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The Extent use of Instructional Strategies in Teaching Biology in Public Secondary Schools, Kakamega North Sub County, Kenya.

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Abstract: *The study investigated extent use of instructional strategies in teaching biology in public secondary schools in Kakamega North Sub County. Performance in mathematics and sciences in the national examinations has been relatively low in Kenya. Therefore, 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 in an attempt to provide remedial measures. SMASSE embarked on in-service training of serving teachers of mathematics and science with an aim of making them better teachers and improve performance in Mathematics and Sciences, including biology. One of the SMASSE initiatives involved teachers adopting refined instructional strategies of teaching biology. However, the extent and scale use of the instructional strategies(the ASEI and PDSI strategies) applied is unknown. Therefore,theaimof the study was to investigate the level and extent use of instructional strategies of SMASSE initiative in teaching biology in public secondary schools. 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. Further, the biology teachers' questionnaire 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. The data collected was analyzed and presented using bar graphs and pie charts. Regression analysis at 95% confidence level and descriptive statistics was used for data analysis. The data shows high degree (70% and above) of use of the SMASSE instructional strategies in teaching of biology. A positive gradient was established showing performance improves with the years of SMASSE in-service training. 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 rationale for research in teaching practices and or instructional strategies and their mode of application inimproving academic performance is urgently required at different levels, especially at the tertiary. According to Wieman and Gilbert (2014) [1], no colleges and university collect data on the teaching practices in use in its courses and more so, efficiently and in consistent manner. The only data collected on teaching is the student course evaluations (Berk, 2005) [2] which provide little information on the instructional strategies or teaching practice and lend little guidance to the teacher/or instructor on how to improve (Cohen, 1980) [3].This is no different in the Kenyan situation. The studies show the need for research data on the mode and effectiveness of particular teaching practices in science, technology, engineering and mathematics (STEM) to improve teaching and learning process in the United States of America [1].Africa countries show similar phenomenon and need for solutions (Akyeampong, 2014)[4] and Kenya is no exception. This approaches can have the net effect in solving the poor performance in mathematics and science subjects experienced in Kenya. Thus, the approach undertaken between Kenya and Japan International cooperation agency,the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project was launched in Kenya on first of July 1998 in 9 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) [5]. 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 is 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 developmentAgenda (Bethell, 2016) [6]. 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) [7].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 [8], [1] and SME in most of theSMASSE-WECSA Member Countries of Africa (SMASSE PROJECT, 2005: URL:http://www.jica.go.jp/) [9].

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 [4]. 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 acknowledges the vital role science and mathematics play in the realization of vision 2030 to attain globally a 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 [7]. This requires remedial action. Therefore, substantial amount of resources both human and budgetary measures are channeled towards enhancing the teaching and learning of science and mathematics at all levels of the education system 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 (Waititu and Orado, 2009) [5]. Thus, the problems and challenges of science education including new opportunities in science education can tackled through research approaches (McFarlane, 2013), [10].

The STEM protocol [8] opines 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 [8]. 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)[11]. 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) [12]. 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[13]; Kahare, 2011[14]). Mwangi (2003) [15] observes 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) [16].

According to the United Nations report (October, 2007)[17]:"*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 [17], 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 [17].Bishop (1985)[18] posit that 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 the instructional strategies used by teachers to achieve better students' academic performance 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. Following the launching of the project, teachers were frequently in-serviced in innovative ways of teaching biology. However, 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. Thus, the researchdata derived 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 is as shown in Table 1.1. From the table 1.1, 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)[19]. 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. The most 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. 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 including 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.

Table 1.1 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	25.7
	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		80	28.91	31.63
	2		80	22.36	
	3		40	12.88	
	overall		200	63.26	
2014	1		80	23.91	31.83
	2		80	18.92	
	3		40	20.82	
	overall		200	63.65	

Source: Kenya National Examination Council Report 2002[20]2003[21]2004[22]2005[23]2006[24]2007[25]2008 [26]2009[27]2010[28]2011[29]2012[30]2013[19]2014[31]2015[32].

Nui and Wahome (2006) [33] 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 led to significant improvement in internal performance in mathematics and sciences in districts where SMASSE had 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 1.2).

Table 1.2 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 are the instructional strategies of 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)[34].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. This is the case in the Kakamega North Sub County curved out of the larger Kakamega district that participated in the pilot phase of SMASSE since 2000. For example, 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 1.3: 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. Performance for other years shows a similar trend (Table 1.1, 1.2). This implies the attainment of SDG's, might not be possible for Kakamega North Sub County, Kenya. 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 of the Study

The purpose of this study was to determine the extent of instructional strategies of the SMASSE initiative on biology performance at K.C.S.E level in public secondary schools in Kakamega North Sub County, Kenya. This was an integral component and policy regarding the SMASSE project implementation is concerned.

1.3 Objectives of the Study

The specific objectives of the study were to i) determine the extent to which the ASEI/PDSI instructional strategy was used in teaching biology in K.C.S.E. secondary schools in Kakamega North Sub County; ii)to examine the relationship between use of ASEI/PDSI instructional strategy and performance in K.C.S.E biology.

1.4 Hypotheses of the Study

The null hypotheses tested were: i) H_1-there is no significant relationship between the extent to which ASEI/PDSI instructional strategy was used in teaching biology and academic achievement in K.C.S.E. in secondary schools in the Kakamega North Sub County; ii) H_2-there is no relationship between the use of ASEI/PDSI instructional strategy and performance in K.C.S.E. biology in secondary schools in Kakamega North Sub County.

1.5 Significance of the Study

The research data would be useful both to theory and to practice. In terms of theoretical value, the data would shed 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 research data 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; iii) the biology teachers would plan and prepare their teaching and learning activities using ASEI/PDSI approach that will promote high achievement in the subject.

1.6 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.

1.7 Limitations of the Study

The study was weighed down with the following limitations: - i) it 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 KCSE 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.

1.8 Assumption of the study

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

1.9 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 (Kersley, 1994) [35]. 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.

