EFFECT OF SMASSE IN-SERVICE EDUCATION AND TRAINING ON BIOLOGY TEACHERS' PEDAGOGICAL SKILLS AND ATTITUDES TOWARDS TEACHING BIOLOGY IN RACHUONYO SOUTH DISTRICT, HOMABAY COUNTY

BY

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DECLARATION AND RECOMMENDATION

Declaration

This is my original work and has not been presented for the award of diploma or conferment of degree in this or any other university.

Sign…………………… Date…………………

Joseph Otieno Abong'o

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Recommendation

This thesis has been submitted for examination with our approval as the university supervisors.

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DEDICATION

This thesis is dedicated to my parents Mr. Alfred and Mrs. Sophia Abong'o for their gratis love and nurture, my loving wife Mrs. Joan Achieng Otieno for her patience, support and empathy during my study and my children Asher Olga and Joseph Junior in whom I find true friendship and kindness.

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ABSTRACT

SMASSE in-service education and training is a programme for mathematics and science teachers in secondary schools piloted in Kenya from 1999 to 2003 and rolled out nationally in 2004. It was conceived as an intervention to reduce the effects of factors that were perceived to be contributing to poor performance in mathematics and science, key of which are poor pedagogical skills and negative attitudes of teachers. However, its effect on these aspects had not been evaluated in Rachuonyo South district. This study evaluated the effect of SMASSE on teachers' pedagogical skills and attitudes to ascertain its relevance as an INSET programme. A descriptive survey research design was used in this study. The accessible population comprised all the SMASSE trained Biology teachers and the Biology students in Rachuonyo South district. A total of 60 Biology teachers and 300 Biology students formed the study sample. Simple random sampling was used to select the teachers while systematic random sampling was used to select the students. Two questionnaires were used to generate the required data from the teachers and students. Research specialists from the Faculty of Education and Community Studies, Egerton University, validated the instruments. The reliability of the instruments was estimated using Cronbach's Alpha coefficient after pilot-testing. Reliability coefficients of Biology Teachers' Questionnaire (BTQ) and Biology Students' Questionnaire (BSQ) were 0.85 and 0.90 respectively. Both descriptive and inferential statistics were used for data analysis. Results indicated that the pedagogical skills scored higher on mean frequencies and effectiveness after SMASSE INSET than before. T-test indicated that the mean attitude scores were significantly different before and after SMASSE INSET at $\alpha=0.05$. The findings, therefore, show that teachers' pedagogical skills and attitudes after SMASSE INSET were better than before the INSET. It is concluded that SMASSE INSET has positively impacted on the pedagogical skills and attitudes of Biology teachers towards teaching Biology. It was however noted that some aspects of student-centred teaching approaches were still weak and irregular in Biology lessons. It is therefore recommended that the INSET be mainstreamed and regularised. It is also recommended that the principles of ASEI-PDSI be introduced in pre-service teacher education curricula. The findings of this study are useful in making teacher education, SMASSE INSET and other future INSETs more effective.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASEI	**:**	Activity, Student, Experiments, Improvisation.
B.Ed.	**:**	Bachelor of Education.
CEMASTEA	**:**	Centre for Mathematics, Science and Technology Education in Africa.
GOK	**:**	Government of Kenya.
INSET	**:**	In-Service Education and Training.
JICA	**:**	Japanese International Corporation Agency.
KESSP	**:**	Kenya Education Sector Support Programme
KCSE.	**:**	Kenya Certificate of Secondary Education.
KIE.	**:**	Kenya Institute of Education.
KMOEST	**:**	Kenya Ministry of Education, Science and Education.
KNEC.	**:**	Kenya National Examinations Council.
MoE	**:**	Ministry of Education.
MOEST	**:**	Ministry of Education, Science and Technology.
NCST	**:**	National Council for Science and Technology.
PDSI	**:**	Plan, Do, See and Improve.
SMASSE	**:**	Strengthening of Mathematics And Science in Secondary Education.
SPSS	**:**	Statistical Package for Social Sciences.

CHAPTER ONE:

INTRODUCTION

1.1 Background to the Study

Teachers are an important resource in the teaching/learning process. They are the main players in the curriculum implementation. Brown, Oke and Brown (1982) maintain that the greatest single factor in the teaching process is the teacher. Improvement of the quality of education would also require improvement of the quality of teachers (Cheng, Chow & Tsui, 2001). According to Oluoch (2002), educational development projects can hardly succeed if teachers are not equipped to implement them. The training and utilisation of teachers, therefore, require critical consideration. Research has shown that teachers usually teach the way they were taught (Frank, 1990; Fulton, 1989; Goodlad, 1990). The manner in which teacher trainees are taught in universities and colleges must therefore be of importance to any education system.

Rapid expansion of education in Kenya has necessitated an expansion of teacher education programmes (Chege & Sifuna, 2006). Kibe, Odhiambo and Ogwel (2008) posit that human resource development is a top priority for the development of Kenya through education. This calls for a comprehensive training policy that would produce adequate and competent manpower for development. The worldwide boom in information technology is placing new demands on teachers, requiring a dynamic, responsive and well coordinated system of teacher education (Government of Kenya (GOK), 2005b). UNESCO (2008) asserts that teachers should be trained by equipping them with appropriate skills and materials to teach diverse student populations and meet the diverse learning needs.

Teacher education and training refers to the policies and procedures designed to equip teachers with the knowledge, attitudes, behaviours and skills required to perform tasks effectively in the school and the classroom (Allen, 2008). According to him, teacher education is divided into three phases; the initial teacher education (a pre-service course), induction (the process of providing training and support during the first few years of teaching), and teacher development or in-service process for practicing teachers. Candidates for pre-service teacher education are secondary school graduates with prescribed levels of achievement. The teacher trainees require both the mastery of the subject matter as well as the necessary pedagogical skills. Okech and Asiachi (1992) argue for more emphasis on acquisition of pedagogical skills in teacher education rather than the accumulation of knowledge of the subject matter.

Sarita and Tomar (2004) reiterate that teacher development is a process, not an event; hence it needs comprehensive growth and support. The teacher training programmes should be in tandem with the learners' needs in schools for better learners' achievement. This calls for a radical change in the methods of preparing and training teachers (Sharma & Kumari, 2004). This justifies the need for In-Service Education and Training (INSET) for serving teachers. SMASSE is, therefore, an example of such an INSET for science and mathematics teachers.

SMASSE is an acronym for Strengthening Mathematics And Science in Secondary Education. SMASSE project is a joint initiative of the Japanese government through the Japanese International Corporation Agency (JICA) and the Kenya government through the Ministry of Education (MoE). It was conceived as an intervention to upgrade the capability of young Kenyans in mathematics and science in secondary education (SMASSE, 1999). It is therefore an initiative aimed at Strengthening Mathematics and Science in Secondary Education through the institutionalisation of in-service training of serving teachers. Through the project, the government aims at in-servicing mathematics and science teachers as a means to enhance subject mastery levels, pedagogical skills and attitudes (GOK, 2005a).

Biology is one of the science subjects offered in Kenyan secondary schools. It aims at equipping the learners with the knowledge, attitude and skills necessary for preserving and controlling the environment (Kenya Institute of Education (K.I.E), 2003). According to Mwirigi (2011), Biology plays a key role in industrialization and other sectors of the economy. Biology is a practical subject, which equips students with concepts and skills that are useful in solving the day-to-day problems of life. Mwirigi asserts that the study of Biology aims at providing the learner with the necessary knowledge and skills with which to control or change the environment for the benefit of an individual, family or community.

Biology is important in fields such as Health, Agriculture, Environment and Education. It is a precursor of biotechnology which is a tool for industrial and technological development. In view of this, the subject would make a significant contribution to the realisation of Kenya's Vision 2030. According to UNESCO (1986), Biology plays a significant role in enhancing the country's social-economic development by enabling exploitation of land, animal and other natural and human resources. In addition, it is vital in maintenance of good health and hygiene (Kenya National Examination Council (KNEC), 1999).

Pre-service training of secondary school Biology teachers is done at the universities and diploma colleges in Kenya. However, as observed by the Kenya Education Sector Support Programme (KESSP) document of 2005 (G.O.K, 2005a), a majority of graduate teachers from these institutions may be lacking adequate pedagogical skills for effective implementation of the curricula, especially Mathematics, Sciences, English and Kiswahili. This points out to a serious need for regular in-service education and training for practicing teachers. Additionally, Kenya's Vision 2030 document (G.O.K, 2008) reveals that the universities and diploma training colleges lack adequate and modern training facilities required for effective delivery of both pre- and in-service teacher education.

The institutions need to be improved and have adequate infrastructure and equipment for pre- and in-service teacher education programmes. Kafu (2011) points out that the issue of facilities and resources for preparing school teachers is critical and adds that the status of current materials for preparing school teachers in Kenya is pathetic. These are inadequate, obsolete, dilapidated and unsuitable for producing a competent teacher who can operate in this century.

The seemingly insufficient teacher preparation has over the years resulted in poor results nationally, especially in mathematics and sciences. There has been public outcry and concern by parents, teachers and educationists in Kenya about poor performance in science subjects and mathematics in national examinations (Mwirigi, 2011). According to him, teachers play a role in this poor performance. Table 1 shows the national Biology Kenya Certificate of Secondary education (K.C.S.E) results from 2000 to 2003.

Table 1

National Distribution of K.C.S.E Graduates for Biology for Selected Grades from 2000 to 2003 before inception of SMASSE INSET

Year	**Grade**						**Percentage**		**Total**
	A	**A-**	**B+**	**D**	**D-**	**E**	**A to B+**	**D to E**	
2000	3,941	2,098	2,380	35,407	23,914	5,421	8.25	43.60	162,589
2001	4,101	4,489	9,647	39,340	24,926	6,911	10.36	40.45	175,975
2002	4,808	5,727	1,236	42,493	28,530	8,928	9.08	54.95	184,509
2003	4,799	1,639	2,599	49,805	61,753	11,314	11.35	48.16	190,372

Source: K.N.E.C (2004).

Table 1 shows that a great percentage of candidates scored grade D and below in Biology. In the year 2003, for example, only 11.35% of the candidates scored grades A, A- and B+ as compared to 48.16% scoring grades D, D- and E. This explicitly shows general poor performance in the subject before SMASSE INSET (Njuguna, 1998). The scenario is not better in Rachuonyo South district as shown in Table 2.

Table 2

Rachuonyo South District K.C.S.E Biology Performance 2003-2007

Year	Entry	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E	Mean
2003	2650	46	72	354	370	266	230	215	150	221	234	60	21	5.611
2004	2783	38	64	372	404	299	257	196	200	207	254	63	26	5.326
2005	2897	98	84	450	487	343	330	254	232	157	212	76	11	7.743
2006	2870	25	54	135	155	189	239	261	304	299	574	340	54	4.779
2007	3015	67	89	256	204	303	350	280	320	276	410	56	19	5.386

Source: Rachuonyo South District K.C.S.E Result Analysis (2008)**.**

In 2006 K.C.S.E Biology results in Rachuonyo South district, out of 2870 candidates who sat for Biology, only 214 obtained grades B+ and above. This is 7.5% of the total number of candidates. However, 1267 or 44.1% obtained grade D+ and below as shown in table 2. In the same year the district performance index for Biology was only 4.7792 out of a possible 12.0. This translates to a mean grade of C- which is below average. Oyaya and Njuguna (1998) and Mwirigi (2011) observe that the blame for poor results has always been on teachers.

Teacher education programmes should aim at enabling the teachers to acquire requisite pedagogical skills, competencies and attitudes. John Dewey ranks the teachers' attitudes highly as an aspect of the 'hidden curriculum' (Dewey, 1956). The teachers' own attitudes towards the students and subject matter often strengthen or weaken the learners' self confidence. According to Brown *et al* (1982), positive attitude to work is one of the professional characteristics of effective teachers.

In order to identify the root causes of poor performance, the SMASSE project carried out a baseline study in 1998 in nine pilot districts (SMASSE, 1999). The nine districts were Kajiado, Gucha, Kakamega, Lugari, Butere-Mumias, Kisii, Murang'a, Maragua and Makueni. The survey also aimed at identifying those factors that contribute to this state of affairs. On the basis of the findings of the study, the project was able to formulate a programme for intervention through the in-service training of teachers and sensitisation of key stakeholders.

According to Njuguna (1998), the study identified many problem areas, some of which the project could address. Those that could be addressed include issues related to attitude, pedagogy, content mastery and resource mobilization. These issues form the basis of the four-year SMASSE INSET curriculum. The guiding principle of SMASSE INSET is ASEI (Activity based, Student-centred teaching/learning, Experimental work as opposed to theoretical treatment along with Improvisation of teaching and learning resources where necessary). The principle is implemented based on the Plan, Do, See and Improve (PDSI) approach so that corrective measures are taken in subsequent cycles of activity to avoid major disruptions (SMASSE, 1999).

The focus of SMASSE INSET has been the use of ASEI/PDSI as a paradigm shift towards student-centred learning as opposed to teacher-centredness (Kibe *et al*, 2008). Attitude change and improvement of teachers’ pedagogical skills are central to the SMASSE project initiatives (Njuguna, 1998). These are key aspects given that traditionally, mathematics and science subjects have been perceived to be difficult and uninteresting. Kombo (2004) points out that the major yardstick used to measure educational output in Kenya is performance in examinations. With very low pass rates in mathematics and sciences in national examinations, therefore, the educational output has consistently been low.

The SMASSE project was launched in Rachuonyo South district in 2004. The first cycle of the INSET was done in August 2004 and the final cycle in August 2007. A SMASSE cycle is a two-weeks training session usually during school holidays (Kibe et al, 2008). There is one SMASSE cycle per calendar year falling either in April or August. The findings of a study carried out by CEMASTEA (Centre for Mathematics, Science and Technology Education in Africa) indicated positive impact of SMASSE INSET on pedagogical skills and attitudes of science and mathematics teachers (CEMASTEA, 2010). The study was conducted to establish the extent of ASEI-PDSI implementation in selected districts in Kenya. However, no empirical study has been conducted so far to ascertain the effect of this INSET on the pedagogical skills and attitudes of Biology teachers towards learning of Biology in Rachuonyo South district. This study therefore attempted to evaluate the effect of the four-year SMASSE INSET programme on pedagogical skills and attitudes of Biology teachers in the district. The study sought to reveal the attitudes and pedagogical skills of the Biology teachers before and after the SMASSE INSET in order to evaluate the effect of the INSET.

