of academic achievement in the subject; achievement in K.C.S.E biology was a reflection of overall performance during the secondary school period; that the higher the degree of implementation of SMASSE in a school, the better the biology performance in K.C.S.E. ; the teacher maintains the teaching strategies and approach employed by teachers of biology, because of SMASSE in-service training; that a class consists of 40 students.

1.8 Theoretical Framework

The study was guided by the constructivist theory of learning. The theory posits that the learners use their previous knowledge to construct their own new knowledge. According to the theory, learners easily engage in sense-making activities if they begin by examining what they already know. They are then ready to construct their own ideas if the teacher provides conducive learning environment. The students are thus responsible for their learning. The responsibility of the teacher is to create a suitable learning environment for the learners to be able to raise questions and seek out solutions to such questions by designing and performing investigations as an empirical basis for constructing knowledge. The teacher is thus a facilitator of learning by the pupil and provides the materials and resources that help the learner to raise questions and conduct investigations. A good classroom environment promotes students' curiosity, rewards creativity, encourages questioning and promotes meaningful understanding through the construction of knowledge. Group work is a component of such classroom environment that involves students in collaboration and dialogue as they construct new knowledge together. Meaningful learning of biology is therefore a product of three interacting components, the student, the teacher and the learning environment. If well planned and executed in lessons the three components promote meaningful and permanent learning among the students.

1.9Conceptual Framework

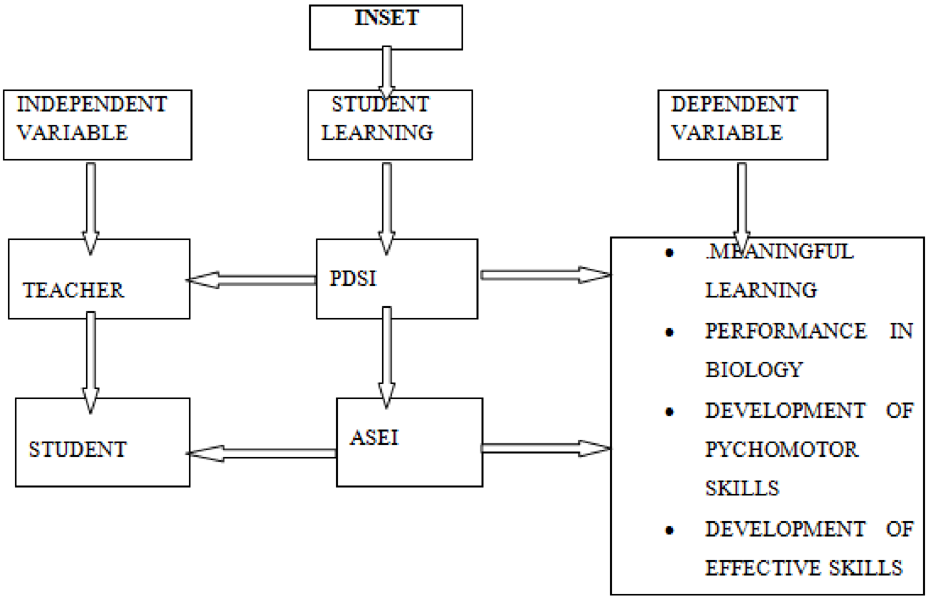

Figure 1: Benefits of in-service training on teachers and students' performance.
Source: Modified from Mukachi (2006) [32].

SMASSE in-service training is anchored in the constructivist theory of learning (that promotes student-centered learning as opposed to teacher-centered learning. The driving force is the ASEI (Activity, Student, Experimentation and Improvisation) movement and PDSI (plan, Do, See and improve) approach. In this enterprise, the role of the teacher is that of guidance while the pupils are active participants in the discovery journey. This relationship is summarized in Figure 1.From Figure 1, it is evident that the SMASSE initiative, as a mediating support in the teaching/ learning enterprise, provides the motivation and momentum for a dynamic relationship between teachers and learners. It also provides momentum and motivation for the teaching process. The ASEI axis provides the drive for effective preparation in terms of lesson delivery, provision of relevant and effective resources, and effective learning activities. The PDSI axis provides the impetus for planning, testing of the plans, lesson delivery, evaluation of learning and remedial activities. Both the ASEI and PDSI mediation collectively leads to dynamic characteristics of both students and teachers. The overall result is acquisition of effective, psychomotor, and cognitive skills that are reminiscent of meaningful learning characterized by enhanced memory and high achievement in biology. This conceptual framework therefore maps out the variables for this study: Independent variables: Integration of SMASSE instructional strategy in terms of incorporation of ASEI/PDSI approaches. The indicators for this include:ASEI (student related component) (A-The type of learning activities undertaken by students; S-Guidance given to students to find solutions to problems and Creative and reflective thinking; E-the type of learning activities undertaken by students in terms of investigation; I-Amount of improvisation.

PDSI (teacher related components)(P-Amount of time spent in planning and quality of lesson plans in use; D- Teamwork and collaborative teaching; S- Evidence of evaluation of teachers work;
I-Revision of teaching strategies).Dependent variables includes: Achievement in biology; ii) Meaningful learning whose indicator were: students-students' interaction; students interaction with apparatus; amount and type of assignment given to students; iii) Cognitive and manipulative skills: the researcher focused on integration of implementation of SMASSE instructional strategy as indicated by: team work and collaborative teaching and learning; amount of improvisation; type of learning activities; PDSI: quality of lessons plans, evaluation of teacher's work as independent variable; and achievement in K.C.S.E biology as dependent variable.

1.11 Operational Definition of Terms

Achievement:	The outcome of the teaching- learning process that the student gain, which is measured in terms of grades ranging from A to E.
ADEA:	Association for the Development of Education Africa.
ASEI:	An acronym used in SMASSE that stands for activity, student, Experimentation and Improvisation.
Biology teaching approach:	As used in this study refers to combination of ways that a teacher uses when presenting the content of the lesson.
Biology teacher:	Teacher presently allocated biology lesson on the timetable and has taught biology to at least form four level.
Hands-on-activities:	Refers to classroom activities that make use of materials where students manipulate the materials either in groups or as individuals. It is an in-depth investigation with objects, materials, drawing meaning and understanding from the experiences and can be called inquiry learning. Hands-on-activities, as used in this study, refer to various practical activities given to students where students are allowed to manipulate equipment and material in groups or individuals.
Hearts-on-activities:	Classroom activities geared to developing positive attitudes towards a subject and its content. These activities motivate the learner in biology as a subject.
Experimentation:	process of scientific test that is done in order to study what happens and gain knowledge.
ICQN-MSE:	-Country Quality Node of Mathematics and Science Education
Improvisation:	Do something with use of whatever is available or use similar version when standard commercial approaches or equipment are insufficient.
In-service:	Refers to training of teachers who are already in the teaching service. This usually takes a short period of not more than a month.
Instructional Strategy:	Ordering or sequence of instructional techniques and approaches in a lesson.
JICA:	Japan International Cooperation Agency.
KNEC:	Kenya National Examination Council
Learning:	Process of gaining knowledge or skills by studying, experience or from being taught.
MSE:	Mathematics and Science Education
Minds-on-activities:	Activities in the classroom that exposes the learner to critical thinkingsituations.
MOE:	An acronym used to refer to Ministry of Education
MOEST:	Ministry of Education Science and Technology
PDSI:	An acronym used in SMASSE that stands for Plan, Do, See, and Improve.
Performance:	Students achievements in physics examination.
SDG:	Sustainable Development Goals.
SMASE:	Strengthening of Mathematics and Science Education.
SMASSE:	Strengthening of Mathematics and Science in Secondary Education
STEM :	Science, Technology, Engineering and Mathematics.
SWA:	SMASSE-WECSA Association.
Teaching:	To give lesson or information to students in a school in order to help them learn something.
TCPP:	Third Country Training Programme.
TIMSS	An acronym used to mean Trends in Interactions Mathematics and Science Study.