1.10 Conceptual Framework

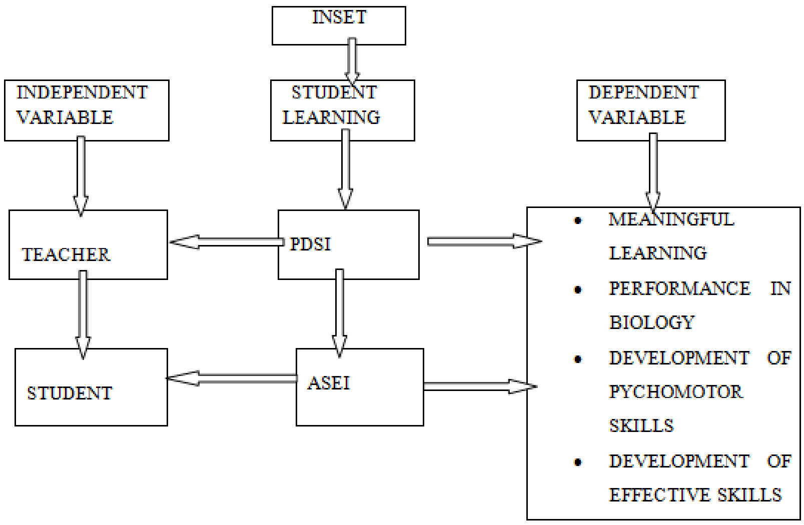

Figure 1.1: Benefits of in-service training on teachers and students' performance.
Source: Modified from Mukachi (2006) [36].

SMASSE in-service training is anchored in the constructivist theory of learning [35] 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 1.1. From Figure 1.1, 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 include: Achievement in biology; Meaningful learning whose indicator are: students-students' interaction, students' interaction with apparatus, Amount and type of assignment given to students; Cognitive and manipulative skills.In this study, 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.

1.12 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. Therefore, the features that affect science education also affect biology education. The aims of teaching school science (Ministry of Education, 1974, pp. 8-10) [37] calls on teachers to: i) assist students to know how scientists carry out their inquiries, how they arrive at conclusions, and how discoveries are made; ii) stimulate students to view science as interplay of theory, experimentation, and application of scientific discovery; iii) 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 were expressed regarding its proper teaching (Bogonko, 1992) [38]. Changeiywo (2000)[39] argued that human resources capacity for rapid industrialization needs to be developed through education in science and technology. However, [18] 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 [17],(Ogunniyi, 1998)[40]. 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 [7]. 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. Recent study shows the percentage of students taking part in the TIMSS assessment who achieved an international minimum standard in mathematics and science is still very low [7]. 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) [40] 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) [42] and [39], 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) [43] reveals that there is a problem with the science education in the secondary schools of many developing countries and the same education tends to focus on abstract principles and theories that are not the countries' economic potential needs or requirements. 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,Zuze, Visser, Winnar, Juan, Prinsloo, Arends and Rogers, 2015)[44]. 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)[46], [44] and Gray (1998)[46] 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. [18] calls this the 'Jug and Mug' method where the teacher is the 'jug' filling the student, the 'mug' with knowledge. However, [43] opines 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 [19] [21] [22][23][24] [26][27] [28] [29] [30][31] 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 [40]. 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 1.4).

Table 1.4: Candidate's performance by gender in the years 2005 and 2006 K. C. S. E.examination in science and few selected subjects

Year	**2005**				**2006**			
Subject	***Female***		***Male***		***Female***		***Male***	
	No sat	Mean score	No sat	Mean Score	No sat	Mean score	No sat	Mean score
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
Hist. & Govt.	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
Comp. 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 1.4, 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 [39] 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) [47]. It is not that teacher educators do not know or are not aware of the importance of these skills [47]. 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 [7]. 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 & Johnson 1991)[48], 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 [10]. 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 competences, it should focus improvements in four areas: Resources, Innovation, Curriculum and Assessment (RICA) according to [7]; 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; embraceinnovationby finding 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 (Nui and Wahome, 2005) [33]. 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)[49]. Indeed, MOEST (2003) [50] (Pp.19) considered developing and operationalizing focused in-service programs as one of the indicators for attainment of enhanced quality of education [5]. According to [33], 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) [51] and is in conformity with worldwide consensus that improving quality of education depends on improvement of quality of classroom practices (Kibe, Odhiambo and Ogwel, 2008)[52].

Lack of adequate textbooks, teaching materials, science teachers, congestion of the curriculum and the high Education budget compromised the quality of education with greatest decline beingin 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)[53]. 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) [54]. This was achieved through in-service education and training (INSET) for serving teachers of Mathematics and Science.

Three cycles were recommended by the Project Design Matrix (PDM) and a fourth cycle by the stakeholders meeting in May 2002. According to [54], each cycle had a main theme. After the success of the pilot phase, theSMASSE project activities were adopted nationally (SMASSE Phase II, SMASSE Report, 2003[55], 2004[56], 2005[57], 2006[58], 2007[59], 2008[60]). [33]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. National wide Survey taken to access the impact of INSET [57] was to establish the SMASSE activities practices in the classroom and subsequent translation intoacademic achievement. However, the available information suggests that this was done in Mathematics, but it was not correlated to the final achievement of the students [33].The SMASSE guiding philosophy for change is Activity, Student, Experimentation, Improvisation, which aims at assisting teachers to shift classroom practice from: i) content based to activity based, ii) lecture / theoretical approach to experiments and research based approach where experience rather than events are emphasized; iii) recipe type large scale experiments to scale down experiments and improvisation. The concept envisage more responsibility placed on student during teaching. This is because the quality of classroom activities is critical for effective teaching and learning (Odalo, 2000 [61]; Oswald, 2002[62]). 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)[63].

[43] posit that students learn science better when teaching methodology enables them to get actively involved in the classroom activities. Thus, the ASEI and PDSI of SMASSE philosophy encourages hands-on and Hearts-on-learning. According to Haury and Rillero (1994) [64], 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

Studies show that biology practical work is still teacher-centered Kipkorir (1996) [65] and negative attitude towards science persists (36). Mukachi (2006) recommended that improvisation should be done to solve the problem of facilities in our schools and in-servicing of teachers is required. However, recent studies revealed student centered learning in physics (Kahare, 2011) [14], a case not documented in biology. Further, learning activities in the recommended textbooks were never taken up. [65] also 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) [66] 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 suggested 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. Much of these 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 in biology. 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 in teaching biology.

III. Research Design and 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) [67]. 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 Matete on the North and on the East is the Nandi escarpment. 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 North Sub 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 Kakamega North Sub County that presented candidates for K.C.S.E examination in the year 2014 was selected. Mugenda and Mugenda (2003) [68], 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.

3.5 Instrumentation

The tools used for collecting data for the study included: - standardized test, Questionnaires, Interview Schedule and Observation Checklist.

3.5.1Standardized Test

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. 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. K.C.S.E results were valid because trained experts moderated the examinations. To ensure what was tested was within the content of the syllabus.

3.5.2Questionnaires

Three sets of questionnaires were designed by the researcher. The teacher questionnaire was administered to teachers of the subject understudy who taught candidates of the year 2014, 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 (the Likert scale type) 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.

3.5.3Interview 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.

3.5.4Observation 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 andestablished the PDSI and ASEI activities.