1.2. Statement of the Problem

SMASSE INSET is the first major in-service programme for mathematics and science teachers in Kenya conducted since 2004. Positive attitude change and improvement of teachers' pedagogical skills are key targets of the SMASSE project. Teaching of Biology, as a science subject, requires a practical approach which is a key emphasis of the SMASSE INSET. The SMASSE Project recognised that the teaching of the subject had been done mainly theoretically and that teachers and students had negative attitudes towards the subject. Poor performance in the subject in K.C.S.E by students rendered proof to this perception. The inception of the SMASSE INSET was seen as an intervention to improve on these weaknesses in the teaching and learning of Biology and other science subjects. However, no empirical study has been conducted in Rachuonyo South district so far to assess the effect of this INSET on the key aspects of its focus. Rachuonyo South is one of the districts which exhibited dismal performance in Biology. This study, therefore, aimed at investigating the effect of SMASSE INSET on Biology teachers' pedagogical skills and attitudes towards teaching of Biology.

1.3. Purpose of the Study

The purpose of this study was to assess the effect of the SMASSE in-service education and training on the pedagogical skills and attitudes of Biology teachers towards teaching Biology in Rachuonyo South district, Homabay County. The study investigated pedagogical skills and attitudes of Biology teachers before SMASSE INSET and compared them with the conditions after SMASSE INSET.

1.4. Objectives of the Study

This study was guided by the following objectives:

i. To determine the effect of SMASSE INSET on the frequency of class experiments organised by Biology teachers in Rachuonyo South district.
ii. To determine the effect of SMASSE INSET on the effectiveness of class experiments organised by Biology teachers in Rachuonyo South.
iii. To determine the effect of SMASSE INSET on the use of improvised teaching and learning resources by Biology teachers in Rachuonyo South.
iv. To investigate the extent to which student-centred teaching approaches are used by SMASSE trained Biology teachers in Rachuonyo South.
v. To determine whether SMASSE INSET has changed the attitudes of Biology teachers towards teaching of Biology in Rachounyo South.

1.5. Research Questions

i. Has the SMASSE INSET affected the frequency of class experiments organised by Biology teachers?
ii. Has the SMASSE INSET affected the effectiveness of class experiments organised by Biology teachers?
iii. Has the SMASSE INSET affected the use of improvised teaching and learning resources by Biology teachers?
iv. To what extent do SMASSE trained Biology teachers use student-centred teaching approaches?
v. Has SMASSE INSET changed teachers' attitudes towards teaching Biology?

1.6. Null Hypothesis

H_O1: There is no significant difference in the attitudes of Biology teachers towards teaching of Biology before and after undergoing SMASSE INSET.

1.7. Significance of the Study

The findings of this study have brought to the fore the extent to which the SMASSE INSET has achieved its core objectives in Rachuonyo South district, Homabay County. The findings are useful to the Ministry of Education and JICA who are co-funding the programme in making necessary adjustments on the INSET objectives and activities. As MoE and JICA are rolling out SMASE (Strengthening of Mathematics And Science Education) in primary schools, the findings of this study are handy in guiding the various stakeholders. The Biology teachers in the district have equally benefited by knowing that the project has improved their attitudes and teaching skills and that future trainings of this kind are worth attending. The findings also serve as a guide to the Kenya Ministry of Education on necessary adjustments in future INSETs. The students have benefited from the improved pedagogical skills and attitudes of teachers after the SMASSE INSET.

1.8. The Scope of the Study

The study was carried out in Rachuonyo South, Homabay County and its scope was restricted to the following:

i. Only qualified Biology teachers who completed SMASSE INSET cycles were studied. The qualified Biology teachers were those with either diploma or degree level pre-service teacher education.
ii. The students studied were only those taught by Biology teachers selected for the study.

1.9. Assumptions of the Study

The study made the following assumptions:

i. The class sizes are within the Ministry of Education recommendation of 40-50 students.
ii. Teaching experiences of SMASSE trained Biology teachers in terms of years of service do not vary significantly.
iii. Teachers have equal teaching workloads.

1.10. Limitations of the Study

i. The study largely relied on the honesty of the respondent teachers and students from whom data was collected.
ii. In some schools the Biology teachers and students were uncooperative, thereby consuming more time than anticipated.

1.11. Definition of Terms

The following terms were used in this study as defined below:

Effectiveness of class experiments: This refers to the ability of class experiments to accurately be executed to enable the students acquire the necessary knowledge and skills. In this study, an effective class experiment was regarded to entail the following aspects:

- Preparation before the experiment.
- Trying out of activities.
- Clarity of instructions.
- Effective guidance and supervision by the teacher.
- Group size and composition with respect to number and ability of students per group.
- Briefing on precautions to be taken.
- Bridging of practical work and concepts to be learnt.

Improvised teaching/learning resources:

This refers to the use of locally available materials from the school's environment to make apparatus and equipment to aid learning instead of the conventional resources available in the market. Improvised materials are important since they reduce the cost of practical teaching of mathematics and science subjects. The improvised materials must truly represent the conventional resources so as not to misinform the learners.

In-service education and training (INSET): This refers to continued training of serving teachers. Such education and training targets priority aspects of teaching/learning occasioned by factors such as curricula changes, technological/industrial needs and epistemological factors.

Learner-centred teaching: Teaching based on the pace, motivation and participation of the learners. Most teaching/learning activities are learner-based and the learner is seen as active in class rather than passive. The learners work in groups, ask questions in class, answer teacher's questions, do assignments, participate in class discussions and have their personal concerns addressed among other aspects.

Pedagogical skills: These are the appropriate teaching skills acquired by the Biology teachers from colleges, universities or in-service training. In this study, pedagogical skills were aspects such as frequent organization of effective class experiments, improvisation and use of teaching/learning resources, proper classroom management and the use of learner-centred teaching approaches.

Pre-service training: Training of prospective teachers prior to initial basic qualification as a teacher. Candidates of these training programmes are usually secondary school graduates with specified entry qualifications. For secondary school teachers, pre-service training is done at the universities and diploma colleges.

Teachers' attitudes: Refer to the way teachers feel and think about the subject and the students. It affects the way teachers behave towards their students and how they approach the subject matter. With positive attitudes, teachers are able to offer better learning opportunities to their students. The teaching/learning of mathematics and sciences can be demystified if teachers' attitude towards the subject is positive.

Teacher Trainee: Refers to an individual undergoing pre-service teacher education and training. Such an individual has not had prior teaching experience.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter covers the information and research findings on teacher education and in-service teacher education and training in general and SMASSE INSET in particular. It flows from an overview of teacher education and training which gives its definition and its worldwide perspectives. This is followed by a description of teacher education and training in Kenya which mainly focuses on education of secondary school teachers in Kenya. The rationale for in-service teacher education and training is discussed followed by the teachers' pedagogical skills and attitudes, improvisation of teaching and learning resources, rationale of SMASSE INSET, ASEI movement and PDSI approach. The chapter finally discusses the theoretical and conceptual frameworks that guided this study.

2.2. Overview of Teacher Education and Training

Teacher education and training refers to the procedures designed to equip prospective and practicing teachers with the knowledge, attitudes, behaviours, skills and competencies they require to perform their tasks effectively in the school and the classroom (Allen, 2008). Allen explains that the term 'teacher education' is widely used as it has connotation of preparing teachers for a professional role as reflective practitioners as opposed to 'teacher training' which gives an impression that the activity involves training staff to undertake relatively routine tasks.

In South Africa, teacher education and training is viewed as the largest single field of study in higher education and is offered by a wide range of institutions (Cheng, Chow & Tsui, 2001). Teachers are an important resource in the teaching/learning process. Kibe, Odhiambo and Ogwel (2008) posit that human resource development is a top priority for the development of Kenya through education. This calls for a comprehensive training policy that would produce adequate manpower for development.

Teachers are the main players in the implementation of school curriculum. In Japan, teaching is considered a respected profession, a lifetime commitment and a much sought-after occupation (Cheng, *et al*. 2001). It is a rather challenging, complex and rewarding profession (Dandekar & Makhija, 2007). According to CEMASTEA (2010), any attempt to improve performance in schools must be based on the recognition that the teacher is actually the kingpin of quality improvement. Oluoch (2002) posits that educational projects can hardly succeed if teachers are not equipped to implement them. Their training and utilization therefore requires critical consideration. Rapid expansion of education globally has been attributed to the expansion of teacher education (Chege & Sifuna, 2006).

Teacher training programmes should be in tandem with the learners' needs in schools to obtain the desired high achievements. This calls for a radical change in the methods of preparing and training teachers (Sharma & Kumari, 2004). Reforms in schools are dependent on the reform of teacher preparation (Cheng, *et al.*, 2001). They further assert that teacher education should be redesigned to strengthen the knowledge base and its connection to both theory and practice.

Teacher education is divided into three phases; Initial teacher education (a pre-service course before being a fully responsible teacher), induction (the process of training and support during the first few years of teaching or the first year in a particular school) and in-service teacher education for practicing teachers (Allen, 2008). In many countries, initial teacher education takes place in institutions of Higher Education, especially universities and colleges. Teacher education curricula can be broken down into blocks: foundational knowledge and skills (philosophy, history, psychology and sociology of education), content area and teaching methods aimed at giving the teacher trainees an appropriate orientation in teaching.

Teacher education affects the quality and professional ability of teachers in schools, both through initial and in-service teacher education (Graves, 1990). According to Singh and Nayak (2007), training for teaching decreases as one progresses from primary to tertiary levels while training in the subject matter increases. As noted by Okech and Asiachi (1992), the balance between acquisition of skills and the subject matter has always been a concern in teacher education. Dandekar and Makhija (2007) observe that a thorough acquisition of pedagogical skills makes one a gifted teacher. Calderhead (1996), Pianata (1999) and Watson (2003) have described teaching as an intensely psychological process that requires a teacher's ability to maintain productive classroom environments and motivate students. According to them, these abilities depend on a teacher's personal qualities and the ability to create personal relationships with her students. Research has shown that teachers usually teach the way they were taught (Frank, 1990; Fulton, 1989; Goodlad, 1990).

2.3. Teacher Education and Training in Kenya

In Kenya, secondary school teachers are trained at the universities and diploma colleges of education. Currently there are seven public universities, 14 chartered private universities, 13 unchartered private universities and at least three diploma colleges in Kenya. Most of these institutions are involved in education of secondary school teachers (GOK, 2005a). University education takes four academic years while diploma education takes three academic years. Each university academic year consists of two semesters of an average 15 weeks each.

The curricula usually follow the concurrent model where the trainee teachers acquire the subject matter and the pedagogical skills at the same time. This model has been criticised by the KESSP document (GOK, 2005b) for being overburdening leading to inadequate subject mastery and pedagogical skills of the graduate teachers. Sessional Paper No. 1 of 2005 recommends a need to restructure secondary teacher training programme to require that teacher trainees first attain qualifications in respective subject areas and subsequently undertake post-graduate training in pedagogy (GOK, 2005b). The paper recommends that the Bachelor of Education (B.Ed.) degree programme be extended to 5 years like other professional degree courses. This is in line with the recommendations of the Republic of Kenya (1988).

Teachers specialise in two teaching subjects. Student teachers are continually assessed and graded on their coursework and final examinations at each academic semester. According to Kenya's Vision 2030 document (G.O.K, 2008), the universities and diploma training colleges lack adequate and modern training facilities required for effective delivery of both pre- and in-service training services. This may limit the dynamism required of the teachers in the fast-changing technological era. The teacher needs to be proactive in order to help the learners to operate locally but think globally (G.O.K, 2001). For example, the use of computers as a modern learning tool should be fully embraced in the teacher education programmes. Further, there is need to professionalise teacher education to make it an exclusive rather than inclusive (stake-holding) enterprise (Kafu, 2011). This will give a clear identity to this programme and teaching profession. If this is buttressed by strong and attractive packages of terms and conditions of service for teachers, the identity of this programme and teaching profession will be clearly defined.

According to G.O.K (2001b), innovative instructional practices are being emphasised in teacher preparation in Kenya through the use of modern technology and more participatory methods of teaching and learning. This aims at making learning more learner-centred as the learners are being required to actively participate in the learning process. The methods promote imaginative, critical and creative skills in the learners resulting in better achievement of instructional objectives. Teacher trainees are also expected to use a variety of learning resources which should be appropriate to the learners level and lesson material being taught. The teachers are expected to be innovative and creative throughout their teaching careers.

The trainee teachers normally undergo three months of teaching practice. This usually serves as the induction phase to the teaching profession when the trainee teachers receive guidance from the practicing teachers. The trainee teachers get to encounter the actual field of teaching where they use the competencies acquired at college. One area of concern is the wide curriculum covered at the universities and diploma colleges which leaves less time for pedagogical training (G.O.K, 2001). This calls for opportunities for in-service training of practicing teachers to improve their competencies and adjust to the changing world of knowledge and technology. However, as observed in Sessional Paper No.1 of 2005, there is lack of adequate opportunities for in-service training, denying most practicing teachers the chance to enhance their skills beyond those acquired during pre-service basic training (G.O.K, 2005b).

2.4. In-service Teacher Education and Training (INSET)

According to Cheng, *et al* (2001), In-Service Teacher Education and Training (INSET) refers to the whole range of activities by which serving teachers may extend and improve their personal qualities, professional competencies, and general understanding of the role schools are play in changing societies. It is "all those planned courses and activities in which a serving teacher, head teacher, school inspector or educational administrator may participate for the purpose of improving his instructional or professional knowledge, interest or skills" (Harris *et al*, 1969). It is one of the three phases of teacher education programmes. The other two phases are pre-service teacher education and training for potential teachers and induction phase for newly recruited teachers in schools (Allen, 2008).

Sarita and Tomar (2004) have described teacher development as a process and not an event. This implies that teacher education should involve continuous professional growth and not just a one-off educational session. The demands on the teacher change considerably during his career hence it does not seem possible to equip the teacher trainee with all the knowledge and skills required for an entire professional life (Olembo, Wanga & Karagu, 1992). According to CEMASTEA (2010), SMASSE INSET is founded on the premise that a teacher is made in the classroom, not in the lecture halls in colleges and universities. UNESCO (2008) mentions professional development as one way of equipping teachers to teach diverse student populations and meet their diverse learning needs.