1.12 Ethical Considerations

None of the information was published in manner in which the individual secondary schools, teachers and students involved in the study will be identified rather are treated confidentially.

II. Literature Review

2.1 Significance of Science Education

Biology is part of the broad science discipline including science education. Therefore, the features that affect science education also affect biology education. The aims of teaching school science (MOE, 1974, pp. 8-10) [33] calls on teachers to: assist students to know how scientists carry out their inquiries, how they arrive at conclusions, and how discoveries are made; stimulate students to view science as interplay of theory, experimentation, and application of scientific discovery; create confidence in students by letting them experiment with events in their day-to-day life.The teaching of science and technical subjects is an important aspect of secondary education, but reservations are expressed regarding its proper teaching (Bogonko, 1992) [34]. Changeiywo (2000) [35] argues that human resources capacity for rapid industrialization needs to be developed through education in science and technology. However, [15] observes that in all developing countries, a shortage of technical work force is the weak link in the chain of economic and industrial development. Despite the significant role of science and technology in social – economic development of a nation, the quality of science and engineering education in Africa is declining ([14]; Ogunniyi, 1998 [36]). Representative evidences from three sub-Sahara African countries (Botswana, Ghana and South Africa), show that young Africans studying science and mathematics in our schools today are not acquiring the relevant conceptual and transformative skills to secure a transformative shift in Africa's development [3]. This suggests we have a crisis on our hands – a learning crisis in MSE in sub-Sahara Africa. The most serious challenge hindering the development of science and technology in Africa include insufficient levels of literacy and shortage of women in science among other things. According to [3], the percentage of students taking part in the TIMSS assessment who achieved an international minimum standard in mathematics and science is still very low. At the most basic level, for mathematics, only 10% reached average achievement in South Africa (2003). In Ghana this is 19% (2011) and in Botswana 30% (2007). For Science the figures are 12% (South Africa); 20% (Ghana) and 34% (Botswana). What was also noticed from the data on learning outcomes is that the quality of experience learning mathematics and science is uneven, gendered, and location-based, i.e. the quality of experience in learning mathematics and science depends largely on whether you attend a school in a rural or urban area, or you are rich or poor. This means the experience of MSE is highly inequitable. This is worse when gender is considered, that women education achievement is low. The same sentiments are echoed by UNESCO (1995) [37] which reports, "*Industrialization needs to be developed through science and technology education. This would support economic growth and sustainable development which can be done through strengthening the access of women and girls who make up at least 51% of the population to science and technology.*" Pp. 39.

The scenario cited is because of the girls' poor performance in science subjects as compared to other subjects. According to Eshiwani (1982) [38] and [35], girls in developing countries have less access to education than boys do. Girls also under-achieve in science and mathematics at the secondary school level in Kenya. Bude (1995) [39] reveals that there is a problem with the science education in the secondary schools of many developing countries. He proceeds to mention that the same education tends to focus on abstract principles and theories that are not the countries' economic potential needs or requirements [39].The criteria of determining dissemination of relevant knowledge to the learners and its application in really life situations demands quick remedial action by policy makers. For example, only 1% of South African learners who participated in TIMSS 2011 had achieved the advanced benchmark – i.e. the ability to apply understanding in relatively complex situations and explain reasoning (Reddy *et al*., 2015) [41]. In the case of Ghana, performance in both mathematics and science has improved only slightly with gender and rural and urban gaps widening. Such inequitable progress means Ghana will not be able to maximize benefits for all young people even if it managed to improve the quality of MSE. When we compare the three sub-Sahara African countries that have participated in TIMSS to Latin American countries, for example, Chile, we see that they are making good progress and closing the equity gap in learning the basics in mathematics and science. So it means they are achieving more equitable and meaningful access to mathematics and science education. Finally, relevant SMASSE and like-tailored models of the MSE type should endow young Africans with skills in interpreting, analyzing and manipulating information or data to harness opportunities for sustainable development.

Tiffin (1994) [42], [39]and Gray (1998) [43] agree in asserting that instructional practices currently used in many schools are expository type in which the teacher dominates the lesson and is constantly in the process of narration. [15] calls this the 'Jug and Mug' method where the teacher is the 'jug' filling the student, the 'mug' with knowledge. However, [39] notes that students could learn science better when the teaching methodology enables them to be actively involved in the class activities. To him, learning science by doing requires a continuously active interaction between learners and their environment. Therefore, there is need to find out if learning in our biology classes is student centered with students interacting amongst themselves and their environment as proposed by SMASSEs.

2.2 Performance in Science Education

A steady decline in academic performance of high school students in the science subjects as well as low enrolment has caused much concern in many developing countries. For instance, the KNEC examination reports [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] indicate that the overall performance of students in science at K.C.S.E level is low compared to other subjects. Performance in science is generally poor in developing countries due to many problems ranging from under-funding of science education programs to language and science versus cultural conflict [36]. These factors affect the quality of science and mathematics education negatively. Analysis of the K. C. S. E. report in science, mathematics and other subject indicates that the students' performance in science and mathematics is poorer than in other subjects and that girls even perform worse than boys overall (Table 3).