3.6 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: i) 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; ii) to issue the questionnaires, to the head teachers, biology teachers and sampled students. The researcher waited for the questionnaire to be completed then 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; iii) 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.

3.7 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) [69] 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.

3.8 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.

3.9 Data Analysis

Both quantitative and qualitative data were generated from the field. The data were analyzed using inferential and descriptive statistics (i.e. percentage and frequency). The analysis was mainly presented in table 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. Results and Discussion

4.1 Extent of Use of ASEI/PDSI Instructional Strategy in Teaching Biology

4.1.1Methods and Activities of Teaching Biology Class

The mean response Likert value of the data sets from different schools was used in the data analysis. It was specifically applied in analyzing data collected from student and teacher questionnaires. The mean of students' was done in two phases. The first mean was retrieved from the data collected in every school. Thus, every question had several responses because not less than 18 students had an answer for each question. Therefore, in order to find the response for every school the mean for the questions was obtained.

Table 1.5: Mean Response Likert value from Students' Responses.

	Students												
Question	1	2	3	4	5	6	7	8	9	10	11	12	Mean
1	5	2	4	4	5	4	5	4	5	4	4	4	4.167
2	4	4	4	4	4	4	4	2	5	4	5	2	3.833
3	2	3	1	2	2	5	2	4	1	2	2	2	2.333
4	5	4	5	4	4	5	4	4	4	4	3	2	4.000
5	2	3	2	2	2	4	5	5	4	2	1	2	2.833
6	4	4	2	4	2	1	4	1	5	2	2	4	2.917
7	4	2	1	2	1	2	2	1	2	1	1	2	1.750
8	2	4	2	2	1	2	2	2	2	1	2	2	2.000
9	2	2	2	2	2	5	4	3	2	2	3	2	2.583
10	4	5	4	2	5	4	4	4	4	2	4	4	3.833
11	4	1	1	4	4	5	4	5	4	4	3	4	3.583
12	5	4	5	4	4	2	4	3	4	4	2	2	3.583
13	4	2	2	2	4	4	4	5	4	3	5	4	3.583
14	4	1	5	2	5	4	4	4	5	4	4	2	3.667
15	4	4	2	4	2	4	4	5	4	2	4	2	3.417
16	5	3	2	4	2	4	4	4	2	2	1	2	2.917
17	4	2	3	2	2	2	2	2	5	4	4	4	3.000
18	2	3	2	4	2	4	2	4	2	2	1	4	2.667
19	5	4	4	4	4	2	4	3	4	4	5	2	3.750
20	5	2	5	4	4	4	4	3	5	4	1	2	3.583
21	2	3	4	2	2	4	5	5	2	4	2	4	3.250
22	5	4	2	4	5	5	5	5	5	4	5	4	4.417
23	4	4	2	4	5	5	5	5	2	4	5	4	4.083

Table 1.5 gives an example of the mean computed from the G secondary School.

That is, the response for question one was obtained by finding the mean of responses for the question. Therefore, it can be deduced that students from G secondary school agree that biology is a practical subject because the mean response for question one of the student questionnaire is 4.167.The mean for every school was then compiled and used to arrive at the final mean response Likert value. Another technique that was used in analyzing responses from students' questionnaires is sampling. A number of questions was sampled from the twenty-six questions and used in the analysis. To be specific, these questions were; question three, five, seven, eight, fourteen, seventeen, twenty-two, and twenty-three of the student questionnaires (Table. 1.5). Regression analysis was also used to determine the value of the R squared output. This owes to the fact that Agresti and Finlay (1997) [70] reveal that the R squared statistic expresses the percentage of the difference in the variables used for a statistical study. Bar graph for the mean response Likert value in all schools was plotted against the questions (1, 2, 3, 4 …23) (Fig.1.2).

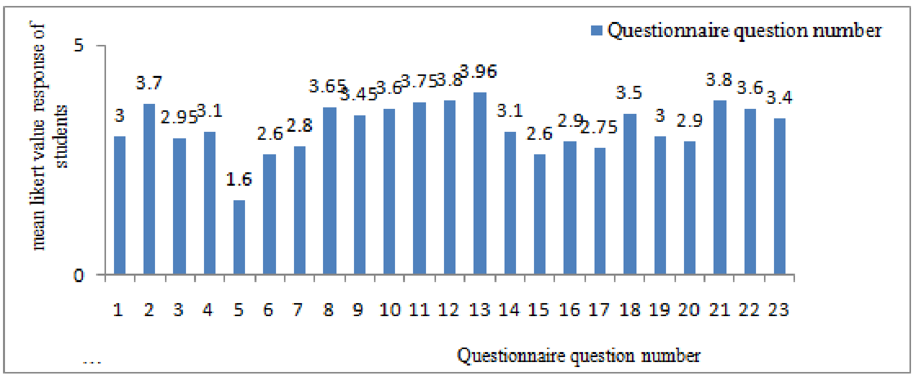

Fig. 1.2 Mean response Likert value of student responsesagainst questionnaire question number

Another set of data was extracted from the teachers' questionnaires for analysis. This was achieved by obtaining the percent frequency for distinct set of parameters in the questionnaires. It is notable that the distinct data sets were grouped due to the nature of the questionnaires used. This gave rise to four products for analysis of the teachers' questionnaires. The products in question are Item 11, Item 12, Item 13, and Item 16. Lastly, the data from teachers' questionnaires was represented on the bar graph for the four items (Fig. 1.3 and Fig. 1.4).
It was also crucial to analyze data obtained from the observation checklist. The data was translated into percentages of the distinct items from the observation checklist. Availability of the work plans and lab use items were significant under the do and evidence sections of the observation checklist.The results obtained from analysis of the student responses had a mean of 3.91. It also gave a standard deviation of 0.61. Table 1.6 gives summary of the mean responses from the sampled questions. The R squared statistic value of 0.11was calculated. The bar graph (Fig.1.2) shows the question number plotted against the average responses obtained from students in all the schools under the study.

Table 1.6: Mean Response Likert Value for the Sampled Questions

Question	3	5	7	8	14	17	22	23
Mean Response Likert value	2.443	3.019	1.561	2.126	3.857	2.565	3.971	3.943

Results from teachers' responses was an improtant outcome for the study. This owed to the fact that responses from students was not enough in achieving the objective for the study. The results from teachers responses on item eleven are provided in the Table 1.7.