Teachers need to keep abreast with current developments and technological inventions. In Japan, for example, advances in science and technology have produced significant changes in the everyday life of Japanese, demanding corresponding shifts in the traditional teaching and learning methods in schools (Cheng *et al*. 2001). According to Cheng et al, in-service education and training is an indispensable means for keeping teachers abreast with new developments in education. Countries such as Hong Kong, the Peoples' Republic of China, the Republic of Korea, the United States, Canada, Newzealand and Japan have or are developing induction programmes and on-the-job support for beginning teachers (Cheng *et al*, 2001).

In-service Education should be seen as a corrective strategy in education aimed at reversing any major deviations from the set goals, aims and objectives (CEMASTEA, 2010). Outdated practices can be kept in check, while at the same time developing professionalism. This is especially so given that curricula, teaching approaches and methods, societal needs and expectations are all bound to change from time to time.

In China, teacher education candidates, prior to licensure, undertake a year-long internship following their coursework. In fact, as observed by Sarita and Tomar (2004), the rate of teacher participation in school-based induction in the Republic of Korea had risen from less than 10% in1992 to about a quarter of all teachers in 1994-95. In some countries it is possible for a person to receive training under the responsibility of an accredited experienced practitioner in a school. According to Sarita and Tomar, in the United Kingdom this has gone so far that graduate teachers may now train entirely on the job, working under supervision and attending seminars in local Teachers' Centres.

In Kenya, however, in-service teacher education and training has not been seriously entrenched and institutionalised in the education system (G.O.K, 2005b). This has meant a fixed outlook of a teacher over the years as a dispenser of knowledge and not a guide to learners as should be the case (G.O.K, 2001a). The advent of SMASSE as an in-service training programme for mathematics and science teachers is seen as an intervention in the right direction. Kenya Education Sector Support Programme (2005-2010) document describes studies which have shown that Secondary Mathematics and Science subjects face several problems, key of which are negative attitudes and weaknesses in pedagogy (G.O.K, 2005a). In a joint venture with the Japanese government, the Kenya Ministry of Education initiated the SMASSE INSET to in-service its practicing teachers on areas of pedagogy, subject matter and attitude change. This study investigated whether the SMASSE INSET has impacted positively on the teachers' attitudes and pedagogical skills as envisaged by its objectives.

2.5. Teachers' Pedagogical Skills

Pedagogy has been defined as the study of teaching methods (Hornby, 2005). Pedagogical skills refer to the appropriate teaching skills acquired by teachers from colleges, universities or in-service training. Brown *et al* (1982:2) defines teaching as ''an attempt to help someone acquire, or change, some skill, attitude, knowledge, ideal or appreciation''. John Dewey maintains that in order to say one has taught, some changes in student behaviour should have taken place (Good & Brophy, 1995). This change in behaviour is what is referred to as learning. The teacher should therefore utilise the most appropriate pedagogical skills that guarantee students' learning at all times.

According to Singh and Nayak (2007), good teaching must be defined in terms of the degree and kind of change caused in students. It is not simply a mechanical operation which can be defined in terms of teacher's looks, his speaking voice, the neatness of his room, and the fact that he never sends anyone to the principal. Effective teaching places a student at the centre completely surrounded by multisensory media arranged by the teacher who functions as a prescriber-organiser. B.F Skinner observes that a teacher is a specialist in human behaviour, whose assignment is to bring about extraordinary complex changes in extraordinary complex material (Dandekar & Makhija, 2007). They add that teacher effectiveness is assessed in terms of pupil behaviour and not in terms of behaviour of teachers.

Traditional teaching methods include: lecture, discussion, demonstration, project and study trips (Brown *et al*, 1982). Newer approaches to teaching are process skills approach, discovery, inquiry or problem solving, laboratory experiments and cooperative concept mapping. In a study by Keraro, Wachanga and Orora (2007), cooperative concept mapping teaching strategy yielded higher student motivation than the regular teaching approaches. The study was carried out to investigate the effects of cooperative concept mapping teaching approach on secondary school students' motivation in Biology. According to them, when students explain and receive explanation from one another in their group, new concepts are retained in memory and related to concepts already in memory.

According to Reyes (1990), many Biology teachers are not familiar with inquiry processes. He indicates that teaching inquiry processes demands the teaching of content inseparable from processes. These new approaches are more learner-centred compared to traditional methods. Zimmerman (1990) and Claxton (1996) believe that the learning process should be organised in such a way that students take responsibility for their own learning. They should be independent and able to make decisions about their learning ability and then plan accordingly. Okere (1996) argues in favour of process skills approach to teaching as opposed to the content approach. He points out that with process skills approach, retention is longer and transfer of skills from one subject to another highly likely.

In science education, instruction involves conceptual change rather than infusion of information into a vacuum (Okere, 1996). The learner's mind should not be perceived as a vacuum but rather with certain conceptions that need to be modified to accommodate the intended learning. Conceptual change therefore requires carefully planned teaching and learning activities. The teacher selects strategies which will produce the desired degree of interaction between student, subject matter and the teacher (Singh & Nayak, 2007). Richardson (1990) states that student-directed learning and curricula have become focal points for all constructivist based teaching and learning practices.

This study investigated the effect of SMASSE INSET on the pedagogical skills of Biology teachers. It sought to establish whether SMASSE trained Biology teachers use newer teaching methodologies that elicit more students' participation and hence better learning. Biology as a science subject requires an integration of both theoretical and practical work to make it easily understood by the students (Mwirigi, 2011). According to him, the largest proportion of teachers still uses the conventional lecture method while teaching Biology. The principle of ASEI-PDSI which was presented as a new teaching strategy by SMASSE INSET was evaluated on its impact on the teachers' pedagogical skills and attitudes towards Biology.

2.6. Teachers' Attitudes

Reyes (1990) defines attitude as a learned predisposition to respond in a consistent favourable or unfavourable manner with respect to a given object. It is the way that one thinks and feels about somebody or something (Hornby, 2005). It is the way that one behaves towards somebody or something. With respect to instruction, it is the way the teachers think and feel about the learners and the subject matter. According to Hendrikz (1986), students define their self concept based on the teacher's own attitudes towards them and expectations from them. This is important, especially when it strengthens or weakens their confidence in themselves.

Richardson (1996) describes attitudes as a 'subset of a group of constructs that name, define and describe the structure and content of mental status that are thought to drive a person's actions'. He explains that with positive attitudes, teachers and students can develop relationships of mutual respect. John Dewey (1956) argues that the attitude of the teachers is an important part of the learning environment of the school, what is referred to as the 'hidden curriculum'. Teachers can instill good attitudes through proper classroom management and student motivation (Good & Brophy, 1995). This instills positive attitudes towards the subject matter in the learners.

Teachers' attitudes are affected by a number of factors. Reyes (1990) observes that teaching characteristics as a profession such as level of salary and prestige affect the teachers' attitudes toward work. Other factors include classroom-based rewards, educational goals, students, and interpersonal relationships. Work conditions like administrative policy, supervision and school structure also affect the teachers' attitudes. Reyes point at two Gallup polls on teacher attitudes, in 1984 and 1986, in which teachers consistently ranked low salary first and discipline problems second as reasons why teachers leave their jobs.

Positive attitude to work has been listed as one of the professional characteristics of a teacher (Brown *et al.* 1982). Good teaching requires the right attitude of a teacher towards students and content. According to Good and Brophy (1995), teachers need to be respected models to learners so that they can acquire the right attitudes. Students acquire the attitudes by observing and relating to their teachers rather than through instruction. However, Good and Brophy assert that attitudes can be developed through persuasive communication and can be conditioned through experience. Good instructional techniques therefore have a role to play in instilling the right attitudes in the learners.

At the classroom level, teacher attitudes affect teaching and students. Research shows that teachers' attitudes influence both their expectations for their students and their behaviour toward them (Alexander & Strain, 1978). They elaborate that these attitudes, expectations, and behaviours influence both student self-image and academic performance. Effective teachers believe that every child will learn and do not point out weaknesses but instead stress individual strengths and talents (Watson, 2003). Pre-service and in-service training has been effective in promoting positive attitudes and facilitating skill acquisition (Salend, l984). Assessing teacher attitudes is vital to providing teachers with the training and support services to enable them to meet the challenge successfully.

Teachers' attitude towards science is a significant predictor of pupils' science achievement as well as their attitude towards science (Yara, 2009). Oylum (2010) further emphasises that teachers' attitudes towards teaching have an effect on their classroom performance. Igwe cited in Yara (2009) stipulates that for teaching and learning of science to be interesting and stimulating, there has to be motivation on the part of both the teacher and the learner so as to ensure the development of positive attitude and subsequently maximum academic achievement.

This study investigated the effect of SMASSE INSET on attitudes of Biology teachers towards teaching of Biology. As an in-service teacher education programme, SMASSE INSET ought to be effective in promoting positive attitudes (Salend, 1984). The study sought to establish if the principle of ASEI-PDSI teaching approach has a role to play in instilling positive attitudes in the teachers toward teaching and learning of Biology. This is important since teachers' attitudes directly impact on their classroom performance (Oylum, 2010).

2.7. Improvisation of Teaching and Learning Resources

Ibeneme (2000) defines teaching and learning resources as materials used in the classrooms or workshops for instruction or demonstration purposes by students and teachers. According to Abiona and Olagunju and (2008), utilization of resources in teaching brings about fruitful learning since it stimulates students sense as well as motivating them. The availability and adequacy of these resources promote effective teaching and learning activities in schools (Mapaderum, 2002; Oni, 1995). Richard (1981) did a study to underscore the importance of practical activities in the learning process. He found out that human beings remember 10% of what they hear, 50% of what is heard and seen, and over 80% of what is heard, seen and done. The need for resources in the teaching and learning process therefore cannot be overemphasised. Dale (1957) reinforces this idea by use of the old Chinese proverb: I hear and forget; I see and remember; I do and understand.

The greatest challenge to the use of teaching and learning resources, however, is their availability and adequacy. As noted by Mapaderum (2002) and Oni (1995), unavailability and inadequacy of these resources have hampered their uses by teachers and students. Chute (1990) observed that it is hard to get teaching and learning resources because of their unaffordable costs. An empirical study was carried out by Nwoji (1999) to establish the availability and adequacy of teaching and learning resources in Nigerian schools. The study revealed that essential facilities such as radios, televisions, computers, chemicals, specimens, video tapes, stoves, burners, models, and charts are not available in schools.

Therefore, improvisation of teaching and learning resources becomes an indispensable task to enrich teaching and learning in schools (Abiona & Olagunju, 2008).

Hornby (2005) defines improvisation as using whatever is available because one does not have what is really needed. Ibeneme (2000) sees it as using alternative materials and resources to facilitate learning whenever there is lack or shortage of some firsthand teaching aids. Eze (1995) refers to it as a substitute for the readymade or imported material. Okeke (1990) urges teachers to produce their own teaching aids in order to teach effectively. According to Okeke, everybody can be involved in the production of these alternatives, that is, the teachers, learners, parents and all stakeholders in education. The locally made materials are usually tailored to meet the local challenges at very cheap or no cost at all. According to Anyakoha (1992) the involvement of teachers and learners in improvising materials gives students and teachers the opportunity to concretise their creativity, resourcefulness and imaginative skills. He suggests that improvisation of resources should be done even when conventional resources are available.

This study also investigated whether SMASSE INSET affected the use of improvised teaching and learning resources by Biology teachers amongst other objectives. The significance of teaching and learning resources in science education cannot be overemphasised. As has been indicated by earlier research findings (Nwoji, 1999; SMASSE, 1998), teaching and learning resources are not sufficient in schools in terms of availability and adequacy. The Biology teacher therefore needs to be equipped with the improvisational skills required to make use of the locally available materials in the teaching and learning process.

2.8. Rationale for SMASSE INSET

SMASSE INSET is principally meant to improve teaching and learning of mathematics and science so as to enhance student achievement in the subjects (SMASSE, 1999). The Kenya government, through the Ministry of Education, consulted the Government of Japan for a remedy for this poor performance. After an agreement with the Government of Japan to support INSET for mathematics and science teachers, the JICA dispatched project study and implementation missions and JICA-MoE Technical Cooperation on

SMASSE Project was launched in July 1998 as pilot project in nine districts (Kibe *et al*, 2008). In 2003, the project expanded to cover the entire country. With the expansion of the project, the GOK/MOE established the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) as a centre for enhancing dialogue and cooperation among mathematics and science educators in Africa. The system of operation is the cascade system of INSET. It is a two-level cascade model where national trainers train district trainers, who train other teachers at the district level (Wambui, 2006).

The project's main activity is INSET for serving teachers of these subjects. The main thrust has been to minimise and eliminate altogether the factors contributing to dismal achievement in mathematics and sciences in secondary education (SMASSE, 1999). These factors were identified by a Baseline study conducted by the Project in 1998. The Project realised that it could not address all the factors and hence isolated those that it has the capacity to (Njuguna, 1998). The main problem areas that the project sought to address are:

- The poor attitude of the teachers, learners and key stakeholders towards mathematics and science subjects.
- Inappropriate teaching methods and approaches.
- Poor content mastery by the teacher.
- Poor utilisation of school learning resources.
- Inadequate supervision/guidance from the MOEST.

The issues identified by the baseline study in 1998 form the basis of the four-year SMASSE INSET curriculum. The guiding principle of SMASSE INSET is ASEI(Activity- based, Student-centred teaching/learning, Experimental work as opposed to theoretical treatment along with Improvisation of teaching/learning resources when necessary). The principle is implemented based on the Plan, Do, See and Improve (PDSI) approach so that corrective measures are taken in subsequent cycles of activity to avoid major disruptions (SMASSE, 1999). The main aim of SMASSE project is to shift classroom practices from being ineffective to effective (Wambui, 2006). It is hoped that the SMASSE INSET will be fully entrenched into the school curriculum. This is important so that teachers can benefit from professional development by sharing of experiences and continuous exposure to new ideas to keep abreast with new developments in the teaching profession (SMASSE, 1999).