Table 3: Candidate's Performance by Gender in the Years 2005 and 2006 K. C. S. EExamination in Science and Few Selected Subjects

Year	**2005**				**2006**			
Subject	***Female***		***Male***		***Female***		***Male***	
	No sat	Subject Mean	No sat	Subject Mean	No sat	Subject Mean	No sat	Subject Mean
Mathematics	118,898	12.97	140,414	18.49	113802	15.78	12323	21.87
Biology	113,605	27.24	121,370	32.01	108065	25	109863	29.84
physics	19,288	32.85	50,136	35.99	21376	39.07	51123	40.82
Chemistry	116,826	24.54	136,684	29.44	111969	22.56	124932	27.01
History & Government	64,826	46.85	78,851	54.84	66228	46.72	78206	54.04
Geography	45,185	38	61,088	43.7	41929	38.16	56088	44.38
C.R.E	67,883	57	52,004	57.74	82613	55.63	61678	55.4
Art &Design	375	59.39	662	57.37	358	61.26	750	61.93
Computer Studies	1708	51.37	1696	57.33	1874	52.09	2309	56.87

Source: Kenya National Examination Council 2007; the year 2006 K.C. S. E report

From the table 3, it is clear that the students' mean score in chemistry and biology for both years was below 35%. In the year 2006, the mean score for girls in biology was 25.00% while that of the boys was 29.84%. The data reveals that Science subjects and Mathematics are performed poorly as compared to other subjects. This opposes the fact that the many curriculum changes carried out [35] should be functional and vision-oriented. Some of the causes of the poor performance are attributed to poor instructional approaches used in teaching. Further, the challenge facing innovations aimed at changing teachers' attitudes and classroom practices is how to provide powerful images of applying science (and mathematics) to solve basic environmental and social problems which pupils can easily identify with and make sense of (Akyeampong and Kuroda, 2007) [44]. It is not that teacher educators do not know or are not aware of the importance of these skills. But, studies have shown there is a gap between desired competences that mathematics and science should foster, and what happens in the actual process of teaching and learning the subjects [3]. Thus, how do we ensure that the innovations and creative ideas about effective MSE are at the heart of how teachers learn to teach mathematics and science to secure these desirable competences? To be specific, 85% of the instructions consist of lectures and give students low chances of interaction (Johnson and Johnson, 1991) [45], creative and critical thinking to solve complex situations.

Teachers' professional development in Nigeria, however, has long been criticized for its lack of sustainability and ability to produce effective change in teaching and students achievement [9]. Education theorists today believe that a critical component of educational reform lies in providing teachers with various opportunities and supports structures that encourage ongoing improvement in teachers' pedagogy and discipline-specific content knowledge. However, the ongoing reforms in education sector and the need to refocus the Nigeria education system towards the goal of the National Economic Empowerment and Development Strategies (NEEDS) demand that the existing In-service and Education Training (INSET) in Nigeria be refocused.For teacher education to produce teachers who can foster desired mathematics and science competence, it should focus improvements in four areas: Resources, Innovation, Curriculum and Assessment (RICA) according to [3]; where resources means that the teacher education requires adequate and relevant instructional resources to support changes to how teachers learn to teach mathematics and science in schools. Thus, effort should deliberately be done to find ways in which technology can be used as an instructional resource to solve routine and complex problems that require application of mathematics and science concepts; embraceinnovation by find ways to infuse mathematics and science teacher education with innovative teaching and learning ideas/practices; review MSE curriculum for a closer alignment between goals and pedagogical practices; provide systems to review and introduce innovations in assessing mathematics and science in teacher education . In an effort to fill the gaps and improve on performance, the Ministry of Education Science and Technology (MOEST), in conjunction with Japan International Co-operation Agency (JICA), launched SMASSE project in 1998. SMASSE addresses instructional approaches used in Kenyan schools and advocates for student-centered learning that is activity oriented.

2.3 The SMASSE Project

SMASSE is an acronym for Strengthening of Mathematics and Science in Secondary Education [30]. It is a joint venture between the Kenyan government through MOEST and the government of Japan through JICA. The SMASSE (Strengthening of Mathematics and Science in Secondary Education) initiative in Kenya was in response to students continued poor performance in the mathematics and sciences, despite a number of efforts that had been implemented to address some of the challenges facing the mathematics and science education. These efforts included: providing schools with qualified mathematics and science teachers; improving remuneration and terms of service for the mathematics and science teachers; providing schools with science equipment and even constructing laboratories. The Ministry of Education considered evolving appropriate pre- and in-service training so as to raise relevance and quality in secondary education (MOEHRD, 1997). Indeed, MOEST, 2003(Pp.19) considered developing and operationalizing focused in-service programs as one of the indicators for attainment of enhanced quality of education [1]. According to [30], SMASSE came into being when there was consistently poor performance in Mathematics and Science because of the broad curricular, lack of facilities, ill equipped teaching skills and inadequate staffing. In an effort to intervene, the Ministry of education came up with the SMASSE project.

The project applied two approaches in strengthening quality of Education: mounting capacity development workshop for school managers' and conducting INSET to strengthen quality of teaching force in mathematics and science. INSET is one of the approaches employed to up-grade teachers' skills and competence the world over (Karega, 2008) [46] and is in conformity with worldwide consensus that improving quality of education depends on improvement of quality of classroom practices (Kibe *et al*, 2008) [47].According to JICA report, SMASSE focuses on Human Resources Development that was to cost approximately 860 million Yen between 1998 and 2002. The report states that Kenya hoped to achieve continuous development through industrialization by the year 2030. This was mainly by improving the education sector. However, was hampered by lack of adequate textbooks, teaching materials, science teachers, congestion of the curriculum and the high Education budget. Consequently, the quality of education started declining in Sciences and Mathematics. As a result, the Kenyan government announced the need to strengthen the teaching and learning in these areas as one of its priorities in the seventh and eighth National Development Plan. The implementation of INSET for teachers of science and mathematics was identified as a top priority in the human resource development program. Thus, the aim of the SMASSE project was '*quality improvement of incumbent teachers in science and mathematics through INSET*'.

Upon implementation of the project, the SMASSE team carried out a Baseline Survey in the nine pilot districts. The baselines survey revealed several factors that directly or indirectly contributed to poor performance in mathematics and science. 'Looking at the factors, it cannot be lost on any keen observer that the teaching and learning of these subjects need a new orientation in terms of approaches and methodologies and in terms of priorities and policies (Kisaka, 2003) [48]. Therefore, the SMASSE project undertook several activities aimed at realizing the goal of enhancing the capability of young Kenyans in Mathematics and Science (Kogolla, 2003) [49]. This was achieved through in-service education and training (INSET) for serving teachers of Mathematics and Science. Generally, implementation of SMASSE project activities was usually focused and well-coordinated to ensure that the activities were directed at addressing specific areas of concern (identified by the 1998 baseline studies).Three cycles were recommended by the project design matrix (PDM) and a forth cycle was recommended by the stakeholders meeting in May 2002. According to [49], each cycle had a main theme. Cycle 1 addressed problems of attitude and aimed at attaining a positive attitude change towards Mathematics and Science education among the teachers and learners. The pilot phase of the project benefitted approximately 4000 (20% of the target group of) teachers (Waititu and Orado, 2009). Buoyed by successful implementation of the pilot project the two parties agreed to scale up the implementation of SMASSE project activities to national scope for another 5 years (SMASSE Phase II:- SMASSE Report, 2003[50],2004[51],2005[52],2006[53],2007[54], 2008[55]). Cycle two of the project was aimed at adopting a practical / activity-oriented approach that is, provide hands-on experience for participants in terms of developing Activity, Student Experimentation, Improvisation (ASEI) lesson plan and using it for peer teaching. The focus was to inculcate practical skills to ensure that learners' participation was high; there was variation of stimuli, which could enhance learning by promoting curiosity and interest, and ensure that they develop manipulative skills. Thus, cycle two provided opportunities to put into practice the dimensions and principles of Activity, Student Experimentation, Improvisation movement (ASEI) and Plan, Do, See, Improve (PDSI) approaches.