Table 1.7: Result for Item 14 of teachers questionnaires

Method/ Activity	Never used	Rarely used	Used quite often	Always used
Lecture	1	11	10	3
Laboratory demonstration by the teacher	0	5	15	3
Laboratory experiments in groups by students	1	2	14	8
Lecture accompanied with class discussion	3	5	10	7
Field trips and excursions	4	12	8	1
Project work	4	12	6	03
Small group discussions on given topics (using reports)	3	6	10	6
Role play	4	6	9	6
Assignment and home work	0	1	8	16

Fig. 1.3 shows the percent frequency of responses by the teachers against the method/activity used as instruction strategy. In the Fig.1.3., 1, 2, 3, 4 and 5 refers to Lecture, laboratory demonstration, laboratory expeiments in small groups, lecture accompanied with class discussion and assignment and homework methods, respectively. Most responses from teachers revealed that most of the activities/method in the questionnaires were used quite oftenly. The lecture method had a frequency of 40%, laboratory demonstration by teachers had percent frequency of 60% and laboratory experiments in small group dicsussions had percent frequency of 56% and lecture/discussion 40% (Fig. 1.3). Also, SMASSE teachers are running away from the lecture method and putting in practice a combination of other better methods proposed by SMASSE (Fig. 1.3). Fig.1.3 shows that laboratory demonstration, small group discussion and laboratory experiments in small goups as the most preferred method and activity employed in biology class. SMASSE adopts learning activies and teaching methods that encourages student-centered learning, for example laboratory experiments in small groups. Students supported this SMASSE approach (Fig. 1.2.) and Table. 1.5. Uniquely, assignment and home work was always preferred to other methods used in teaching biology class (Fig. 1.3).

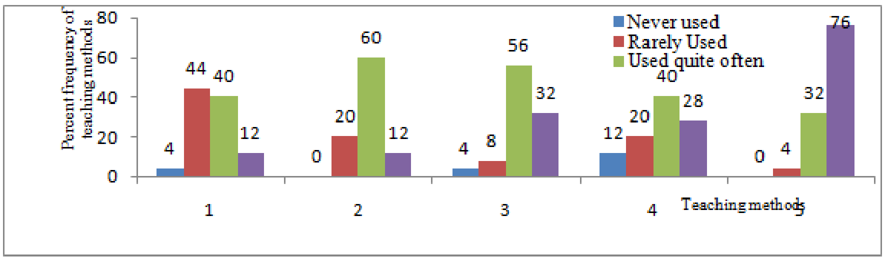

Figure 1.3. Percent frquency of different taching methods employed by SMASSE teacher in biology class

The field trip and excursion (56%) and project work (56%) were the least preferred method (Fig. 1.4). The reasons advanced by the teachers include the expenses involved, the high degree of organization that ensues, time consuming, complex to the level of the learner and very involving.

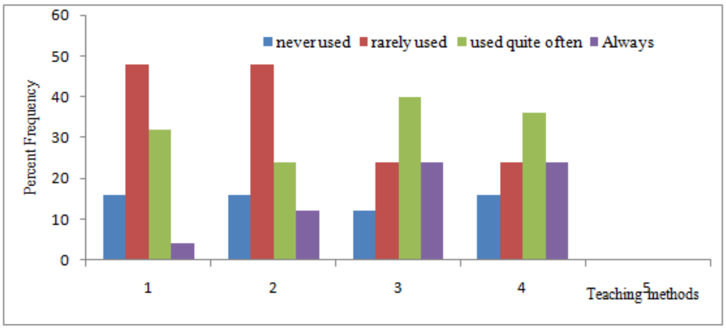

Fig. 1.4. Percent frequency of different teaching method employed by SMASSE teacher in biology class

Quite often than not role play, and assignment and homework method/activities were always preferred than lecture method (Fig. 1.3 and Fig. 1.4). Furthermore, assignment and homework was the most preferred learning method/activity (Fig. 1.3) employed in biology class because it is not much of the teacher-centered learning activity.

4.1.2 Teaching Practices Employed by Teacher of Biology in Biology Class

Different teaching SMASSE practices are prudent for proper learning to take place in biology class. Fig. 1.5. shows different teaching practices in different SMASSE complaint schools adopted by teachers in Kakamega North Sub County. From the figure, teaching biology class for an absent teacher (96%) and co-teaching of some biology topics is highly practiced (Fig. 1.5).Further, the practice of inviting a personnel (48%) in biology related fields to give a lecture in biology related issues is usually practiced (Fig.1.5).Invitation of biology teachers from neighbouring schools to teach some sub-topics in biology is rarely practiced (56%) as shown in the Fig. 1.5. Thus, contemporary science education is for teachers of science and science curriculum planners to view science as a consensus-building

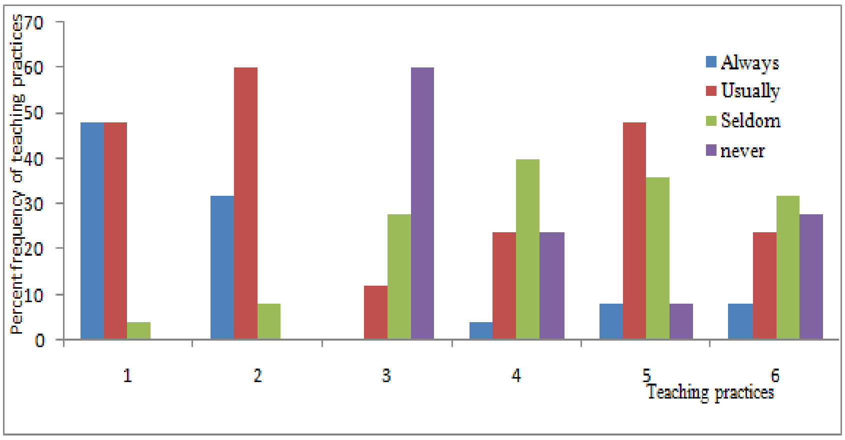

Figure 1.5. Percent frequency of different teaching practices employed by SMASSE teacher in biology class

discipline as it can be used to bring together people from diverse backgrounds and cultures with diversity of scientific thinking to make science learning a team and collaborative effort. This learning practices applies also to handling theory work by different teacher and another one practical work (60%). SMASSE encourages team teaching that minimise the (non-SMASSE) incompetence of applying SMASSE instructional strategy in non-SMASSE complaint teacher. Strengthening cooperation and collaboration in the development of scientific knowledge in individuals is based on the idea that: learners should be taught that scientific work is a communal and competitive activity. Whilst individuals may make significant contributions, scientific work is often carried out in groups, frequently of a multidisciplinary and international nature (Bartholomew, Osborne and Ratcliffe, 2004) [71]. New knowledge claims are generally shared and, to be accepted by the community, must survive a process of critical peer review (p. 658). Especially this is so in teaching different topics to the same students at different times, for example,when the teacher is absent or during co-teaching. This phenomena of team teaching, cooperation and exchange of information arising from exchange of teachers benefits the student, a practice of SMASSE. Through the activities of SWA, similar approaches modeled around the SMASSE Kenyan project have been initiated in different countries. Apart from Kenya, Southern (Zambia and Malawi) and Western (Senegal and Burkina Faso) African countries have developed and adopted their unique experience and accelerated multi-polarity of the MSE cooperation [4]. This SMASSE compliancy that has shown improved mean score performance in Kenya is replicated in Nigeria [11]. This intervention of Strengthening Mathematics and Science Education (SMASE) in training and re-training of teachers at enhancing quality classroom activities in Mathematics and Science subjects through Activity, Student-Centre, Experiments, Improvisation (ASEI)-Plan, Do, See, Improve (PDSI) instructional strategy. This instructional strategy has cultivates learner's mathematical and scientific thinking ability and have provided one of the best regular INSET for primary and secondary Mathematics and Science teachers as observed during the SMASE impact survey in the three piloted states in Nigeria [11].