2.9. ASEI Movement and PDSI Approach

Effective teaching requires one to continually seek to improve, reflect on and refine instructional practice. This is only possible if one adopts ASEI/PDSI approach in teaching (Ogolla, 2001). Ogolla emphasises that the ASEI/PDSI approach is the vehicle for achieving not only the SMASSE goal, but also promoting effective teaching practices and efficient learning. The ASEI movement and the PDSI approach form the pillars of the SMASSE project. This section discusses the two pillars of the SMASSE project in details.

2.9.1. ASEI Movement

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

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

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

The movement considers the quality of classroom activities as critical to achieving effective teaching and learning (Ogolla, 2001). The activities here can be hands-on, minds-on, hearts-on and mouths-on. They should be carefully selected, sequenced and directed to provide meaningful experiences to the learners. Carefully thought out practical activities assist learners to hypothesise, make conjectures, discover, verify and validate laws and reinforce new concepts/ideas thereby developing the scientific and mathematical cultures. This ensures the development of a stable body of knowledge in the learners.

In performing experiments, SMASSE advocates for incorporating improvisation. This is important where conventional equipment/apparatus or chemicals/materials are not available or in order to perform scaled down experiments. ASEI also advocates for integration of practical work with theory lessons by providing a bridge to enhance learning. Improvisation also creates awareness in the teacher of the unlimited opportunities that exist in seeking and using locally available resources. Recently, science educators have advocated for process skills approach to teaching as opposed to the content approach (Okere, 1996). This emphasises the need for frequent experiments in the learning of sciences since retention is longer and transferability of skills from one subject to another is highly likely.

The SMASSE project envisages a post-ASEI era of effective classroom practices in schools (Wambui, 2006). It aims at a shift from knowledge-content based to activity-focused approach, teacher-centredness to learner-centredness, lecture/chalk and talk to experiment/research-based approach. Improvisation of teaching and learning resources and carrying out of small scale experiments are key aspects in achieving the post-ASEI targets. Benard and Benard (2005) emphasise a shift to use of experiments as teaching tools in the classroom since its pedagogical advantages have become more apparent. One primary advantage of use of experiments is their ability to actively involve students in the class and learning process.

2.9.2. PDSI Approach

In order to attain the 'ASEI condition' outlined above, it is essential to adopt a cyclic approach known as PDSI which is an acronym for Plan, Do, See, Improve. Teachers are encouraged to take time when planning to reflect on the most appropriate activities that will enhance effective learning using the resources available (Ogolla, 2001). The planning involves preparation of an ASEI lesson plan which should take into consideration students' previous knowledge, number of students, facilities and resources available and lesson evaluation.

'Doing' is shared between a teacher and learners where a teacher's role is facilitation and not the dispenser of knowledge. Teaching should be seen as 'non-directive' and removes teachers from their usual role as information dispenser, confirmation provider and limit setter (Cantor, 1946). According to Mwirigi (2011), teacher-student interactions should not be authoritarian or impersonal in class. He indicates that this would contribute to negative attitude of the students towards learning, especially in Biology. Students need to be active participants in the learning process.

'Seeing' encourages a teacher to include a feedback mechanism in their lessons and teaching functions. Lesson evaluation is seen as the key to improvement of lesson delivery. Evaluation therefore should essentially be formative rather than summative. This allows room for remedial work aimed at improving students' performance.

Improvement should be done by incorporating information obtained from feedback during and after lessons. This is a continuous activity, which ensures that a teacher's skills improve and confidence increase as the instructional programmes are enriched (Ogolla, 2001).

2.10. Theoretical Framework

This study is based on the constructivism theory of learning as proposed by various constructivist theorists, notably Jean Piaget (Pollard, 2006). According to Piaget (1970), people learn through an interaction between thinking and experience, and through the sequential development of more complex structures. Piaget asserts that knowing is not a copy of reality. He further stresses that to know an object or an event is not simply to look at it and make a mental copy or image of it but to modify, to transform the object and to understand the way the object is constructed.

When children encounter a new experience they both accommodate their existing thinking to it and assimilate aspects of the experience. In constructivism, learners construct meaning from input by processing it through existing cognitive structures and then retaining it in long-term memory (Okere, 1996). Constructivists view learning as depending on the degree to which learners can activate existing cognitive structures or construct new ones to subsume the new input (Bartlett, 1932).

The study attempted to find out whether SMASSE INSET has enhanced capacities of teachers to organise class interactions and activities that elicit accommodation and assimilation of incoming information in the cognitive structures of learners. The core role of a teacher is to create a learning environment that allows learners to activate existing cognitive structures or construct new ones to subsume the new input. Teaching and learning should progress from known to unknown to enable learners to link new ideas to the existing knowledge. It also assesses the abilities of the SMASSE trained Biology teachers' pedagogical skills in retaining attention of their students on the subject matter. Better pedagogical skills are more likely to result into better learning, hence more intellectual growth on the part of learners. With positive attitudes of teachers towards teaching and learning of Biology, learning can be made more interesting and learners get more motivated. This can be achieved by using relevant examples which have applications in real life situations and organising experiments to link theory to practice.

2.11. Conceptual Framework

SMASSE INSET was conceived as an intervention measure to improve performance in mathematics and sciences in secondary education (SMASSE, 1999). Kombo (2004) notes that the yardstick used to measure educational output in Kenya is performance in examinations. With very low pass rates in mathematics and sciences in national examinations, therefore, the educational output in these subjects has persistently been low. The KESSP document (Government of Kenya, 2005) attributes poor performance in mathematics and sciences to weak pedagogies and negative attitudes of teachers, students and parents towards the subjects. Attitude change and improvement of teachers' pedagogical skills are central to the SMASSE project initiatives (Njuguna, 1998). These are key aspects given that traditionally, mathematics and science subjects have been perceived to be difficult and uninteresting. The conceptual framework is presented schematically in Figure 1.

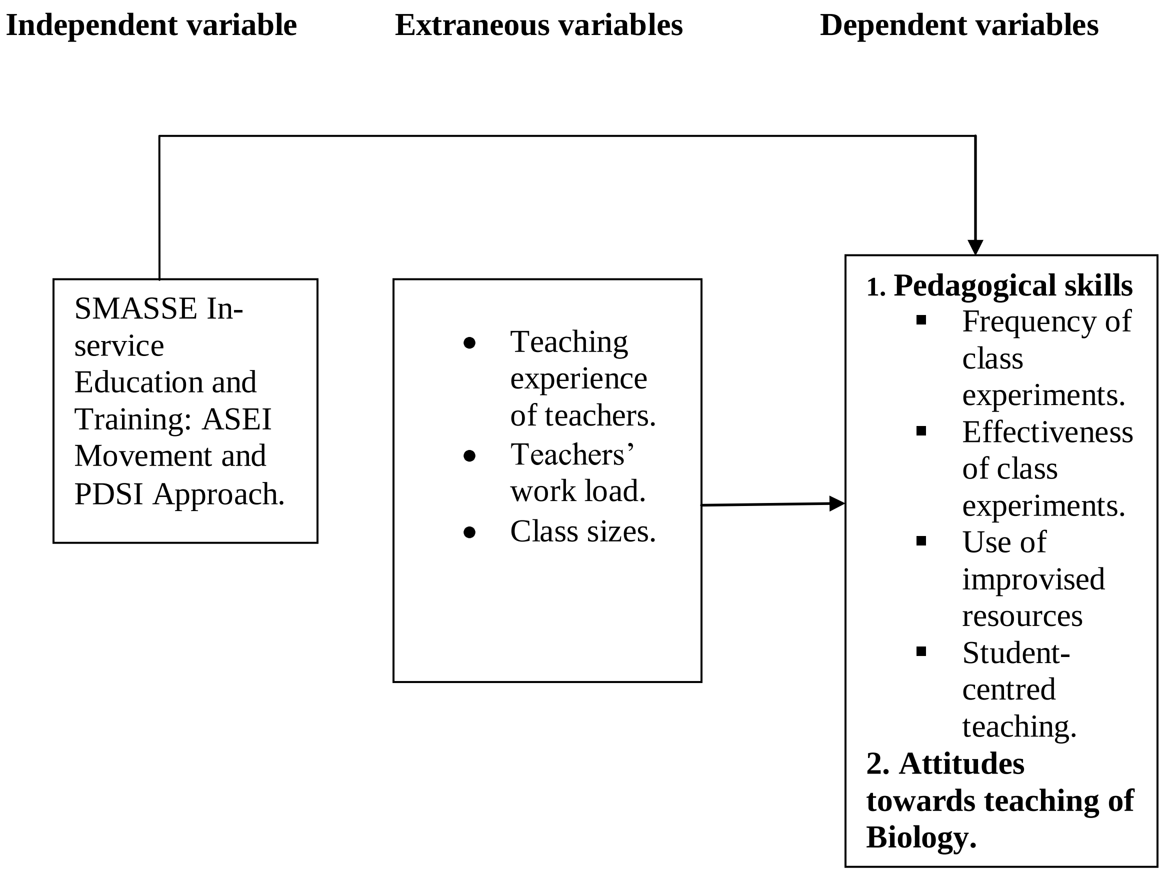

Figure 1: Relationship between the Independent and Dependent variables

In conceptualising the study, the researcher attempted to point out how the independent variable (SMASSE INSET) interacts with the dependent variables (teachers' pedagogical skills and attitudes towards teaching of Biology) as shown in Table 1. The study hypothesised that for high educational output (performance) to be realised, the SMASSE INSET has to succeed in positively impacting on attitudes and pedagogical skills of Biology teachers. Teachers need to adopt the constructivist approach to teaching in order to actively involve the learners. The influence of the extraneous variables such as class sizes, teaching experience and teachers' workload was controlled by randomisation (Mugenda & Mugenda, 2003). It was also controlled by sampling teachers with the requisite qualifications, that is, diploma and university level of pre-service teacher education. The influence of such extraneous variables was, therefore, assumed in this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter describes the research methodology used in this study. It covers the description of the research design used. This is followed by a description of target and accessible populations of the study. The chapter in addition highlights the sample size, sampling procedures that were used and instrumentation. The final sections of the chapter dwell on data collection procedures and data analysis techniques used.

3.2. Research Design

The study utilised the descriptive survey research design. This design involves observing and describing behaviour of a subject without influencing it in any way (Shuttleworth, 2008). Survey research design is a very valuable tool for assessing opinions and trends (Peil, 1995). Orodho (2003) points out that descriptive survey is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals. It can be used when collecting information about peoples' attitudes, opinions, habits or any other educational or social issues (Orodho & Kombo, 2002). Fraenkel and Wallen (1996) explain that the aim of survey research is to collect data from one group to describe some characteristics of the group.

The design was appropriate for this study since the Biology teachers under study had already undergone the SMASSE INSET and the researcher did not have the opportunity to manipulate the training conditions, objectives or activities. The major purpose of this design is description of state of affairs as it exists (Kombo & Tromp, 2006). In this study, Biology teachers who had undergone four years of SMASSE INSET (independent variable) were studied to establish whether they use new and better pedagogical skills and whether their attitudes had changed positively or negatively towards teaching and learning of Biology (dependent variables). The study sought to unravel the pedagogical skills and attitudes of the teachers before the INSET and then compared with the current status of the variables after the INSET.

3.3. Target and Accessible Population

The target population of this study comprised all SMASSE trained Biology teachers and all secondary school Biology students in Kenya. The main subjects of the study, however, were Biology teachers who had undergone four years of SMASSE INSET and the Biology students in the respective classes taught by the SMASSE trained teachers. The accessible population was all SMASSE trained Biology teachers and all secondary school Biology students in Rachuonyo South district, Homabay County. The district consists of 70 secondary schools; 60 of them single streamed and 10 multiple-streamed. According to the data available at the District Education Office, the total number of SMASSE trained Biology teachers in Rachuonyo South was 100 by November, 2010. With each teacher handling an average class population of 40, the total population of students was about 4000. The student respondents were those taught by the SMASSE trained Biology teachers, irrespective of their class levels.

3.4. Sample Size and Sampling Procedures

This section has detailed how the sample size was arrived at in part 3.4.1 and the sampling procedures used in 3.4.2.

3.4.1. Sample Size

The general rule in the determination of sample sizes is to use the largest sample possible (Kathuri & Pals, 1993; Mugenda & Mugenda, 2003). Kerlinger (1964) explains that a smaller sample results in larger error than a larger sample. Balian (1988) asserts that sample sizes usually range from 60 to 300 respondents with most averaging about 200, although the nature of the study dictates the specific size of the sample. The minimal sample size for survey research is 100 subjects (Kathuri & Pals, 1993; Borg & Gall, 1983; Gall, Borg & Gall, 1996). According to Gay (1987), the minimum sample size for a descriptive survey research is 10% of the accessible population. Krejcie and Morgan (1970) provide a formular for calculating sample sizes. This formular was used by Kathuri and Pals (1992) to develop a table showing suitable sample sizes for given populations.

From the table provided by Kathuri and Pals (1992), 50 Biology teachers were to be sampled from a population of 100 in the study area. However, Balian (1988) proposes a percentage adjustment of 10% to 30% to initial sample sizes to compensate for attrition, respondent refusal to participate, or other circumstances which gives an upward adjustment of 8 to 24 in this case. The study therefore settled for a sample size of 60 which falls within the proposed range after upward adjustment. Five students were sampled per teacher to respond to students' questionnaire items. This gave a total sample of 300 students. Therefore, the study sample comprised a total of 360 subjects.

3.4.2. Sampling Procedures

Simple random sampling was used to select a study sample from the list of SMASSE trained Biology teachers in the district. The list of SMASSE trained Biology teachers used as a sampling frame was obtained from the District Education Office, Rachuonyo South. Simple random sampling is important in reducing the influence of extraneous variables in a study (Mugenda & Mugenda, 2003). Balloting was used to randomly pick the sample of 60 teachers. This procedure is justified for selection of small samples as opposed to the use of tables of random numbers (Peil, 1995).

Systematic random sampling was used to select participating students in this study from class registers. According to Peil (1995), this method is satisfactory where there are no systematic differences according to positions on the list. In the class registers, names of students are ordered based on their admission numbers and this does not allow any systematic differences according to positions in the registers. The number of students in the class register was divided by five so that every n^{th} subject was included in the study (Kathuri & Pals, 1993). For example, in a class of forty students, 8^{th}, 16^{th}, 24^{th}, 32^{nd}, and 40^{th} students in the class register were sampled. This procedure was meant to ensure random sampling of students of different intellectual abilities.