From January of this year (2009), the implementation of the project activities has been farther scaled up to cover primary level education as well, up to the year 2013 [1]. The theme of cycle 3 was "Actualizations of Activity, Student Experimentation, Improvisation"– so the INSET [54] focused on classroom implementations of Activity Student Experimentation Improvisation / Plan Do See Improve principles. Actualization of Activity Student Experimentation Improvisation was extended to the forth cycle. This study wished to find out whether 'Actualization of ASEI' had been brought to the real classroom situations. In this study, the researcher was to find out if the learning is student-centered, activity-centered through experimentation and if improvisation is, being practiced where there is no conventional equipment.[30] state that as a follow-up of SMASSE, Kenya personnel conducted monitoring and evaluation of application and impact of the principles of ASEI movement and PDSI approach in the class room in Malawi, Zambia, Rwanda and Zimbabwe in May 2005. In September 2004, a National wide Survey was taken to access the impact of INSET [54]. This survey aimed at finding out how SMASSE activities were practiced in the classroom and how they were translated to achievement. However, the available information suggests that this was done in Mathematics, but it was not correlated to the final achievement of the students [30]. According to the JICA report, terminal evaluation carried out between 13^{th} and 26^{th} October 2002 indicated that it was difficult to measure the attainment of the overall goal ''upgrading the capability of young Kenyans in Mathematics and Science education.'' The report also noted that nine among seventy districts were target areas therefore activities, students' experiments, improvisation (ASEI) lessons introduced by the project were practiced in the target areas only.

There seems to be a contradiction between the objectives of SMASSE and the current practices. This is evident from the speech of Mr. Edward Tindi, the chairperson of SMASSE in Africa while addressing a conference for science teachers across Africa in Nairobi in January 2009. In his speech, Mr. Tindi noted, "there is something fundamentally wrong with the way we are teaching these subjects.'' He went further and gave the views of pedagogical experts whose questions in examination are set contrary to the approach of SMASSE where ''teaching of these subjects should be like an open field'', giving room for creativity. It was indicated that teaching is exam oriented with schools competing to emerge at the top every year as this provides more recognition of the school. The conference was aimed at bringing science and mathematics teachers together to identify problems and share experiences and information on how to handle the sciences and mathematics subjects to bring about change. The SMASSE guiding philosophy for change is Activity, Student, Experimentation, Improvisation, which aims at assisting teachers to shift classroom practice from: content based to activity based; lecture and theoretical approach to experiments and research based approach where experience rather than events are emphasized; recipe type large scale experiments to scale down experiments and improvisation. In this concept, more responsibility is placed on students during teaching. This is because the quality of classroom activities is critical for effective teaching and learning (Odalo, 2000[56]; Oswald, 2002[57]). This necessitates that while planning for teaching and learning activities, a teacher should target at insightful learning as opposed to rote learning that was revealed by the baseline studies carried out by the SMASSE team in 1998 (SMASSE Report, 1999)[58].[39] states that students learn science better when teaching methodology enables them to get actively involved in the classroom activities. Thus, the ASEI philosophy of SMASSE encourages hands-on and Hearts-on-learning. This is aimed at ensuring that, skills, knowledge and positive biological attitudes are instilled in the learner.

According to Haury and Rillero (1994), hands-on-learning ensures that the learner is "doing'' science allowing her or him to be involved in a total learning experience that enhances critical thinking. Hands- on-learning allows for in-depth investigation with objects, materials, phenomena and ideas. This makes students to directly observe and understand science hence learn the "what'', "how'', "when'' and "why'' of things with which they interact. SMASSE advocates for a range of teaching strategies to address diversity in the contemporary biology class. This includes discussion, small group experiments that allow students to interact with one another as well as the apparatus, project work, field excursion, role-play, use of assignment etc., which is aimed at enhancing development of creative thinking and problem solving ability. Hands-on-science therefore is the philosophy guiding when and how to use the broad range teaching strategies. This study was geared towards finding out the extent to which hands-on, minds-on and Hearts on activities were carried out in biology classes and how this relate to performance in biology.

2.4 Research Findings in Biology Education

A study carried out by [39] on the extent to which Science process skills of investigation used in biology practical, revealed that Biology practical work is still teacher-centered and that negative attitude towards Science still persists. Mukachi recommended that improvisation should be done to solve the problem of facilities in our schools and that in-servicing teachers is required. Kipkorir (1996) [59] in a study on teaching facilities in Biology and their influence on the subject performance at K.C.S.E level in Kericho District found out that learning was teacher-centered. However, recent studies revealed student centered learning in physics (Kahare, 2011) [60] and about 90% show positive attitude towards the subject. Further, students (70%) agree

that performance has improved. Learning activities suggests in the recommended books were never taken up. He further reported that Resources such as laboratory, laboratory apparatus, and materials may have been available in the schools studied but the frequency of use was low. In addition, Githui (1996) [61] indicated that lack of in-service training contributed to low performance. No recent study has been carried out in biology education.
In the literature, it was cited that facilities contributed to lack of practical work and poor performance. Improvisation was recommended, therefore, in this study, the researcher wanted to find out the level of improvisation being done as purported by SMASSE and how this relates to Biology achievement. Similarly, lack of in-service training was cited as contributing to low performance and in-service was recommended as a measure to improve on performance. Therefore, the researcher wished to establish the relationship between the frequencies of in-service and achievement in Biology. It was also cited that learning was teacher-centered, SMASSE advocates for student-centered earning which is to be achieved by ASEI movement and PDSI approach used in teaching Biology.

2.5 Gap in Literature

Much of the information on impact of SMASSE is in the area of Mathematics. Very little information is available in the area of Biology; therefore, the researcher wished to attempt to fill up the gap. This was done by investigating the relationship between the level of implementation of SMASSE initiatives and achievement in K. C. S. E. Biology in Kakamega North Sub County. It was also notable that there is little literature on the benefits of ASEI/PDSI instructional strategy of teaching biology.

III. Methodology

3.1 Research Design

The expost-facto research design was adopted for this study. In an expost-facto research, inferences are made concerning relationship among variables without direct control of the independent variable because their manifestations have already occurred and cannot be changed (Kerlinger, 1973) [62]. In this study, the level of implementation of SMASSE, as an independent variable could not be controlled by the researcher.

3.2 Area of study

The area of study was Kakamega North Sub County of Kakamega County, Kenya. Kakamega North Sub County was curved out of the larger Kakamega on the south and boarders MateteSub County on the North, on the East is the Nandi escarpment. The main economic activities in this area are farming where inhabitants practice both crop farming and animal husbandry. The Sub County had 36 secondary schools at the time of the study of which 35 are public and one private. The reason for carrying out the study in this area was that the researcher was stationed in one of the schools in the Sub County thus making the study economical in terms of finances and time. Besides the area had also shown poor performance in K.C.S.E and especially in biology yet it was curved out of the larger Kakamega County where the pilot phase of SMASSE was conducted since the year 2000.