4.1.3 Student Centered Activity

The data indicates student centred activities of note taking method. Most of the teachers (72%) did not favour providing notes after teaching. Further, 88% of the teachers opts for writing main topics from which the student develop and synthesis comprehensive notes (Fig. 1.6). Leading questions were also availed for students making notes as shown by high degree of compliaance (92%) in the Fig.1.6. This student centred approach of providing challenging opportunity of developing notes based on the main points provided by the teacher of biology enable the student to enhance creative thinking and interactions between students. The student take it as a challenge of note taking knowing they will be evaluatedor marked by the teacher of biology (Table 1.7).

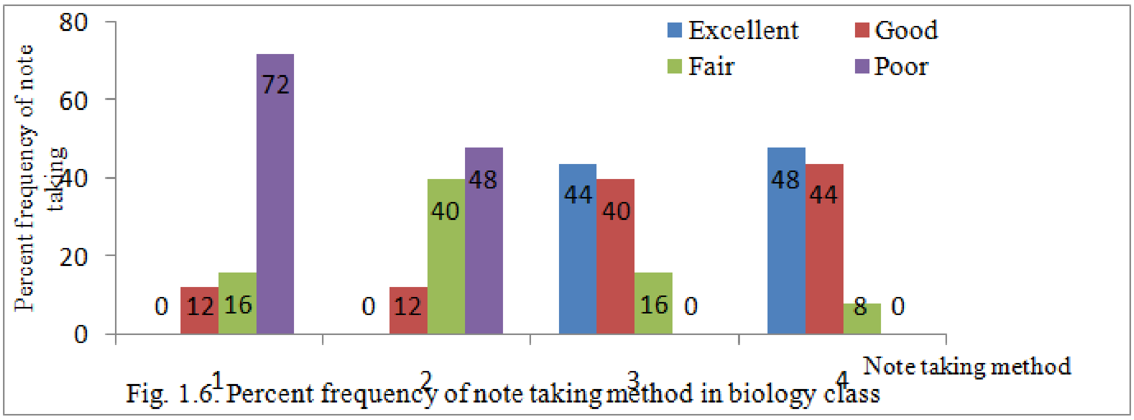

Fig. 1.6. Percent frequency of note taking method in biology class

4.1.4.Teachers' Activities in Preparation to Teach Biology Class

The SMASSE teachers activity include planning experiment to be done by student, setting up and conducting the experiment before hand , checking the success or failure of the experiment and improving the set up of the experiment for it to work before students do it. These four components forms the philosophy of SMASSE which involve Plan, Do, See and Improve (PDSI). Teacher-complaincy to this instructional strategy was quite evident and frequently applied at the following percent frequency: planning experiment to be done by students (72%), setting and conducting experiments (76%), checking the success or failure of the experiment (72%) and improving the of experiment (76%) as shown in Fig. 1.7

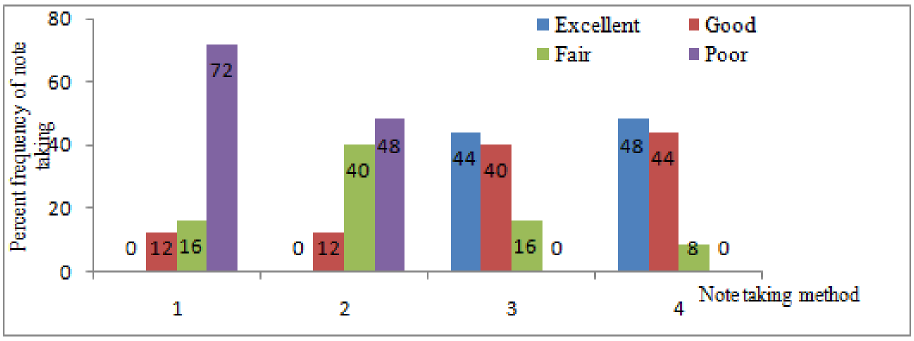

Fig. 1.6. Percent frequency of note taking method in biology class

Thus, most of the teachers were SMASSE complaint. However, about 23% and below were non-SMASSE complaint as shown in Fig. 1.7. in adopting Plan, Do, See and Improve (PDSI) approach. Further, SMASSE teachers quite often marked student notes. Table 1.8 shows teachers often marked notes (84%) and 4% always marked notes. However, 8% rarely marked and 4% rarely marked student notes. This imply 12% of the teachers depict non-SMASSE complaint characteristics inspite of the SMASSE In-Set service training.

Table 1.8: Percent frequency of teacher marking students notes

Teacher activity	Always marked	Often marked	Rarely marked	Never marked
Percent frequency	4	84	8	4

4.1.5 Observation Checkist Responses

The data from the observation checklist also focussed on the PDSI section of the study. This is shown in Table 1.9 that gives summary of the results obtained from the observation checklist.

Table 1.9: Percentage responses for items from the observation checklist.

PDSI Technique	Percentage Responses
Evidence of student centered learning	56%
Evidence of planning	73%
Evidence of do	61%
Evidence of see	74%
Evidence of improve	71%

Students' responses had a mean of 3.91 and a standard deviation of 0.61 based on Likert scale that had maximum possible responses of 5.00. This standard deviation predicts positively skewed trend in the usage of ASEI in Kakamega North Sub County. This owes to the fact that a mean of 3.91 is close to four. It is also enhanced by the reality that the standard deviation of the results (0.61) is close to 0.5. This indicates that the responses from the students were centered near the mean. From the results in Table 1.9, questions that had the least responses from students were structured negatively. Consider the case for question 3; "We do not carry out biology practical due to lack of apparatus and materials." Apparently, an average response of 2.443 indicates that students carried out biology practical because of the presence of materials and apparatus. The same applies to questions five, seven, eight, and seventeen. On the other hand, the responses that recorded high averages were structured positively. For instance, question twenty-two reads, "As we learn biology, students take note of key points as the lesson progresses." It follows that an average response of 3.943 indicates that most students consent with question twenty-two of the students' questionnaires.