3.5. Instrumentation

Two instruments were used to collect the data required to achieve the objectives of this study from the Biology teachers and students. The two instruments were the Biology

Teachers' Questionnaire (BTQ) and the Biology Students' Questionnaire (BSQ) which are discussed in sections 3.5.1 and 3.5.2.

3.5.1. Biology Teachers' Questionnaire (BTQ)

A Biology Teachers' Questionnaire (BTQ- Appendix A) was constructed by the researcher. It was used to solicit information from SMASSE trained Biology teachers. It gathered information on the frequency and effectiveness of class experiments organised by the teachers before and after undergoing SMASSE INSET. It was also used to collect information on the number and use of improvised teaching/learning resources before and after undergoing SMASSE INSET. Finally, the BTQ was used to establish the Biology teachers' attitudes towards teaching of Biology before and after undergoing SMASSE INSET. The BTQ contained 21 items of which 12 are structured matrix items, seven are closed-ended and two are open-ended.

Seven matrix items were on the Likert scale assessing the effectiveness of class experiments organised by Biology teachers before and after undergoing SMASSE INSET by indicating the level of effectiveness of the class experiments based on the parameters given. The scale ranged from 'Very ineffective' to 'Very effective'. The minimum score was one for 'Very Ineffective' and the maximum score was five for 'Very effective'. Five matrix items assessed the teachers' attitudes towards teaching of Biology. The minimum score was one for 'Strongly Disagree' and the maximum score was five for 'Strongly Agree'. The closed-ended questions were used to ensure objectivity and clarity of the subjects' responses for ease of statistical analyses while the open-ended items allow the respondent some room for independent opinion (Mugenda & Mugenda, 2003).

Two closed-ended and open-ended items assessed the frequency of class experiments while seven closed-ended items assessed the use of improvised teaching resources by the teachers before and after undergoing SMASSE INSET. Closed-ended items had five possible responses from which the respondent chose one. The responses were scored from one to five depending on the number of possible responses given. The open-ended items allowed the respondents to give their own subjective opinions with regard to their pedagogical skills and attitudes. The responses were not scored for statistical analysis but were used to make qualitative judgements on the variables. The researcher was able to gain more insight on the teachers' perceptions and attitudes regarding the study variables through the open-ended items.

3.5.2. Biology Students' Questionnaire (BSQ)

Biology Students' Questionnaire (BSQ- Appendix B) was also constructed by the researcher. It was used to collect data from Biology students taught by the teachers under study. Five students per class were used to respond to student questionnaires regarding the use of student-centred approaches by their teachers during Biology lessons. The five students were sampled from a class taught by the teacher under study. The students gave evidence of their involvement in Biology lessons by answering questionnaire items regarding the teaching approaches used by their teachers.

BSQ contained 18 items in total. The first 12 were matrix questions based on Likert scale that assessed the frequency of students' active participation during Biology lessons. The scale ranged from 'Not at all' to mean no students' participation to 'Very frequent' to mean very active students' participation. The minimum score was one for 'Not at all' and the maximum score was five for 'Very frequent'. Five questions were closed-ended to allow students pick the responses that best suited their opinions on class participation.

All closed-ended questions had five possible responses. The minimum score was one and the maximum five. The final question was open-ended to allow the students room for independent expression of their opinions regarding class participation. The responses to this question were not scored but used by the researcher to make qualitative judgements on the variables. Both instruments contained the Likert-scale type items that allowed for statistical analyses necessary for answering the research questions and accepting or rejecting the null hypothesis.

3.6. Validity and Reliability of Research Instruments

This section explains how validity of the research instruments was ensured in 3.6.1 and the procedure of pilot-testing and estimation of the reliability of the instruments in part 3.6.2.

3.6.1. Validity of Research Instruments

Validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). It has to do with the accuracy of the data collected in representing the variables of the study so as to make accurate and meaningful inferences. According to Kathuri and Pals (1993), validity refers to how well the measured indicators really measure what they are supposed to measure. This is especially true in educational research where constructs like achievement, attitude, motivation, creativity and aptitude which cannot be directly measured, but must be inferred from representative measurement.

Five research specialists from the Faculty of Education and Community Studies of Egerton University validated the instruments, whose focus was face and construct validities (Kerlinger, 1964; Gall, Borg & Gall, 1996). Two secondary school teachers helped in content validation of the instruments. The teachers were those who had conducted academic research in the past and with the knowledge of objectives and principles of the SMASSE INSET. The validation procedures concentrated on face, content and construct validities of the instruments.

Face validity refers to the appeal and appearance of the instrument, that is, the instrument should appear to measure what it should measure, in this case, pedagogical skills and attitudes of SMASSE Biology teachers. Content validity refers to the representativeness of the items as they relate to the entire domain or universe of content being measured while construct validity refers to accuracy of the instrument in measuring what it should measure (Kathuri & Pals, 1993). The questionnaire items were made as relevant, objective and clear as possible to improve face validity. The items were proof-read to effectively eliminate systematic/non-random error which is due to poor validity of the instruments (Tindal & Marston, 1990).

3.6.2. Reliability of Research Instruments

The reliability of an instrument refers to its suitability over time or the level of internal consistency (Fraenkel & Wallen, 2000). To estimate their reliability, the instruments were pilot–tested on teachers and students from the neighbouring Nyakach district, Kisumu County. Piloting was done to establish whether relevant data was to be collected and to identify problems that were likely to occur during administration of the instruments. It was also done to check the clarity of items in research instruments. This was done after sampling but before the actual study began. The acceptable pilot sample size is 1% to 10% of the sample size (Mugenda & Mugenda, 2003). Five teachers and 25 students were used in the pilot study.

After piloting, Cronbach's Alpha coefficient was used to estimate the reliability of each instrument. The use of Chronbach's alpha coefficient was appropriate since the items were not scored dichotomously and scores took a range of values (Thorndike & Thorndike, 1994). This is a general, all purpose formula applicable to all types of scales and requiring only one administration of the instrument (Suter, Allyn & Bacon, 1998). Cronbach's Alpha coefficient was computed using the Statistical Package for Social Sciences (SPSS) version 17.0. The reliability coefficient for the teachers' questionnaire (BTQ) was 0.85 (n=5) while that for the students' questionnaire (BSQ) was 0.90 (n=25). Reliability coefficient of 0.7 and above is acceptable in social science research (Mugenda & Mugenda, 2003). According to Fraenkel and Wallen (1990), an alpha value of 0.7 is considered suitable to make possible group inferences that are accurate enough. Therefore, BTQ and BSQ were found to be reliable enough hence were used to collect data.

3.7. Data Collection Procedures

The researcher sought research authorisation from the National Council for Science and Technology (NCST) of the Ministry of Higher Education through the Board of Postgraduate Studies, Egerton University to collect data (Appendix C). The researcher later sought for permission from the Rachuonyo South District Education Office to be allowed to visit schools. The researcher visited each of the schools whose teachers and students were sampled for the study where the head-teachers' permission to conduct the study was sought. The researcher personally met the sampled teachers and emphasised the nature and importance of the study and implored them to encourage their students to participate in the study. The questionnaires were self-administered by the researcher to improve the return rate. Fifty out of sixty BTQs were returned after filling giving a return rate of 93.3% whereas for BSQ, the return rate was 240 out of a possible 300, equaling to 80%. The return rates were satisfactory for the study.

3.8. Data Analysis Techniques

The data collected was summarised, organised and presented in form of tables, bar graphs, pie charts and histograms. Descriptive statistics, specifically frequencies, means, standard deviations and percentages were computed from the data so as to answer the research questions. SPSS version 17.0 for windows was used to run paired samples t-test to accept or reject the null hypothesis, H_O1. T-tests are important since they assess whether there is statistically significant difference between the means of two conditions (Dancey & Reidy, 2004). Paired samples t-test is used where participants perform in both conditions. In this study, the teachers' attitudes toward teaching Biology before and after SMASSE INSET were compared. Dancey and Reidy support the use of t-tests for the analysis of data from Likert-type scales. The analysis accepted an alpha-value of 0.05.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of findings. The results are presented and interpreted based on the objectives that guided the study. The following were the objectives of the study:

i. To determine the effect of SMASSE INSET on the frequency of class experiments organised by Biology teachers in Rachuonyo South district.

ii. To determine the effect of SMASSE INSET on the effectiveness of class experiments organised by Biology teachers in Rachuonyo South.

iii. To determine the effect of SMASSE INSET on the use of improvised teaching and learning resources by Biology teachers in Rachuonyo South.

iv. To investigate the extent to which student-centred teaching approaches are used by SMASSE trained Biology teachers in Rachuonyo South.

v. To determine whether SMASSE INSET has changed the attitudes of Biology teachers towards teaching of Biology in Rachounyo South.

4.2. Frequency of Class Experiments Organised by Biology Teachers

The first objective was to determine whether SMASSE INSET had an effect on the frequency of class experiments organised by Biology teachers. They were to indicate the frequency of class experiments they organised before and after undergoing SMASSE INSET and the factors that hinder organisation of class experiments in Biology. The results are presented in sections 4.2.1 and 4.2.2.

4.2.1. Frequency of Class Experiments Before and After SMASSE INSET

The Biology teachers were asked to state the frequency of class experiments they organized before and after undergoing SMASSE INSET. Their responses were categorised and scored in the range of one to five. 1 represented ‘Very Rarely’, 2 ‘Rarely’, 3 ‘Not Sure’, 4 ‘Frequently’ and 5 ‘Very Frequently’. Their responses, frequencies and percentages are presented in Table 3.

Table 3

Frequency of Class Experiments Before and After undergoing SMASSE INSET

N = 50

Response	**Score**	**Before**	**After**
Very Rarely	1	5 (10%)	0 (0%)
Rarely	2	30 (60%)	0 (0%)
Not sure	3	0 (0%)	10 (20%)
Frequently	4	15 (30%)	30 (60%)
Very frequently	5	0 (0%)	10 (20%)
		Mean = 2.5000	Mean = 4.0000

Results in Table 3 shows that 70% of teachers under study indicated that they rarely organised class experiments before undergoing SMASSE INSET. This means that they largely taught Biology theoretically. Thirty percent (30%) of the teachers indicated that they frequently organised class experiments before undergoing SMASSE INSET. After undergoing SMASSE INSET, 80% of the teachers indicated they now frequently organise class experiments, the other 20% were not sure of their frequency of class experiments. None of the teachers indicated 'Rarely' or 'Very Rarely' on their frequency of class experiments after undergoing SMASSE INSET. The mean score after undergoing SMASSE INSET is 4.000 meaning that on average, the teachers now organise class experiments frequently. However, before SMASSE INSET the mean score was 2.500 meaning Biology teachers rarely organised class experiments or they were not sure of frequency of experiments.

Figure 2 is a bar graph which pictorially compares the frequencies of class experiments organised before and after SMASSE INSET.

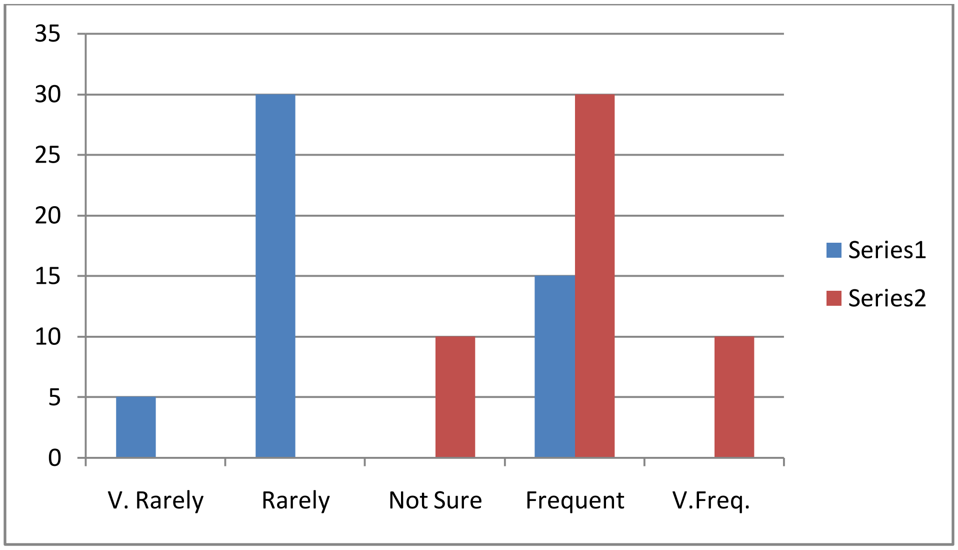

Figure 2: Bar Graph comparing the Frequencies of Class Experiments organised by Biology Teachers Before and After SMASSE INSET

Figure 2 reveals that teachers organise experiments more frequently after SMASSE INSET. Series 1 represents the frequencies before SMASSE INSET while series 2 represents the frequencies after SMASSE INSET. Series 1 is highest at 'Rarely' while series 2 is highest at 'Frequent'. This implies that, on average, teachers rarely organised class experiments before SMASSE INSET but they now frequently organise class experiments after SMASSE INSET

4.2.2. Factors that hinder the use of Practical work in Teaching of Biology

The teachers were asked whether, in their own opinion, Biology can always be taught by use of practical activities. Out of 50 respondents, 10 (20%) responded with 'YES' while 40 (80%) responded with 'NO'. An overwhelming percentage of the teachers believed Biology cannot always be taught by practical work. They gave a number of factors that hinder use of practical activities in the teaching of the subject as shown in Table 4.

Table 4

Factors that Hinder Use of Practical Activities in Teaching of Biology as Expressed by SMASSE Trained Biology Teachers

Factor	Frequency	Percentage
Expense involved	6	15
Time consuming	9	22.5
Limited resources	12	30
Too many lessons	5	12.5
Cumbersome preparations	4	10
Abstract concepts	2	5
Absenteeism of students	1	2.5
Inability to improvise	1	2.5

Results from Table 4 indicate that thirty percent (30%) of the teachers indicated limited resources as the main hindrance to practical activities in Biology. Twenty two point five percent (22.5%) of them indicated that organisation of practical activities is time consuming. Coupled with too many lessons that they handle (12.5%), the teachers implied that time is a very constraining factor. Fifteen percent (15%) of the teachers indicated the high expenses involved. Two point five percent (2.5%) of the teachers studied indicated inability to improvise as a hindrance. Ten percent (10%) of the teachers gave cumbersome preparation as the reason for not always teaching Biology through practical activities. Five percent (5%) of teachers studied felt that some concepts in Biology are too abstract to be taught using practical activities. Lastly, 2.5% of teachers under study cited absenteesm of students as a factor hindering practical activities in the teaching of Biology.