3.3 Population

The target population of the study was all biology students in the 35 public secondary schools in existence in the Sub County since 2008. This was used to establish the trend in K.C.S.E biology achievement from the year 2008 in the Sub County. The accessible populations were all form three and form two biology students in the sampled schools. Form two and form three students were used to allow the researcher get views from students who had been taught by SMASSE in-serviced teachers who also taught the 2014 K.C.S.E biology classes. Twenty-five out of the 35 public schools were in existence before SMASSE Inset and presented candidates for the K.C.S.E examination during the study.

3.4 Sample and Sampling Procedure

The selection of the sample was phasic. First, a saturated sample consisted of all the 25 public secondary schools in the Kakamega North Sub County that presented candidates for K.C.S.E examination in the year 2014 was selected. Mugenda and Mugenda (2003) [63], argue that a sample should be large enough to represent the salient characteristics of the accessible population. Thus, the use of 25 schools represents the entire population of schools, which met the inclusion criteria for the study implies that the sample is large enough. Second, purposive sampling was used to select the biology teachers who had undergone SMASSE initiative training and who taught the 2014 K.C.S.E biology classes in the sample schools. Third, the researcher then requested the class teacher of the class to provide the sample frame. Simple random sampling was applied to select twelve students out of the class to respond to the questionnaire. Twelve students were randomly selected for either form two or form three, from each of the twenty-five public schools in Kakamega North Sub County. In total, three hundred students and twenty-five teachers responded to students' and teachers' questionnaire, respectively. Fourth, purposive sampling was also be used to select the teachers for other classes that had been trained through the SMASSE initiative and have remained in the same station for at least five years. The head teachers of the 25 sampled schools were also involved in the study.

3.4 Instrumentation

This section highlights the tools used for collecting data for the study. These were standardized test, questionnaire, interview schedule and observation checklist.

3.4.1 Standardized Test

With respect to this study, K.C.S.E examination served as standardized test measuring an individual's knowledge. K.C.S.E results (obtained from the Kenya National Examination Council) were used as a measure of learner's academic achievement in biology because it is considered reliable and valid. The test is reliable because it has a relation with the actual teaching in the classroom. It is crucial to point out that the researcher did not give the examinations, but relied on results released by the Kenya National Examination Council. Kenya National Examination Council comprises of trained staffs that do marking under closely supervised and controlled conditions. This implies that K.C.S.E results were valid since trained experts moderated the examinations. This ensured that what was tested was within the content of the syllabus.

3.4.2 Questionnaires

Three sets of questionnaires were designed by the researcher, one administered to teachers of the subject understudy who taught candidates of the year 2014. The purpose of this questionnaire was to find out if the teachers' have undergone SMASSE in-service training. The items in the questionnaire focused on finding out how teachers implement ASEI/PDSI of SMASSE. The head teachers' questionnaire was administered to head teachers in the sampled schools. The questionnaire contained items aimed at finding out the amount of support given by the head teacher as a stakeholder in SMASSE implementation. The biology students' questionnaire on the other hand was of the Likert scale type. It was administered to either form two or form three students taught by the SMASSE trained biology teacher(s) of the school. The purpose of this questionnaire was to use students' views to find out the level to which the teachers used the SMASSE instructional strategy. The questionnaire aimed at establishing the frequency of practical work in school, the nature of practical work, teaching methodology, use of improvised facilities, team teaching and use of resource persons and follow up by the teachers.

3.4.3 Interview Schedule

More information was collected by way of interviewing the biology teachers and laboratory technicians. This focused on the use of work plans, time spent in planning, revision of teaching strategies, teamwork, and management skills.

3.4.4 Observation Checklist

Biology teachers who were trained with SMASSE and had stayed in the same station for at least four years were observed while teaching. Their work plans were also examined. The observation checklist established the PDSI and ASEI activities.

3.5 Data Collection Procedure

The sampled schools were pre-visited to inform the head teachers about the study. An actual visit to the sampled schools involved three activities: to obtain K.C.S.E biology results of the schools from the year 2001 to 2014. This was obtained with permission from the head teachers and the researcher worked in conjunction with the D.O.S/curriculum master, H.O.D science or biology subject head to complete the results data sheet; to issue the questionnaires, to the head teachers, biology teachers and sampled students. The researcher waited for the questionnaire to be completed and completed the biology result data collection sheet with the assistance of the director of studies. Collection of the student questionnaires and data from the respondents was done on the same day to avoid loss of data from students; carry out group focus interview of the science teachers in school. In addition, biology teachers who complied with SMASSE and had been retained in the same station long enough were re-visited and observed while teaching. The researcher completed the observation checklist during the observation.

3.6 Piloting of Research Instruments

The research instruments were pre-tested in two public schools outside the Kakamega North Sub County. Piloting was done to refine the instruments before they were subjected to actual research. Mugenda and Mugenda (1999) [64] observe that piloting ensures that research instruments are clearly stated and have the same meaning to all respondents. Since the actual study was in 25 schools, pre-testing on two schools constituted 8% coverage of the total sample population. Pre-testing ensured that the instruments are of acceptable reliability and validity.

3.7 Validity and Reliability of Instruments

To establish face and content validity of the questionnaires designed, the researcher requested two experts from the department of science and mathematics education at Masinde Muliro University of science technology to proof read and provides necessary input. They were guided by the objectives and expected outcomes of the questionnaire prepared by the researcher. Comments received from the experts were used to modify the instruments and make them more adaptable to the study. The reliability of the instrument was verified by testing for the reliability. The items were organized into two halves; one half in odd numbers and the other half in even numbers. These corresponding items tested same ideas worded differently. The items were scored and a correlation in scores determined using the split half technique in excel. The Cronbach's alpha coefficiency was 0.732, 0.75 and 0.71 for the three instruments which is larger than 0.7, hence reliability.

3.8 Data Analysis

Both quantitative and qualitative data were generated from the field. The data were analyzed using inferential and descriptive statistics. The analysis was mainly presented in tabular form, but with the aid of bar graphs and charts where necessary. For quantitative data, regression analysis was computed at a 95% confidence interval to establish the relationship between the variables under study. The same technique was also used to test for the hypotheses of the related variables. The Microsoft Office Excel software was used to analyze the data.

IV. ResultsAnd Discussion

4.1 Performance mean score in biology during SMASSE period

Figure 2 shows performance score mean in biology since implementation of SMASSE In-Set in Kakamega North Sub County. The SMASSE project was implemented in 1998. This implies the influence of SMASSE was observed in 2001.Consequently ASEI and PDSI instructional strategy started influencing the way biology subject was being taught during the learning process. The student started to digest the SMASSE strategy idea of imparting biology concepts.