In short, the results from the teachers' questionnaires indicate that most teachers are using the student-centered approach in teaching biology. The results obtained from the observation checklist indicate that the SMASSE in-service trained teachers used the PDSI technique during teaching. This owes to the fact that schools with SMASSE trained teachers were revisited. From the results above, it is clear that all the sections had an average minimum of fifty six percent. This indicates that teachers in these schools applied the PDSI techniques in teaching. The results obtained from the study indicate that there is a relationship between SMASSE in-service training of teachers and use of ASEI/PDSI approach.

4.1.6Teachers' Perspective on ASEI (Student Centred Approach)

The teachers' perspective on student-centred approach while teaching biology class was investigated as an aspect of ASEI instructional strategy. Fig. 1.8 shows that all teachers agree that student learn biology best when engaged in practical activities. In this Fig.1.8., 1, 2, 3, 4, 5 and 6 refers to students learn best when they engage in practical activities, usually require to plan and conduct biology in small groups, biology practical is not carried out when apparatus and materials are not available, students write laboratory reports of the experiments performed in the laboratory, students are sometimes asked to collect and bring materials from the environment which are used to make apparatus and equipment for use in practical work and where conventional laboratory equipment's are not available alternatives are used to allow biology practical's to be carried out, respectively.

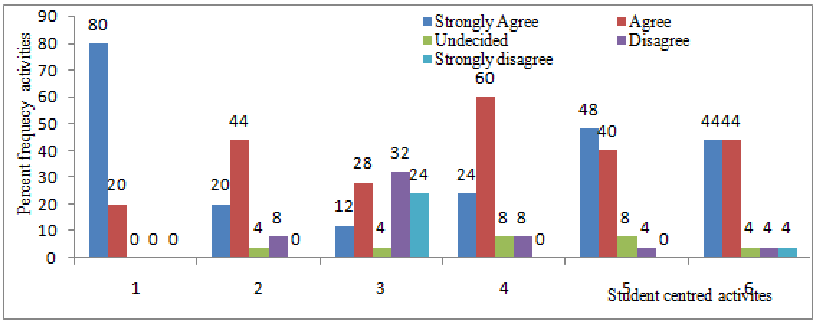

Fig. 1.8. Percent frequency of student centred activities in biology class

60% of the teachers agreed that students are usually required to plan and conduct biology in small groups. Only 40% of the teachers were of the view that biology practical is not carried out when apparatus and materials were not available (Fig. 1.8). 84% accept that students write laboratory reports of the experiments performed in the laboratory. 88% are of the view that students should collect and bring materials from the environments to be used to make apparatus and equipment for practical work. Further, 88% think that alternatives should be allowed during biology practical if there are no conventional equipment and laboratory facilities (Fig. 1.8).Generally, 24% and below think otherwise as shown in the Fig. 1.8. The above observation confirm to the characteristics of activity, students, experiments and improvisation (ASEI). This embedded SMASSE instructional strategies concurs with the Hudson's action-oriented and issues-based curriculum that can be realized by applying his 3-phase approach: (i) modeling – where the teacher demonstrates and explains the desired behavior, and provides illustrative examples; (ii) guided practice – students perform specified tasks within an overall action strategy with the help and support of the teacher; and (iii) application – students function independently of the teacher (McFarlane, 2013; Pp. 103). This 3-phase approach advocated by Hodson as part of an action-oriented and issues based science curriculum takes into consideration the participatory pedagogy of Barrett (2008) [72] and the empowerment approach of Birdsall (2010)[73] as student-focused instructional approaches to promoting science literacy. Scientific literacy is not only a response to need for improvement in general human conditions and situations, but is highly needed to respond appropriately to nature's furies and to the many problems and challenges that emerge from our actions and behaviors. Thus, instructional methods and the body of knowledge constituting science must be reconsidered to incorporate strategy as part of the need-based response to contemporary problems to which the field can be applied as a body of knowledge. This means that the mono-methodological approach to science education is no longer viable in today's world and that problem-focused and practical ideas need to play a major role in science literacy education. This is because globally diverse society demands diversity of scientific thinking to be encouraged and play major role as a widely accepted perspective and norm in a knowledgeable scientific society.

According to [71], the idea of "Diversity in Scientific Thinking" should be supported because "Pupils should be taught that science uses a range of methods and approaches and that there is no one scientific method or approach" (p. 657). This is really radical thinking when it comes to consideration on the objectivity, empiricism and traditional methods of science education. However, this is required because technology is so widespread that the label of "science" and title of "scientists" and emergence of new inventions are not restricted to the formally educated scientifically literate individuals at the forefront of the discipline in our society. This is an aspect of student centred approach in teaching biology class by SMASSE complaint teachers. Thus, above 60% of the teachers engage in ASEI and student centred approach as shown by high index of compliancy in terms of percent frequency in Fig. 1.8.

4.1.7 Planning and Preparation Activities of the Biology Teacher

This instructional strategy involving PDSI was studied and data collected presented in a pie chart format. Fig. 1.9 shows planning and preparation activities of scheme of work when the year commences. In this Fig. 1.9, 1 and 2 refers to make new scheme of work at the start of the year and don't attempt, respectively.

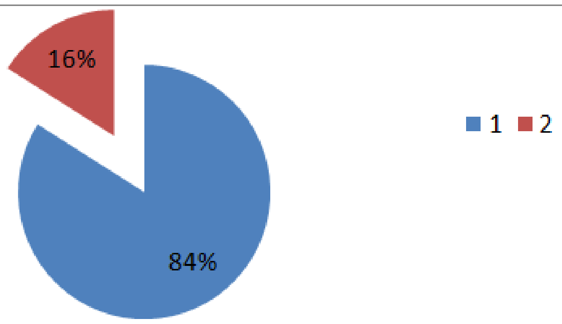

Fig. 1.9: Planning and preparations activities of scheme of work at the start of the year

Most of the activities of the teacher engaged in adjustingscheme of work acccording to the syllabus and academic programmes of the school. This group of the teachers constitute 84% as shown in Fig.1.9. 16% do not conform to this standard of performance (Fig. 1.9). Fig.1.10 shows that most of the teachers (76%) are engaged in reviewing the scheme of work when the term commences.