Figure 3 is a pictorial illustration of the factors that hinder use of practical activities in teaching of Biology and their percentages as mentioned by the Biology teachers.

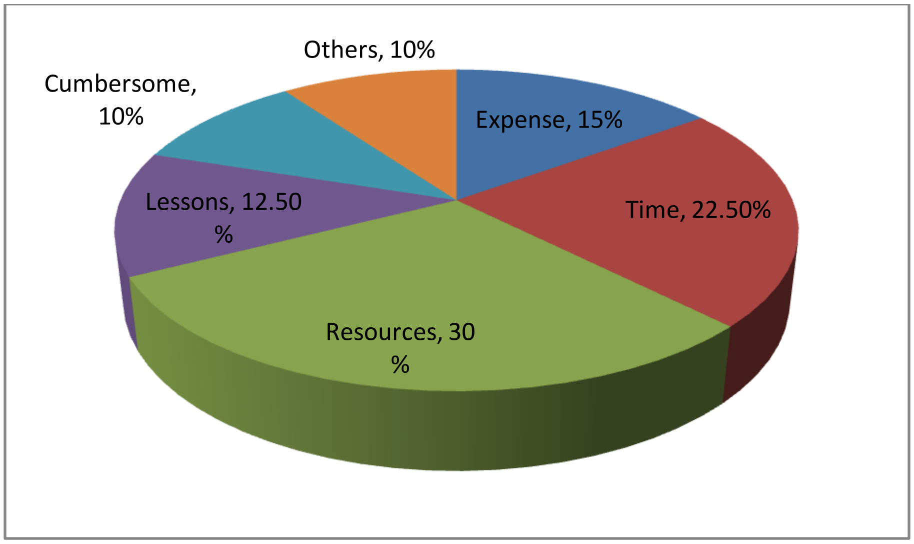

Figure 3: Pie Chart showing factors that hinder Use of Practical Activities in teaching of Biology

From Figure 3, the main hindrances to practical activities in Biology are limited resources (30%) and time (22.5%), high expense (15%) and many lessons (12.5%). This result shows that resources necessary for practical activities in Biology are rarely sufficient and time is usually a limiting factor. Other major factors that hinder practical work were given as too many lessons and high expense involved. This implies that for teachers to organise more practical activities, sufficient resources should be provided and teachers be able to acquire improvisation skills. Understaffing in schools should also be addressed so that teachers are able to handle fewer lessons and hence get enough time to prepare for practical activities.

4.3. Effectiveness of Class Experiments organised by SMASSE Trained Biology Teachers

The second objective was to determine whether SMASSE INSET has improved the effectiveness of class experiments organised by Biology teachers or not. Teachers were required to rate the effectiveness of class experiments they organised before and after undergoing SMASSE INSET. They responded to statements that were used to operationalise the term 'effectiveness' of class experiments. They indicated the level of effectiveness of class experiments organised before and after undergoing SMASSE INSET based on the statements. The rating scale used was as follows:

Very Ineffective (1) Ineffective (2) Slightly Effective (3) Effective (4) Very Effective (5)

The teachers' responses, frequencies and means are as shown in tables 5 and 6.

Table 5

Effectiveness of Class Experiments Before SMASSE INSET

N = 50

Statements	**Responses and Frequencies**					
	1	**2**	**3**	**4**	**5**	**Mean**
1. Preparation before the practical.	5(10%)	5(10%)	25(50%)	15(30%)	0	3.000
2. Trying out activities before the practical to ensure materials used will give expected results.	0	10(20%)	25(50%)	5(10%)	10(20%)	3.300
3. Giving of clear instructions to learners.	0	15(30%)	5(10%)	10(20%)	15(30%)	3.200
4. Proper guidance and supervision of the learners by a teacher during the practical.	0	5(10%)	30(60%)	5(10%)	10(20%)	3.400
5. Making good group sizes with suitable composition.	0	10(20%)	15(30%)	25(50%)	0(0%)	3.300
6. Briefing students on any precautions to be taken to ensure the safety of students and equipment.	0	5(10%)	15(30%)	15(30%)	15(30%)	3.800
7. The ability of the teacher to establish link/bridge between the practical work and the concept to be learnt.	0	10(20%)	15(30%)	10(20%)	15(30%)	3.600
Aggregate Mean						**3.371**

Before undergoing SMASSE INSET, thirty percent (30%) of teachers rated their preparation before practical as effective while none rated their preparation as very effective. Twenty percent (20%) rated themselves as ineffective. The mean score is 3.000 corresponding to slightly effectiveness. On trying out activities before the actual practical, thirty percent (30%) of the teachers rated themselves as effective before undergoing SMASSE INSET and 20% rated themselves as ineffective. The mean score is 3.300 implying slight effectiveness. On giving of clear instructions to learners, 50% rated their skills as effective before SMASSE INSET whereas 30% rated their skills as ineffective. The mean score is 3.200 implying slight effectiveness.

Thirty percent (30%) of the teachers rated themselves effective on their abilities to offer proper guidance and supervision of learners during the practical before undergoing SMASSE INSET. On the same aspect, 10% of the teachers indicated ineffective. The mean score is 3.400. The implication is that majority of teachers considered their abilities on these aspects as slightly effective before SMASSE INSET. On making of group sizes with suitable composition, 25% of the teachers responded with effective before SMASSE INSET while 20% responded with ineffective. The mean score is 3.300 implying slight effectiveness.

Sixty percent (60%) of the teachers rated themselves effective on briefing the students on precautions to be taken to avoid accidents before SMASSE INSET and 10% responded with ineffective. A mean score of 3.800 implies effectiveness on this aspect. The last aspect was the ability of the teachers to establish link/bridge between the practical work and the concept to be learnt. Fifty percent of the teachers indicated effective before SMASSE INSET and 20% indicated ineffective. A mean score of 3.600 implies effectiveness.

On average, less than half of the teachers considered their abilities as effective on these aspects before SMASSE INSET. An aggregate mean score of 3.371 implies that teachers considered their abilities in organising class experiments before SMASSE INSET as slightly effective.

Table 6

Effectiveness of Class Experiments After SMASSE INSET

N = 50

Statements	Responses and Frequencies					
	1	**2**	**3**	**4**	**5**	**Mean**
1. Preparation before the practical.	0	0	10(20%)	5(10%)	35(70%)	4.500
2. Trying out activities before the practical to ensure materials used will give expected results.	0	0	5(10%)	10(20%)	35(70%)	4.600
3. Giving of clear instructions to learners.	0	0	5(10%)	5(10%)	40(80%)	4.700
4. Proper guidance and supervision of the learners by a teacher during the practical.	0	0	0	20(40%)	30(60%)	4.600
5. Making good group sizes with suitable composition.	0	0	0	20(40%)	30(60%)	4.600
6. Briefing students on any precautions to be taken to ensure the safety of students and equipment.	0	0	5(10%)	15(30%)	30(60%)	4.500
7. The ability of the teacher to establish link/bridge between the practical work and the concept to be learnt.	0	0	0	15(30%)	35(70%)	4.700
Aggregate Mean						**4.600**

The mean score for each statement is calculated by summing up the product of each response score and response frequency then dividing by 50 while the aggregate mean is calculated by getting the average of all the statement means.

After undergoing SMASSE INSET, 80% of the teachers rated their preparation as effective while none rated themselves as ineffective. The mean score on this aspect is 4.500 implying the teachers rated their skills as very effective. On trying out activities before the actual practical, 80% rated themselves as effective while none rated themselves as ineffective. With a mean score of 4.600, the teachers rated their skills on this aspect as very effective. Ninety percent (90%) indicated effective on giving of clear instructions to learners. None of the teachers indicated ineffective on this aspect. This yielded a mean score of 4.700 implying very effective. All the teachers (100%) indicated that their skills are effective on ability to offer proper guidance and supervision of the learners during the practical. A mean score of 4.600 corresponds to 'Very Effective' on this aspect.

On making of group sizes with suitable composition, 90% responded with effective after SMASSE INSET and none responded with ineffective. With a mean score of 4.600, the teachers indicated that they are very effective on this aspect. All the teachers under study (100%) rated themselves as effective on briefing of students on precautions to be taken to avoid accidents. This shows that none of the respondents indicated either ineffective or very ineffective. A mean score of 4.500 corresponds to 'Very Effective' on this aspect. The last aspect was the ability of the teachers to establish link/bridge between the practical work and the concept to be learnt. All the teachers indicated effective after SMASSE INSET. With a mean score of 4.700, the teachers expressed that they are very effective on this aspect of practical work.

In all the seven aspects, there are zero scores for ineffective and very ineffective abilities after SMASSE INSET. The aggregate mean score for the responses after SMASSE INSET is 4.600. This means that teachers perceive the experiments they organise after SMASSE INSET as very effective based on the aspects used in this study. The experiments organized before SMASSE INSET were, however, only slightly effective with a mean score of 3.371.

4.4. Use of Improvised Teaching and Learning Resources

The third objective was to determine whether SMASSE INSET affected the use of improvised teaching and learning resources by Biology teachers. Teachers were required to indicate adequacy of teaching and learning resources in their schools, the number of teaching and learning resources they improvised before and after undergoing SMASSE INSET and to name the specific teaching and learning resources they improvised after SMASSE INSET. They were also required to indicate the number of weekly lessons they taught using improvised teaching and learning resources before and after undergoing SMASSE INSET and whether the use of improvised teaching and learning resources was as effective as use of conventional resources. The results are presented and interpreted in sections 4.4.1, 4.4.2, and 4.4.3.

4.4.1. Adequacy of Biology Teaching and Learning Resources in Schools

Teachers were required to indicate the level of adequacy of Biology teaching and learning resources in their schools. They used a rating scale ranging from 1 for 'Very inadequate' to 5 for 'Very adequate'. The results are presented in Table 7.

Table 7

Adequacy of Biology Teaching and Learning Resources in Schools

Adequacy of Resources	Score	Frequency N = 50	Percentage
Very inadequate	1	0	0
Inadequate	2	11	22
Average	3	30	60
Adequate	4	9	18
Very inadequate	5	0	0
	Mean score = 2.960		

Sixty percent (60%) of the teachers indicated that their schools have average adequacy of teaching and learning resources. Twenty two percent (22%), however, indicated that the teaching and learning resources in their schools are inadequate. A mean of 2.960 implies that the resources are less than adequate in schools on average. Figure 4 is a presentation of the results on a line graph.

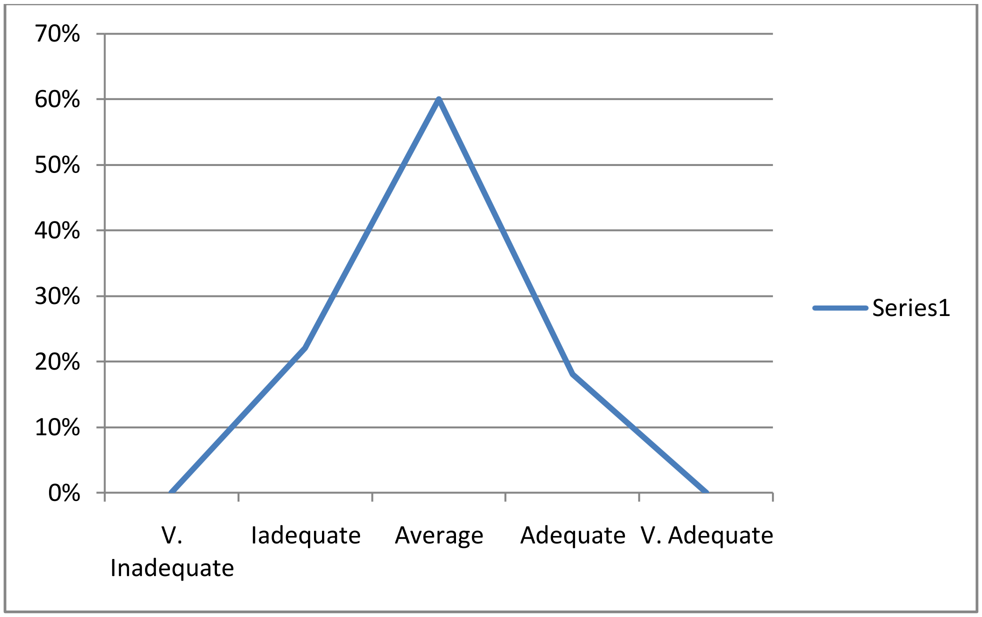

Figure 4: Line Graph showing Adequacy of Biology Teaching and Learning Resources in Secondary Schools

From figure 4, the graph peaks at a point corresponding with 'Average' response. This implies that teaching and learning resources are only fairly adequate in schools. The fact that Biology teaching and learning resources are less than adequate in schools indicates that they are a constraining factor in the teaching and learning of Biology.

4.4.2. Teaching and Learning Resources Improvised by Biology Teachers Before and After SMASSE INSET

The teachers were required to indicate the number of teaching and learning resources they improvised before and after undergoing SMASSE INSET. They used a rating scale ranging from 1 = None to 5 = Very many. The results are presented in table 8.

Table 8

Improvised Biology Teaching and Learning Resources Before and After SMASSE INSET

Number improvised	**Frequency N = 50**		**Percentage**	
	Before	**After**	**Before**	**After**
None	0	0	0	0
Very few	35	0	70	0
Few	10	18	20	36
Many	5	32	10	64
Very many	0	0	0	0

Results from Table 8 indicate that 'None' category did not attract any response either before or after SMASSE INSET. This means that all teachers had at least improvised some teaching and learning materials before and after SMASSE INSET. Ninety percent (90%) of the teachers had only improvised few resources before SMASSE INSET while 10% indicated they had improvised many teaching and learning resources. This shows that there was very little improvisation of resources by teachers before SMASSE INSET. Thirty six percent (36%) of teachers under study indicated they only improvised few resources after SMASSE INSET while 64% indicated they had improvised many resources after SMASSE INSET. This reveals that improvisation increased after

SMASSE INSET. Teachers have greater capacity and will to improvise resources after the INSET.