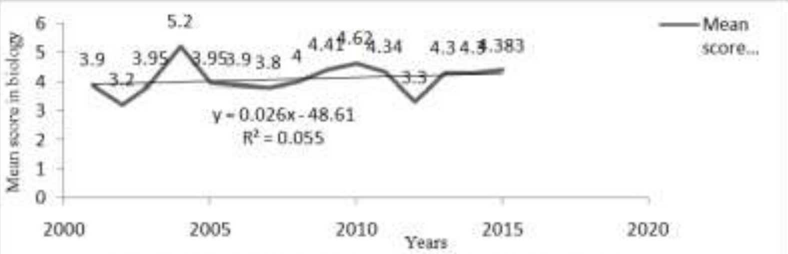

Fig. 2. Performance mean score in biology since implementation of SMASSE In-Set in Kakamega North Sub County

During the 2001 to 2004 period, there was slight improvement in biology in the mean score in biology subject compared to the overall performancein biology in the Sub County (Fig. 2). The performance in 2004 year was the best compared to all the three years and evidence by the meanof 49.07% and standard deviation of 22 (KNEC Examination Report, 2005..Pp. 54-55). In 2006 the mean score was 54.89% and standard deviation 31.00 (KNEC Examination Report, 2005..Pp.37). Further, this was the first time the biology examination was offerred under revised curriculum (KNEC Examination Report, 2005..Pp.). During this year, some of the observation included, "The topic of support and movement does not seem to be taught using actual specimens", Practical application of population estimation in ecology is not exclusively taught". Still, that details of process and explainations was lacking leading to supeficial answers and loss of marks (KNEC Examination Report, 2005..Pp. 56). These observations are part of causes for decline or drop in performance in biology examination from 2005 to 2007. However, there was improved performance from 2009 to 2015 to stabilize at the mean score of 4.30 for two year duration followed by slight improvement in performance. The positive gradient of 0.031 from the equation given by the best line of fit (**y=0.0263x - 46.614**) confirm the improvement index in overall biology performance from 2001 to 2015 period. This could have been possible because problems, for instance, negative attitude of student towards biology, affecting implementation of ASEI/PDSI were being addressed. This released stress on the SMASSE activities which led to improved performance in biology. Therefore, rejects

H_3 and conclude that there is significant relationship between use of ASEI/PDSI instructional strategy and performance in K.C.S.E biology.

4.2 Frequency of SMASSE in-service Training and K.C.S.E Performance in Biology

Another objective of this study was to determine whether the experience obtained from SMASSE in-service training has an effect on K.C.S.E biology achievement. It follows that data collected for the study was analyzed to establish the objective mentioned before. This was achieved by focusing on schools that had their students taught by SMASSE in-service trained teachers. The frequency of SMASSE training was used as the predictor variable in this analysis. A regression analysis was computed at a 95 % confidence interval to establish the relationship between the two variables. Results were also obtained from a study that analyzed whether the experience obtained from SMASSE in-service training had an effect on the students results. The schools from group J had their mean scores from the year two thousand and eight to thousand and fifteen averaged. The outcomes (the averages) were recorded alongside the frequencies of annual experience from the teachers (Table 4).

Table 4: Frequencies of annual experience from the SMASSE in-service trained teachers and theircorresponding K.S.C.E. mean score

School	Number of years of SMASSE training	K.C.S.E. Mean score
A	7	5.302
B	3	3.75
C	4	3.61
D	6	3.58
E	6	6.09
F	5	4.33
G	4	4.10

Using regression analysis, the frequency of training acted as independent variable while the school means was the dependent variable. The excel output for the regression analysis is represented by the Table 5.

Table 5: Regression output of school mean scores against the annual experience of SMASSEin-service trained teachers

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.6256708							
R Square	0.3914639							
Adjusted R Square	0.2697567							
Standard Error	1.2085059							
Observations	7							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	4.697566894	4.698	3.2164	0.132875			
Residual	5	7.302433106	1.46					
Total	6	12						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.9358028	2.31171787	0.405	0.7024	-5.006657	6.8782628	-5.00665717	6.87826276
X Variable 1	0.9251333	0.515841894	1.793	0.1329	-0.400881	2.2511471	-0.40088052	2.25114709

The results from the regression output above indicate that there is a moderate positive relationship between the frequency of SMASSE in-service training and the K.C.S.E. results. This owes to the reality that Taneja (2009)[65] reveals that a correlation coefficient that is close to positive one means there is a strong positive relationship between the two variables under study. Consequently, a correlation coefficient of 0.626 implies that there is a moderate positive relationship between the frequencies of SMASSE in-service training and K.C.S.E. results. This is enhanced by the positive gradient of 0.936. The output also provides a p-value of 0.133. The p-value of 0.133 is greater than 0.05. Therefore, rejects H_1 and conclude that there is a significant relationship between the frequencies of SMASSE in-service training at a 95% level of significance.

4.3 The Trend in K.C.S.E Performance in Biology

The K.C.S.E biology results for the years 2008 to 2015 were obtained from the schools. The mean scores were represented against their respective years on the line graph (Fig.3). For instance, the mean score for all the schools under the study for the year 2008 was plotted against the year 2008. The line graph illustrates the trend of annual results for Kakamega North Sub County. The best line of fit on the graph establishes whether there was an improvement or a drop in performance for the entire period under study. The relationship between K.S.C.E. performance and SMASSE was established in order to test hypothesis H_2. The trend was defined by the equation for the best line of fit. The outcome of the study revealed that the best line of fit was **y = 0.0016x+ 1.0696**. The data plotted on the line graph depicted the trend in K.C.S.E performance from 2008 to 2015. The graph below (Fig.3) illustrates the trend of the performance. The graph shows a steady improvement from 2008 to 2010. It is then that there was a steady decline in the results with a slight improvement in 2013. Apparently, the results from above indicate that the trend was positive from 2008 to 2010. This owes to the fact that the best line of fit had a positive gradient.

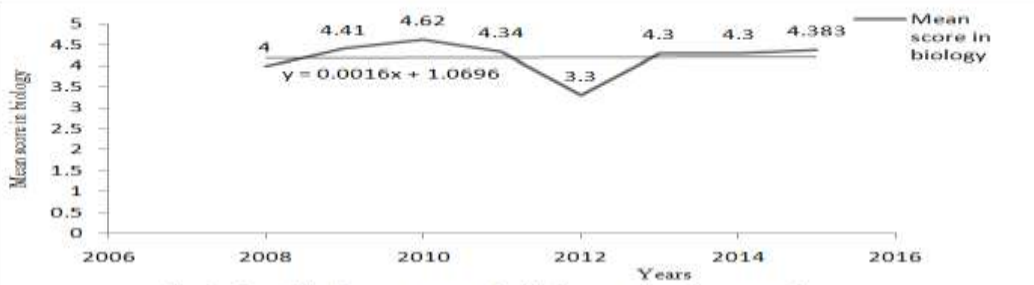

Fig. 3. Trend in the mean score in biology against the year of K.S.C.E. performance in Kakamega North Sub County