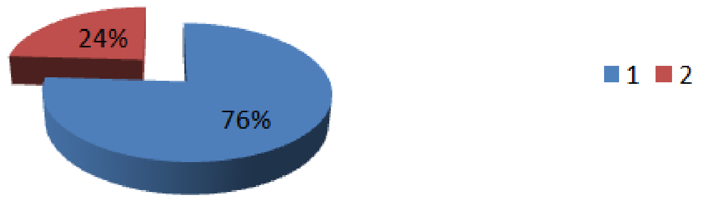

Fig.1.10 Percent frequency activities engaged in the scheme of work at the beginning of the term

The tendency of those who do not adhere to this phenomenaon is 24%. The high percentage of adherent shows most of the teachers are SMASSE complaint. Fig. 1.11 indicate the degree of the update and evaluation activities of scheme of work during the term. 80% of the teacherspractice this while 20% does not. This could be due to lack of supervision by head teachers, heavy work load and negative attitude.

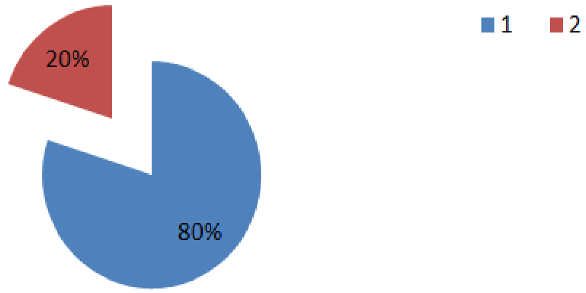

Fig. 1.11. Planning and preparations activities of scheme of work during the course of the term

Fig. 1.12 shows the percentage (76%) of teachers who engage in daily preparation of lesson plans that should concur with scheme of work. This could show progressive work covered for updates. 24% represent those who do not prepare lesson plans on a daily basis. This group do not adhere to SMASSE standards. This could be attributed to heavy work load and lack of interest in the profession.

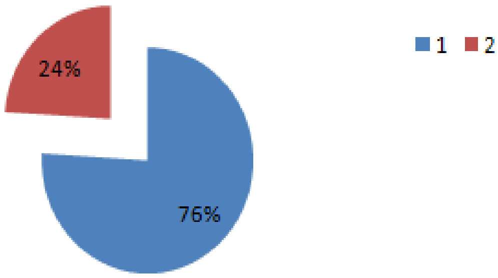

Fig. 1.12. Planning and preparations activities of SMASSE lesson plan for the biology class

Fig. 1.13 represents lesson making by SMASSE teachers for the biology class. This includes preparing freshnotes and updating earlier notes. 80% of the teachers are engaged in this activity. In Nigeria, preparing to teach for example biology, lesson study (Shuaib, 2016) [11] is encouraged and involves teaching improvement and knowledge building process that has its origin in the Japanese elementary education; it involves a comprehensive process of planning, observation, analysis and identifying the best approaches in a classroom.
This an inquiry approach to professional development that requires teachers to identify an area of instructional interest, collect data to analyses and make instructional changes based on the data (Shuaib, 2016). This kind of professional development make teachers acquires current and up to date knowledge in the field of mathematics and science. This SMASSE compliancy improves the learning process through effective and efficient work plans that improves performance in biology class. Thus, the mean score in biology in the Kakamega North Sub County was improved.

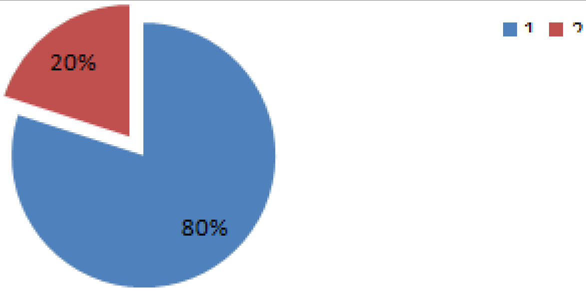

Fig. 1.13 Planning and preparation activities of SMASSE lesson notes for the biology class

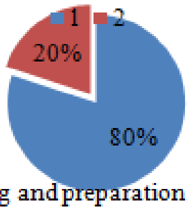

Fig.1.14: Planning and preparation activities of SMASSE examination and continuous assessment test for biology class

80% of the teachers engage in the planning and preparation activites of SMASSE characteristics in the examination processing (Fig. 1.14) to achieve desirable and performance behaviour in the K.C.S.E. results as standardized test. This SMASSE activity provides for accuracy, reliability and validity of the evaluation of the standardized test. Generally, above 75% of SMASSE complaint teachers have positive attitude towards the planning and preparationsof examination and continous assessment tests. These Smasse instructional strategies have contributed to improved performance in biology results in the Sub County.Therefore, reject $H_1$and conclude that there is high percent frequency use of SMASSE (ASEI/PDSI) instructional strategies in teaching biology in secondary schools in Kakamega North Sub County.

4.2 The Relationship Between K.C.S.E Results and SMASSE in-service Training

The researcher also determined the relationship between the K.C.S.E. results and the use of SMASSE teaching techniques. The researcher categorized the schools under the study into two groups. The first group comprised of schools that had SMASSE in-service trained teachers while the second group comprised of teachers that lacked SMASSE in-service training (Table 1.10). The group that comprised of SMASSE in-service trained teachers was named grouped j and the opposing group was named group k. It should be noted that group j teachers taught students in the following schools A, B, C, D, E, F, G and H. On the contrary, teachers from group k taught in P, Q, R, S and T. The average mean scores for the two sets of schools were determined for every year. The average was then used for regression analysis against the years. Finally, the critical statistical r squared value was determined and used to test the hypothesis. The same procedure was repeated for schools that had their students taught by teachers without SMASSE in-service training. The outputs from the analysis were compared in order to establish the effect of SMASSE in-service training on students' academic achievement. The schools without SMASSE in-service trained teachers constituted the control experiment.

Table 1.10 below provides the outcome for the mean scores obtained from schools that were taught by SMASSE in-service trained teachers. Clearly, the peak of achievement by students in the K.C.S.E. exam was witnessed in the two thousand and four examinations. On the other hand, the minimum performance was recorded in two thousand and two.