Figure 5 is a pictorial presentation of the percentages of number of teaching and learning resources improvised by Biology teachers before and after SMASSE INSET in form of a bar graph.

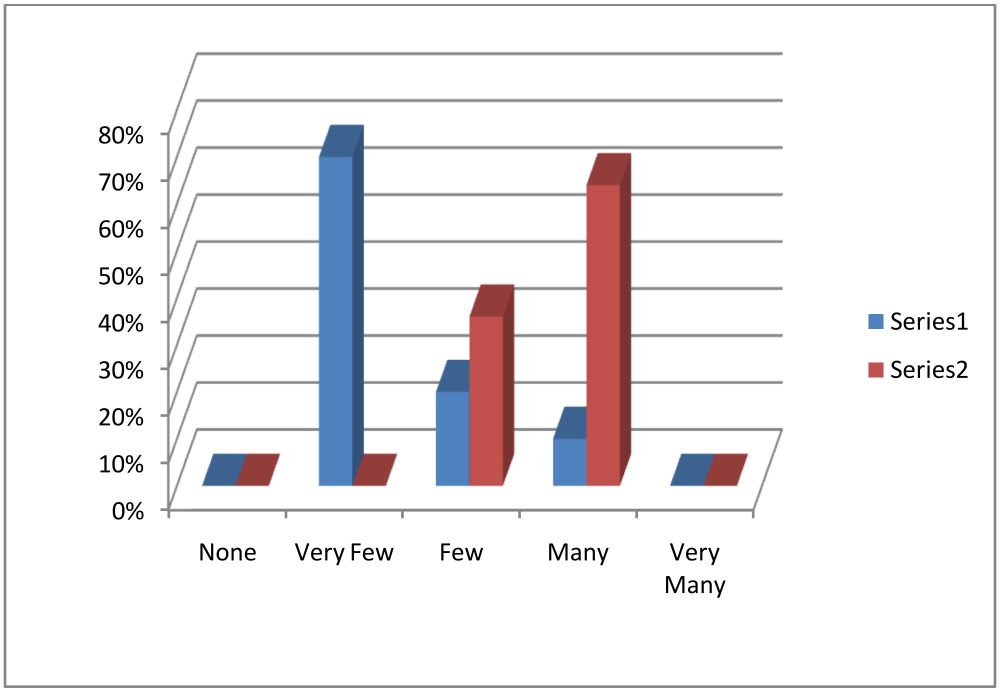

Figure 5: Bar Graph showing the difference in number of Teaching and Learning Resources Improvised by Biology teachers Before and After SMASSE INSET

From figure 5, more resources were improvised after SMASSE INSET. Series 1 represents the percentages before SMASSE INSET while series 2 represents the percentages after SMASSE INSET. Series 1 is highest at ‘Very Few’ while series 2 is highest at ‘Many’. This means that teachers improvised very few resources before SMASSE INSET but they now improvise many resources after the INSET. SMASSE INSET has therefore improved their improvisation skills.

The teachers were asked to list some of the teaching and learning resources they improvised after undergoing SMASSE INSET. They cited a number of resources as shown in table 9.

Table 9

Teaching and Learning Resources Improvised by Biology Teachers

Improvised Resources	Frequency	Percentage	Cumulative Frequency
Chest cavity model	8	17.8	8
Erector pili muscles on skin	1	2.2	9
Nerve cell model	1	2.2	10
Coakroach model	1	2.2	11
Model of xylem vessels	1	2.2	12
Quadrats	7	15.6	19
Pooter	4	8.9	23
Peppered moths models	1	2.2	24
Blood vessels using rubber tubes	4	8.9	28
Rib cage using wires	3	6.6	31
Model of DNA molecule	2	4.4	33
Models of heart and eye	10	22.2	43
Models of joints	2	4.4	45

A number of teaching and learning resources were improvised by the teachers after undergoing SMASSE INSET. A total of 13 improvised resources were cited. Models of the heart and the eye topped the list with 22.2% followed by models of chest cavity at 17.8%. Fifteen point six percent (15.6%) had improvised quadrats while pooters and blood vessels using rubber tubes were improvised by 8.9% each. Six point six percent (6.6%) improvised rib cage using wires and 4.4% each indicated models of DNA molecules and models of joints. More complex models like xylem vessels, cockroach, nerve cell and erector pili muscles were less frequently improvised. They were only mentioned once each by the respondents.

4.4.3. Frequency of Use of the Improvised Teaching and Learning Resources

The teachers were required to indicate the frequency of use of the improvised teaching and learning resources before and after SMASSE INSET. They were to indicate the approximate number of weekly lessons they used to teach using improvised resources before SMASSE INSET and the number they now teach using improvised resources after SMASSE INSET. They were to use a rating scale ranging from 1 representing 'None' to 5 representing 'All'. Table 10 is a presentation of the results.

Table 10

Frequency of Use of Improvised Teaching and Learning Resources Before and After SMASSE INSET

N = 48

Response	**Frequency & Percentage**	
	Before SMASSE INSET	**After SMASSE INSET**
None	0 (0%)	0 (0%)
Very Few	24 (50%)	0 (0%)
Few	24 (50%)	18 (37.5%)
Many	0 (0%)	30 (62.5%)
All	0 (0%)	0 (0%)

Sixty two point five percent (62.5%) of the teachers used the improvised teaching and learning resources in teaching 'many' of the weekly lessons after the SMASSE INSET. Before the SMASSE INSET, all teachers indicated that they only used improvised teaching and learning resources to teach 'few' or 'very few' weekly lessons. Thirty seven point five percent (37.5%) of the teachers still indicated they taught few weekly lessons using improvised teaching and learning resources after undergoing SMASSE INSET. For majority of teachers, therefore, SMASSE INSET has improved their abilities to use improvised teaching and learning resources.

Figure 6 is a bar graph showing the frequency of use of improvised teaching and learning resources before and after SMASSE INSET.

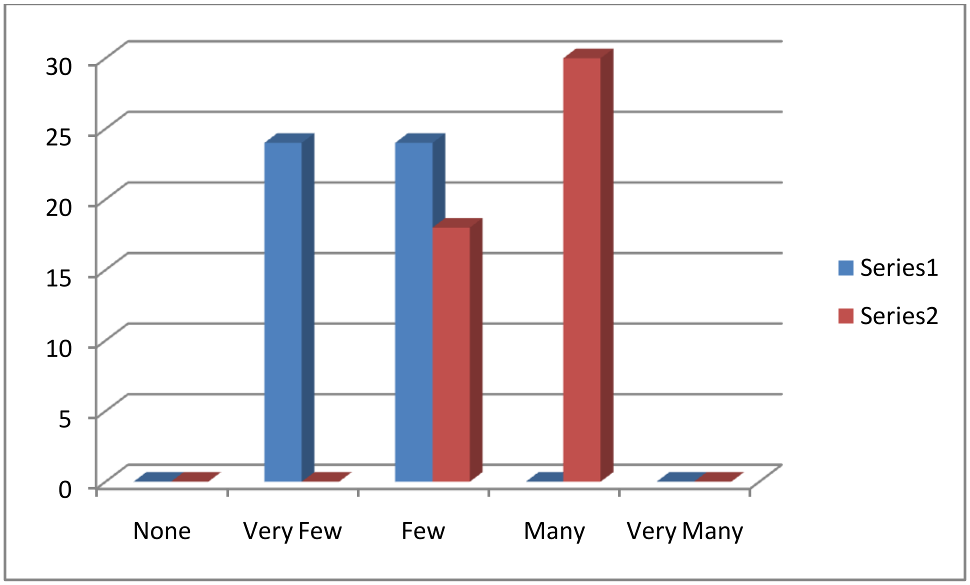

Figure 6: Bar Graph on the frequency of use of Improvised Teaching and Learning Resources Before and After SMASSE INSET

Series 1 represents frequency of use before SMASSE INSET while series 2 represents the frequency of use after SMASSE INSET. It is evident from the graph that the frequencies are higher after SMASSE INSET. Frequencies for ‘Very Few’ and ‘Few’ are higher before SMASSE INSET while responses for ‘Many’ only feature after SMASSE INSET. Few weekly lessons were taught using improvised teaching and learning resources before SMASSE INSET while many are taught using improvised resources after the INSET. This implies that SMASSE INSET has increased the frequency of use of improvised teaching and learning resources.

4.5. Use of Student-Centred Teaching Approaches by SMASSE Trained Biology Teachers

The fourth objective was to determine the extent of use of student-centred teaching approaches by SMASSE trained Biology teachers. Student-centred approaches were viewed as those that elicit high level of student participation and leave the teacher merely as a guide in the learning process. Biology Students' Questionnaire (Appendix B) was used to solicit information from students regarding their class participation. The results are presented in sections 4.5.1, 4.5.2, 4.5.3, and 4.5.4.

4.5.1. General Students' Class Participation

The students indicated the responses that best reflected their opinions about their levels of participation in class using the following scale:

Not At All (1) Very Rarely (2) Rarely (3) Often (4) Very Often (5)

The frequencies of the students' responses and means are presented in table 11.

Table 11

Class Participation by Students taught by SMASSE trained Biology Teachers

N = 240

	Questions	Responses and Frequencies					
		1	**2**	**3**	**4**	**5**	**Mean**
i.	How often do you work in groups during Biology lessons?	20	64	34	72	50	3.28
ii.	How often does your Biology teacher ask questions in class?	0	4	12	64	160	4.58
iii.	How often do students get opportunity to ask questions in class during Biology lessons?	0	18	14	76	132	4.34
iv.	How frequent does your Biology teacher give assignments?	0	6	58	114	62	3.29
v.	Are the assignments marked and returned in time?	0	7	39	91	103	4.21
vi.	How frequent do you have class discussions?	25	29	66	72	48	3.37
vii.	Does the teacher allow for different opinions during class discussions?	0	8	28	60	144	4.38
viii.	How frequent are experiments organised in Biology?	9	69	54	74	34	3.23
ix.	Do you ever go for Biology field excursions?	103	75	47	0	15	1.95
x.	Does the Biology teacher ever deal with the students individually?	21	26	27	111	55	3.64
xi.	Are students given opportunity to plan for experiments?	102	30	42	70	26	2.91
xii.	Do you suggest improvements to be made in experiments in order to get better results?	16	13	21	30	151	4.08
	Aggregate Mean						**3.59**

The mean score for each question is calculated by summing up the products of each response score and response frequency then dividing by 240 while the aggregate mean is calculated by getting the average of all the statement means.

When asked of the frequency of group work in their classes, 50.8% of the 240 students indicated often, 35% indicated rarely while 14.2% indicated not at all. With a mean score of 3.28, the implication is that students rarely work in groups. Ninety three point three percent (93.3%) of the students under study indicated that their teachers often ask questions in class. Only 6.7% indicated that their teachers rarely ask questions in class while none of the students indicated 'not at all'. The mean score is 4.58, implying very often use of this approach. On frequency of students' opportunity to ask questions, 86.7% of the students indicated often, 13.3% indicated rarely while none of the students indicated 'not at all'. The mean score is 4.34. This implies that majority of teachers always grant students opportunity to ask questions and seek clarification on concepts covered.

According to 73.3% of the students, teachers often gave assignments in Biology. Twenty six point seven percent (26.7%) of the students indicated that teachers rarely give assignments. 'Not At All' category did not attract any response. This shows that a majority of teachers usually give assignments to students. However, a mean of 3.29 indicates that teachers still rarely give assignments to students. The assignments given by teachers to students are often marked and returned to students in time according to 80.8% of the respondent students. According to nineteen point two percent (19.2%) of the students, however, the assignments are rarely marked and returned to students in time. The mean score is 4.21. The implication here is that majority of teachers give regular feedback to their students on their assignments. 'Not At All' category attracted no response.

On the frequency of class discussions, 50% reported that they were often. Thirty nine point six percent (39.6%) indicated that they were rarely organised while 10.4% indicated there were never class discussions at all. A cumulative percentage of 50% for 'Rarely', and ‘Not At All’ indicates that a large number of teachers have not fully adopted this student-centred teaching methodology. A mean score of 3.37 indicates this approach is rarely used by teachers. Asked whether their teachers are accommodative of different opinions during class discussions, a majority (85%) of students agreed that often their teachers allowed for different opinions. This huge percentage means that majority of teachers do allow for students’ different opinions during class discussions. Fifteen percent (15%), however, reported that their teachers rarely allowed for different opinions during class discussions while none mentioned ‘Not At All’. A mean score of 4.38 indicates the teachers often allowed for different opinions.

On frequency of class experiments, 45% indicated often. Fifty one point three percent (51.3%), however, believed that class experiments are rarely organised by their teachers. According to 3.7% of the students, class experiments are never organised by their teachers. This shows that more than half of the students rated the frequency of class experiments as either rare, very rare or not at all. A mean score of 3.23 implies that class experiments are rarely organised. Asked if they ever go for Biology field excursions, 6.3% agreed that they very often go for field excursions. Fifty point eight percent (50.8%) indicated that they rarely went for field excursions while 42.9% said they had never gone for field excursions at any given time. With a majority of students (93.7%) indicating that they rarely or have never gone for field excursion in Biology, it shows that teachers do not use this teaching method. The mean score is 1.95 implying rare use of this approach. This is probably due to high costs involved and a lot of time required in planning for field excursions.

On dealing with students individually by the Biology teacher, 69.2% of the students agreed that their teachers often deal with students individually. According to 22.1% of the students, their teachers rarely deal with students individually. For 8.7% of the students, their teachers never make any effort to deal with students individually. The high percentage for often indicates that teachers make good effort in paying attention to students’ individual differences. A mean of 3.64 indicates that teachers often deal with students individually.

Asked whether students are ever given opportunities to plan for experiments, 40% of the students agreed that they are given opportunities to plan for experiments. Thirty percent (30%) indicated that they rarely get involved in planning experiments while another 30% had never been involved in planning experiments. With 30% of students having not found opportunity to plan for experiments and 30% rarely doing so, it is evident that teachers do not grant their students sufficient opportunity to plan for experiments. A mean of 2.91 implies rare involvement. On suggestion of improvements to be made on experiments for better results, 75.4% of the students agreed they give suggestions. Fourteen point two percent (14.2%) were rarely involved while 10.4% were never involved at all. This shows that a good number of students usually suggest improvements on experiments. A mean of 4.08 further suggests that the students often suggest improvements on experiments.