According to Best and Kahn (2004) [66], the gradient from the best line of fit determines the trend of a given observation. A positive gradient indicates a positive relationship while a negative gradient indicates a negative relationship. From the equation given by the best line of fit (y = 0.0016x + 1.0696), the gradient is 0.08. This indicates that there was an improvement in the entire performance from 2008 to 2015. Thus, reject $H_2$and conclude that there is a positive trend in the performance of the K.C.S.E. results and the years of SMASSE in-service training. The trend from the line graph also indicates that there was a gradual improvement from 2008 to 2011. This shows that the SMASSE in service training had gradual and progressive effect on the trend of students' performance in the K.C.S.E examination. However, the same trend declined steadily from 2011 to 2012, but with a slight improvement on the final year (2015). This trend could have been due to increased participatory activities of the students in the simplified and improvised experiments by the teachers. It also suggests improved students' positive attitude change towards biology [49]. However, the slight drop in the performance demands further investigations. For example, more techniques for teaching biology need to move away from teacher-centered to learner-centered [59][32] Bartholomew, Osborne and Ratcliffe (2004)[67] and often transfer of SMASSE trained teachers affected upward trend in some schools. Improved SMASSE in-service training may have contributed to the positive performance. [62]deems that, this should be the way in the future.

V. Conclusion

Progressive studies (Kersley, 1994) should be encouraged to determine the causal factors and their interactive effects on the performance of candidates in biology, and by extension Mathematics and Sciences. Apparently, the impact of SMASSE in-service training has been witnessed. It is clear that there are many positive outcomes from the implementation of the SMASSE project. It follows that the ministry of education should appreciate this fact and provides more support to the project. This could be done by increasing the necessary funding available. The SMASSE training should be related to the vertical mobility of the teacher. Thus, to motivate science teachers "SMASSE" certificates should be recognized for promotion/upgrading purpose. This would enable the trainees to increase on the number of trainers. The ministry can also encourage more teachers to attend the SMASSE training because of the notable improvement it produces on K.C.S.E results. SMASSE trained teachers should be source of future trainers of new employed biology teachers to save on financial limitations which have prohibitive progress.

There is to train teachers who have minimal, or no SMASSE in-service training. Special INSET for newly employed teachers should be organized each year so as to ensure they are brought on board. Senior SMASSE teacher educators should be considered in retraining the newly employed teachers at the county level under auspice of the County director of education. This owes to the reality that this work has established SMASSE in service training has a positive effect on the K.C.S.E. results. It has also shown that the more experience a given teacher acquires the higher the chances of the same teacher producing better results. That, SMASSE teachers who already had some SMASSE in-service training should strive to acquire more training.

Ultimately, it is advisable that teachers should make effort to improve on areas that recorded low levels of implementation. For instance, teachers should improve on the use of project work, field trips and field excursions.One suggestion is to carry out future research in other Sub Counties and in other counties; and that similar studies should be undertaken in other science subjects-chemistry, physics and mathematics within the county and other counties in Kenya. Since this study focused mainly on the classroom activities; a further study can be done on factors outside class that affect implementation of SMASSE. Further study can also be done on the appropriateness of the INSET curriculum.

Acknowledgements

I am grateful to the supervisors and researchers, Prof. W.W. Toili and Prof. Dickson S.O. Owiti for their guidance and advice during research work. Am indebted to Dr. Stephen F. Sikolia for the research work advice and preparation of the manuscript.Specialthanksto the institutional heads who granted permission to collect data and the Kakamega North Sub County staff and academic committee for allowing me to access vital data on educational in the Sub County. I am also indebted to my family and relatives for their financial, material and moral support given during the course of the study.

References

[1] Waititu, M.M. and Orado, G.N., Managing teachers and instruction of mathematics and science: Lessons from the SMASSE experience in capacity development. Workshop at secondary education in Africa (SEIA) follow up technical workshop on science and mathematics held in Tunis, Tunisia, on the 6th January-February, 6, 2009.
[2] Bethell, G., Assessment of Mathematics in sub-Sahara Africa: Status, Challenges and Opportunities. Cambridge Education, UK. 2016.
[3] Akyeampong, K., *Relevant Mathematics and Science Education in the transformative shift of Africa*: A Key Note Address presented at the Regional Conference of Mathematics and Science Education in Africa, Nairobi, Kenya, 2016.
[4] Wieman, C., Applying new research to improve science education. Issues in Sciences and Technology *Fall*, 2012, Pp. 25-31.
[5] Wieman, C. and Sarah, G., The Teaching Practices Inventory: A new tool for characterizing Colleges and University Teaching in Mathematics and Science. *Life Science Education*, Vol. 13, 2014, 552-569.
[6] SMASSE, SMASSE Cycle Four Training Manuals. (RL: http://www.jica.go.jp/), 2005.
[7] Akyeampong, K., Reconceptualised Life Skills in Secondary Education in the African context – Lessons learnt from Reforms in Ghana. *International Review of Education* African Economic Outlook (2014). Youth in African labour markets. Too many bad jobs in poor countries, too few jobs in middle income countries. Accessed 26th February, 2014 (http://www. africaneconomicoutlook.org/en/in depth/ youth employment/youth-in-african-labour-markets/).
[8] MacFarlane, D.A., Understanding the Challenges of Science Education in the 21st Century: New Opportunities for Scientific Literacy**.** *International Letters of Social and Humanistic Sciences*, 4, 2013, 35-44.
[9] Shuaib, Z.M., Strengthening mathematics and Science Education (SMASSE) for improving the Quality of teachers in Nigeria. Geophysical Research Abstracts, 18: EGU, 2016.
[10] Maundu, N. J., Sambili, H. J. and Muthwii, M.S., Biology education: A methodological approach. Nairobi: Lectern, 1998.
[11] Odhiambo, H., *Education Reform*. Daily Nation February 26, 2000, Nairobi. A publication of Nation Media group, 2000.
[12] Mwangi, W., *Tackles disparities in Exams.* Nairobi: Nation Media Group. Feb., 2003.
[13] Kenya Vision 2030, Vision 2030, a competitive and prosperous Kenya. Nairobi: Government of Kenya, 2007.
[14] United Nation Report, Oct., 2007.
[15] Bishop, G., *Curriculum Development: A text book for students*. London: MacMillan Education Ltd, 1985.
[16] Kenya National Examination Council, "The year 2001 K.C.S.E Examination Report.", 2002.
[17] Kenya National Examination Council, "The year 2002 K.C.S.E Examination Report.", 2003.
[18] Kenya National Examination Council, "The year 2003 K.C.S.E Examination Report.", 2004.
[19] Kenya National Examination Council, "The year 2004 K.C.S.E Examination Report.", 2005
[20] Kenya National Examination Council, "The year 2005 K.C.S.E Examination Report.", 2006.
[21] Kenya National Examination Council, "The year 2006 K.C.S.E Examination Report.", 2007.
[22] Kenya National Examination Council, "The year 2007 K.C.S.E Examination Report.", 2008.
[23] Kenya National Examination Council, ("The year 2008 K.C.S.E Examination Report.", 2009.
[24] Kenya National Examination Council, "The year 2009 K.C.S.E Examination Report.", 2010.
[25] Kenya National Examination Council, "The year 2010 K.C.S.E Examination Report.", 2011.
[26] Kenya National Examination Council, "The year 2011 K.C.S.E Examination Report.", 2012.
[27] Kenya National Examination Council, "The year 2012 K.C.S.E Examination Report.", 2013.
[28] Kenya National Examination Council, "The year 2013 K.C.S.E Examination Report.", 2014.
[29] Kenya National Examination Council, "The year 2014 K.C.S.E Examination Report.", 2015.
[30] Nui, W.N. and Wahome, A.N., SMASSE project. Tsukuba journal of Educational study in Mathematics, Vol.25, 2006 online.
[31] Mzalendo, *Eye on Kenya Parliament.* Online www.mzalendo.Com/2006/08.
[32] Mukachi, F.W., *The extent to which the Science process skills of Investigation used in Biology practical work. A comparative study of selected schools in Nyandarua District Kenya Unpublished.* M.Ed. Thesis Njoro Egerton University, 2006.
[33] Ministry of Education (MOE), *Chemistry SSP guides* Nairobi: Jomo Kenyatta Foundation, Foundation, Kenya, 1974.
[34] Bogonko, S. N., *A History of Modern Education in Kenya*. Nairobi: Evans Brothers Kenya Ltd., 1992.
[35] Changeiywo, J.M., *Student Image of Science in Kenya: A comparison by gender difference; levels of schooling and Regional Disparities*. Unpublished PhD Thesis Njoro, Kenya: Egerton University, 2000.
[36] Ogunniyi, M.B. (1996). *Science Technology and Mathematics, the problem of developing critical Human Capital in Africa*. International Journal of Science education 18(3), 1996, 267 – 284.
[37] U.N.E.S.CO, *World Education Report.* Paris: United Nations Educational Scientific and cultural organization, 1995.
[38] Eshiwani, G. S.,*A Study of Women's Access to Higher Education in Kenya With a Special Reference in Mathematics and Science Education*. Bureau of Education Research Nairobi, 1982.