Table 1.10: K.C.S.E. biology mean scores results for schools taught by SMASSE In-service trained teachers

Year	A	B	C	D	E	F	G	Average
2001	0.00	3.95	-	3.636	5.210	4.760	4.740	4.46
2002	0.00	2.94	3.600	3.440	4.320	3.700	3.690	3.62
2003	4.650	4.490	2.900	3.140	5.560	4.130	4.264	4.162
2004	5.823	4.730	5.000	4.730	6.810	5.260	5.927	5.469
2005	5.770	4.070	2.790	4.100	5.330	3.482	4.041	4.226
2006	5.560	2.820	3.500	3.220	7.700	4.149	4.295	4.463
2007	5.148	3.140	3.120	2.761	7.700	3.500	2.421	3.970

2008	4.859	3.850	4.330	3.640	Y	5.630	3.388	4.283
2009	4.621	4.470	4.510	3.096	8.075	6.123	3.358	4.866
2010	3.962	6.690	4.000	3.267	8.822	5.665	3.607	5.145
2011	4.895	3.790	4.350	2.542	7.405	4.953	3.759	4.528
2012	3.952	3.000	4.060	3.238	6.371	3.816	2.831	3.895
2013	4.594	3.100	5.350	2.435	9.028	3.955	2.180	4.388
2014	5.077	2.740	5.000	2.565	10.026	3.832	2.630	3.263
2015	4.787	3.540	6.560	3.000	10.914	4.233	3.466	3.811

The results from the study reveal that there is a relationship between the K.C.S.E results and instructional strategies of SMASSE in-service training. From the regression output in above, one can easily identify this assertion. This owes to the fact that the Multiple R or the correlation coefficient is 0.623.
Table 1.11 shows regression analysis output obtained using the Microsoft excel software. This reveals that there is a moderate positive relationship between the K.C.S.E performance and the instructional strategies mounted by SMASSEin-service training. In fact, the gradient from the analysis is 2.551. This stresses the fact that there is a positive relationship between the two variables under discussion. The R square statistic indicates that there is a 0.388 chance that the plots for the variables will fall on the best line of fit. The results also indicate that the degrees of freedomused were seven. From the same regression output, the p value from the regression analysis is 0.099. The critical value

Table 1.11: Regression output for means scores against the years

Regression Statistics Output								
Multiple R	0.6233113							
R Square	0.3885170							
Adj. R Square	0.2864577							
Standard Error	0.4529716							
Observations	8							
ANOVA	*df*	*SS*	*MS*	*F*	*Sig. F*			
Regression	1	0.78179134	0.78	3.810	0.098788			
Residual	6	1.23109974	0.21					
Total	7	2.01289108						
	Coefficients	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.5506851	0.92596174	2.76	0.033	0.284938	4.81643	0.2849383	4.8164318
X Variable 1	0.4114798	0.21080171	1.95	0.099	-0.104333	0.92729	-0.1043334	0.9272931

for seven degrees of freedom was obtained as 1.36. Evidently, the 0.099 is less than 1.36. According to Taneja (2009) [74], *the p-value is the likelihood that you are rejecting the null hypothesis when in fact it is true. Another way of thinking about the p-value is that it is a measure of the probability that the pattern we see in our data is due to chance alone. Most commonly in science we set our level of acceptance of this error (rejecting the null hypothesis when in fact it is true) at 5% or less. Therefore, if the p-value is less than or equal to the critical region we reject H_O in favor of H_A.*Thus, reject H_3 and conclude that there is a significant relationship between instructional strategies employed by SMASSE in-service training and K.C.S.E performance at 95% level of significance.

4.2.1 Performance mean score in biology during SMASSE period

Figure 4.9 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. 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. 1.15).The performance in 2004 year was thebest compared to all the three years and evidence by the meanof 49.07% and standard deviation of 22 [24] (Pp. 54-55).In 2006 the mean score was 54.89% and standard deviation 31.00 [24].Further, this was the first time the biology examination was offerred under revised curriculum [24]. 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 [24] (Pp. 56). These observations is part of causes for decline or drop i 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

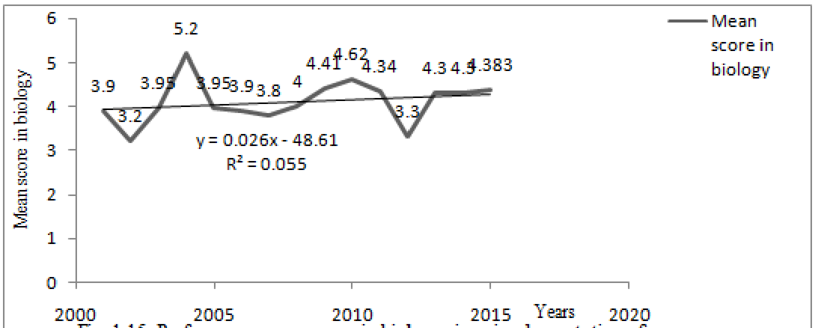

Fig. 1.15. Performance mean score in biology since implementation of SMASSE In-Set in Kakamega North Sub County

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_2 and conclude that there is significant relationship between use of ASEI/PDSI instructional strategy and performance in K.C.S.E biology.

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

The data was collected 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 frequency of SMASSE in-service Training and K.C.S.E Performance in Biology. Results were also obtained from a study that analyzed whether the experience (number of years) during 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 1.12).

Table 1.12: Frequencies of annual experience during the SMASSE in-service training and their corresponding K.S.C.E. mean score

School	Number of years of SMASSE training	Mean
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 1.13.

Table 1.13: Regression output of school mean scores against the annual experience of SMASSE in-service trained teachers

Regression Statistics output								
Multiple R	0.6256708							
R Square	0.3914639							
Adj. R Square	0.2697567							
Std. Error	1.2085059							
Observations	7							
ANOVA	*df*	*SS*	*MS*	*F*	*Sig. F*			
Regression	1	4.6975669	4.68	3.214	0.132875			
Residual	5	7.30243316	1.46					
Total	6	12						
	Coefficients	*Std. Error*	*t Stat*	*p-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0*	*Upper 95.0%*
Intercept	0.9358028	2.3117179	0.41	0.702	-5.00666	6.87826	5.006657	6.878263
X Variable 1	0.925133	0.515842	1.79	0.133	-0.40088	2.25115	0.400881	-2.251147

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) 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, there is a significant relationship between the frequencies of SMASSE in-service training and K.C.S.E. performance at a 95% level of significance.

V. Conclusions, Recommendations And Suggestions

The researcher established that biology teachers who were SMASSE trained used the ASEI/PDSI approach in their professions. All methods used to collect and analyze data proved this assertion was true. For instance, information collected from the observation checklist had the least SMASSE technique recording a 56% frequency. The information collected from the teachers and students' questionnaires also stressed the same finding. Teachers apply the skills obtained from SMASSE in-service training to influence active learning by the students. Further, there is a positive linear relationship between the number of years of SMASSE in-service training and achievement in the K.C.S.E results. The impact of SMASSE in-service training has been observed and there are many positive outcomes from the implementation of the SMASSE project. It is recommended 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 years trained. 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. According to this study, there are suggestions that calls for scholar's attention. To begin with, this study revealed that teachers use most of the techniques acquired from SMASSE in-service training. However, the same study reveals that teachers rarely apply field excursions and project work in teaching. This prompts for attention from scholars to identify the reasons why the stated techniques are not utilized. Under the same topic, it is also advisable to complete a study of the possible outcomes of applying the above techniques in teaching, especially the tertiary level. Another 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 but subsequent studies 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.

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