[39] Bude, U., *Strategies for using Information to Improve Learning. Conditions and Instructional practices at the School Level*, (Bonn: permingation press, 1995).

[40] Reddy, V., Zuze, T.L., Visser, M., Winnar, L., Juan, A., Prinsloo, C.H., Arends, F & Rogers, S., Beyond Benchmarks – what twenty years of TIMSS data tell us about South African Education? HSRC, IEA, TIMSS, 2015.

[41] Tiffin, S., *The key to profit a practical guide to Managing Science and Technology.* Ottawa: IDRC, 1994.

[42] Gray, B.,*Towards accessible Science for pupils in Rural areas. Issues of curriculum, Teaching and in-service support for teachers. In Ogunniyi (Ed.) Promoting public understanding of Science and Technology in Southern Africa pp. 222-232.* Belvitte, SASSME University of Western Cape, 1998, 222-232.

[43] Johnson, D.W. and Johnson R. J., *Learning together and alone.* England Cliffs Prentice Hall, 1991.

[44] Karega, M., *Increasing Effectiveness of South-South Cooperation: the Case of SMASSE Kenya and SMASE-WECSA, A paper Presented at the Workshop for Practitioners of South-South and Triangular Cooperation* During the Fifth Annual United Nations Day for South-South Cooperation And the Launch of the Global South-South Development Expo at U.N. Headquarters/New York), 18th December, 2008.

[45] Kibe, Odhiambo and Ogwel, Impact of SMASSE INSET on students' capacity through improved teaching and learning in the classrooms, a paper presented at the 8th Regional conference for SMASSE WECSA, Nairobi, 2008.

[46] Kisaka, L.G., Teaching approaches and methods. A paper presented during cycle 1 of National INSET at Kenya Science Teachers College, Nairobi, Kenya, 2003.

[47] Kogolla, P., *INSET objectives* SMASSE project National INSET at Kenya Science teachers college, Nairobi, Kenya, 2003.

[48] SMASSE, ASEI/PDSI Training Manuals**.** Unpublished, 2003.

[49] SMASSE, ASEI/PDSI Training Manuals**.** Unpublished, 2004.

[50] SMASSE, SMASSE Cycle Four Training Manuals. Unpublished, 2005.

[51] SMASSE, SMASSE Cycle Four Training Manuals. Unpublished, 2006.

[52] SMASSE, Attitudes towards mathematics and sciences. Paper presented during 1st cycle of National SMASSE INSET. CEMASTEA, unpublished, 2007.

[53] SMASSE, SMASSE Cycle Four Training Manuals. Unpublished, 2008.

[54] Odalo, B., *Alarm over poor grades*. The daily Nation, Nairobi Kenya; Nation Media group ltd., 20th March, 2000, Pp. 23.

[55] Oswald, J., New Jersey Commission on Higher Education wards, Teacher Preparation grants in New Jersey Commission on Higher Education News release for immediate release, July 19, 2002.

[56] SMASSE (1999). SMASSE Bulletin. Vol. 1. Unpublished, 1999.

[57] Kipkorir, J.K., *Teaching facilities in Biology and their influence on the subject performance at K.C.S.E level in Kericho District*. Unpublished PGDE thesis Njoro. Egerton University, 1996.

[58] Kahare, M.W., Impact of strengthening of mathematics and science in secondary education programme on the teaching and learning of physics in mixed day secondary schools in Lari district, central province, Kenya. M.Ed. (Sci.). Kenyatta University, 2011.

[59] Githui, S.W., *The effect of availability and used of teaching Resources and Facilities in performance in Biology in Nyeri District.* Unpublished PGDE. Thesis Njoro, Egerton University, 1996.

[60] Kerlinger, F.N., *Foundation of Behavior Research.* New York: CBS College Publishing, 1986.

[61] Mugenda, O. M. and Mugenda. A.G, *Research Methods Quantities and Qualitative Approaches.*(Nairobi: Act press publisher, 2003)

[62] Mugenda, O. M. and Mugenda. A.G, *Research Methods Quantities and Qualitative Approaches.*(Nairobi: Act press publisher, 1999)

[63] Taneja, H. C., *Statistical methods for engineering and sciences*. New Delhi: I.K. International, 2009.

[64] Best, J.W. and Kahn, J.V., Descriptive Studies: Assessment, Evaluation and Research. In: *Research of Education* 10th Eds. (U.S.A., 2014)

[65] Bartholomew, H., Osborne, J. and Ratcliffe, M., Teaching students "ideas-about-science" five dimensions of effective practice. *Science Education*, 88(5), 2004, 655-682.

[66] Kersley, G. (1994). Constructivist Theory (J Bruner).Available:http//www.gwu.edu/~tip/bruner.html. Retrieved on 15/4/2010.