Considering the means of the responses, only one (1.95) for the frequency of field excursions falls below 2.500 hence corresponding to 'Very Rarely'. On four other questions, the means of responses fall between 2.500 to 3.500 corresponding to 'Rarely'. However, on all the other seven questions asked, the means of responses range from 3.64 to 4.58 corresponding to 'Often' and 'Very Often'. An aggregate mean of 3.590 expresses that teachers often actively involve their students by using student-centred teaching approaches.

4.5.2. Extent of Students' Involvement in Class Discussions

To establish the extent of students' involvement in class discussions, the students indicated the extent to which they get involved in class discussions. Their responses were based on a rating scale ranging from 1 for 'Not At All' to 5 for 'Very Much'. Their responses, frequencies and percentages are presented in table 12.

Table 12

Students' Involvement in Class Discussions

Response	Score	Frequency N = 240	Percentage
Not At All	1	20	8.3
Slightly	2	24	10.0
Fairly	3	116	48.3
Much	4	28	11.7
Very Much	5	52	21.7
	Mean=2.817		

Results from Table 12 show that 48.3% of the students cited that their involvement in class discussions is fair, 10.0% rated it as slight while 8.3% 'Not At All'. Only 33.4% of the students rated the extent of their involvement in class discussion as much. A mean score of 2.817 shows that, on average, students' rated their involvement in class discussions as fair. This implies that the class discussions are not as learner-centred as they ought to be. Teachers still exercise a lot of control in these discussions. For 8.3% of students under study, they are never involved in any way in class discussions. This could mean that the discussions are never there at all or, if there, they are totally teacher-centred with students only being spectators.

4.5.3. Extent of Students' Involvement in Class Experiments

In order to establish the extent of involvement in class experiments, the students were asked to state the extent to which they were involved in class experiments. They were to rate this using the following scale: 1 for 'Not At All', 2 for 'Slightly', 3 for 'Fairly', 4 for 'Much' and 5 for 'Very Much'. Their responses, frequencies and percentages were as shown in Table 13.

Table 13

Students' Involvement in Class Experiments

Response	**Score**	**Frequency N = 240**	**Percentage**
Not At All	1	24	10.0
Slightly	2	104	43.3
Fairly	3	36	15.0
Much	4	40	16.7
Very Much	5	36	15.0
	Mean=2.500		

Results from Table 13 indicate that 43.3% of the students cited that they were only slightly involved in class experiments, 15% indicated they are fairly involved while 10% are never involved at all. Only 31.7% of the students under study indicated they are much involved in class experiments. There is an indication of very low involvement of students in class experiments (Mean score = 2.500). In as much as the experiments are carried out, they are largely teacher-centred and the students play very minimal role.

When the results are presented on a pie chart, an illustration shown in Figure 7 is developed.

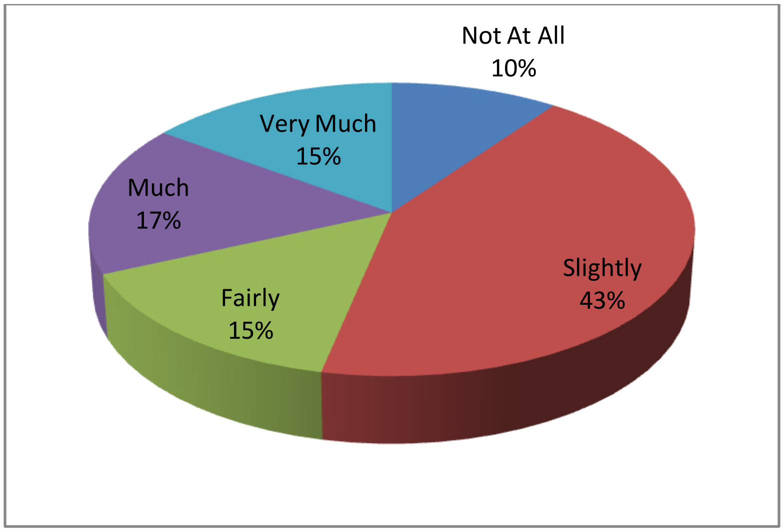

Figure 7: Pie chart showing extent of students' involvement in class experiments

It is explicit from the chart that majority of the students under study (43%) believed their involvement in class experiments was only slight; in as much as 44.8% of the students indicated they often and participated in class experiments (Section 4.5.1). The chart further illustrates that 10% of the students are never involved in class experiments at all. Only 17% of the students indicated much involvement in class experiments. This implies that students' involvement in class experiments is not to a great extent.

4.5.4. Students Overall Assessment of their Class Participation and Suggested Aspects for Improvement

In order to establish their overall assessment of class participation, students were asked to rate their level of class participation in Biology lessons on a scale of one to five. 'One' represented 'very poor' while 'five' represented 'very good'. Their responses and frequencies are presented in Table 14.

Table 14

Students' Overall Assessment of Level of Participation in Biology Lessons

Response	**Score**	**Frequency N = 240**	**Percentage**
Very Poor	1	4	1.7
Poor	2	32	13.3
Fair	3	60	25.0
Good	4	92	38.3
Very Good	5	52	21.7
	Mean = 3.6500		

Results from Table 14 show that majority of students (60%) indicated that, in overall, their level of class participation is good. Fifteen percent (15%) of the students, however, cited that their class participation remained poor. This implies that on average, SMASSE trained Biology teachers involve students in their lessons to a good extent (Mean score = 3.6500). Figure 8 shows the distribution of the students' responses on a bar graph.

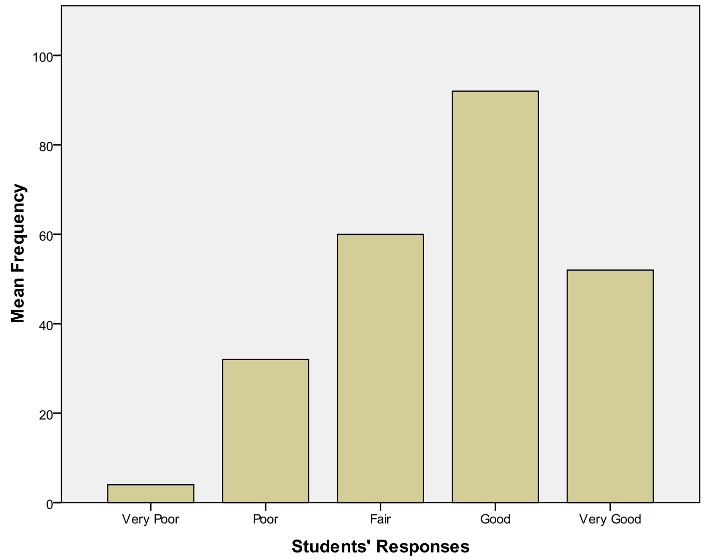

Figure 8: Bar Graph showing Students' Overall Assessment of their Class Participation

From figure 8, It is clear that majority of the students believe their level of class participation is good. Only a small frequency of 36 out of 240 indicated that their class participation is poor. One hundred and forty four (144) of them agree that their class participation is good. This implies that SMASSE trained Biology teachers use student-centred teaching approaches.

Finally, the students were asked to suggest aspects of teaching and learning of Biology that needed to be improved so as to enable them better enjoy Biology lessons. The results are presented in Table 15.

Table 15

Students' Suggestions on Aspects of Improvement in Biology Teaching and Learning

Improvement	Frequency	Percentage
More field trips	55	22.91
Exposure to more experiments	51	21.05
Organising more group discussions	38	16.10
Increasing laboratory equipment	34	13.93
Organising contests with other schools	18	7.43
Giving more revision questions	12	4.95
More revision books	10	4.33
Involve students in planning for experiments	9	3.72
Giving clearer explanations	7	2.48
Teachers to be more friendly and open	5	1.96
Improvement in practical organisation	3	1.24

Topping the list of the suggested aspects that need to be improved is the need to organise more field trips (22.91%). Field trips offer learners learning environments different from classroom situations. Exposure to more experiments was suggested by 21.05% of the students as an aspect that can improve teaching and learning of Biology. Teachers usually avoid exposing students to more experiments due to several reasons, some of which are discussed in section 4.2 of this report. Sixteen point one percent (16.1%) of the students suggested organisation of more group work as an aspect that can improve teaching and learning of Biology. According to these students, fellow students can explain some concepts better than a teacher by use of a language that the others understand better.

The percentage of students who suggested increasing of laboratory equipment as a way of improving teaching and learning of Biology was 13.93%. This is based on the understanding that without adequate laboratory equipment, class experiments cannot be regularly and effectively organised. The easiest remedy to this is improvisation of the teaching and learning resources.

4.6. Attitudes of SMASSE Trained Biology Teachers towards Biology

The fifth objective was to determine whether SMASSE INSET has changed the attitudes of Biology teachers towards Biology. Using a Likert-type scale ranging from 1 (Strongly Disagree), 2 (Disagree), 3(Not Sure), 4 (Agree) and 5 (Strongly Agree), teachers were required to respond to five statements assessing their attitudes towards teaching and learning of Biology before and after undergoing SMASSE INSET.

Table 16 shows the distribution of teachers' responses to the statements assessing their attitudes by percentages on each and every level of the scale per item and the mean score on each of the statements.

Table 16

Teachers' Responses on Teaching of Biology

N = 45

Statements	**Teachers' Responses (%)**					
	SD	**D**	**NS**	**A**	**SA**	**Means**
1. Before undergoing SMASSE INSET, Biology was easy to teach.	22.2	11.1	11.1	55.6	0	3.00
2. After undergoing SMASSE INSET, Biology is now easy to teach.	11.1	0	0	33.3	55.6	4.22
3. Before undergoing SMASSE INSET, teaching of Biology was interesting.	0	11.1	33.3	55.6	0	3.44
4. After undergoing SMASSE INSET, teaching of Biology is now interesting.	0	0	11.1	44.4	44.4	4.33
5. SMASSE INSET has improved my attitude towards teaching of Biology.	0	11.1	11.1	0	77.8	4.44

Results from Table 16 show that ease of teaching Biology has a mean of 3.00 before SMASSE INSET and a mean of 4.22 after SMASSE INSET. This implies that teachers were not sure of level of ease of Biology teaching before SMASSE INSET but they do agree that after SMASSE INSET, teaching of Biology is easy. Interest of teaching Biology has a mean of 3.44 before SMASSE INSET and a mean of 4.33 after SMASSE INSET. The interpretation is that teachers were not sure of their level of interest of teaching Biology before SMASSE INSET but after SMASSE INSET, they agree that teaching of Biology is interesting. Teachers generally agree that SMASSE INSET has improved their attitude towards teaching and learning of Biology (mean = 4.44).

The individual statement scores were summed up to form an attitude score for each respondent before and after SMASSE INSET. The scores varied between 5, indicating the least level of attitude, and 25, indicating the highest level of attitude towards teaching Biology. The higher the score, the higher was the level of attitude towards teaching Biology and vice versa. The scores were later collapsed into three ordinal categories in order to differentiate between the levels of attitude among the sampled respondents. This included a mean score below 15 meaning negative attitude, a score of 15 meaning neutral attitude and a score above 15 meaning a positive attitude. Table 17 summarizes the levels of attitude towards teaching Biology before and after SMASSE INSET.

Table 17

Levels of attitude towards teaching Biology Before and After SMASSE INSET.

N = 45

Group	Levels of Attitude	Frequency	Percentage
Before SMASSE INSET	Negative	15	33.3
	Neutral	5	11.1
	Positive	25	55.6
	Total	45	100
After SMASSE INSET	Negative	5	11.1
	Neutral	0	0
	Positive	40	88.9
	Total	45	100

Results from Table 17 indicate that 55.6% of the respondents recorded a positive attitude towards teaching Biology before SMASSE INSET, 33.3% had negative attitudes and 11.1% neutral attitudes. After SMASSE INSET, 88.9% of the teachers indicated positive attitude towards Biology teaching, 11.1% recorded negative attitudes while none had neutral attitude. The results imply that teachers have more positive attitudes towards Biology teaching after SMASSE INSET.

Paired samples t-test was used to establish whether there was any significant difference in attitudes of the teachers before and after undergoing SMASSE INSET. Paired samples t-test was used to compare the means of the same subjects in two occasions (before and after undergoing SMASSE INSET). For it to be used, the grouping variable: the two occasions (before and after undergoing SMASSE INSET) was a nominal variable, while the test variable, that is, attitude index score was an interval variable measured in actual scores. Table 18 summarizes the output of paired samples t-test.

Table 18

Paired Samples T-test of Attitude score Before and After SMASSE INSET

Occasion	**N**	**Mean Score**	**Std. Dev**	**t-value**	**df**	**p-value**
Before SMASSE INSET	45	3.00	1.261	-10.319	44	0.000
After SMASSE INSET	45	4.22	1.241			

Results from Table 18 show that the difference between the means of the two conditions is 1.222. The t-value for the difference between the sample means is -10.319 with an exact 2-tailed significance level of 0.000. Since the p-value (0.000) of the t-value is less than 0.05 alpha-level [$t(45) = -10.319$, $p < 0.05$], the t-value computed is significant. This implies that the null hypothesis is rejected since mean difference is significant. Therefore, there is a statistically significant difference between teachers' attitudes towards Biology before and after SMASSE INSET. The teachers have positive attitudes towards teaching Biology after SMASSE INSET.

The last item on this objective asked teachers to indicate their general level of agreement on whether SMASSE INSET has improved their attitudes towards Biology. They were to indicate whether they Strongly Disagreed (SD), Disagreed (D), Not Sure (NS), Agreed (A) or Strongly Agreed (SA) that SMASSE INSET improved their attitudes towards Biology. Their responses, frequencies and percentages are presented in table 19.

Table 19

Level of Agreement on whether SMASSE INSET has improved Teachers' Attitudes towards Biology

N =50

Response	Frequency	Percentage
Strongly Disagree (SD)	0	0
Disagree (D)	6	12
Not Sure (NS)	6	12
Agree (A)	0	0
Strongly Agree (SA)	38	76

Results from Table 19 indicate that 76% of the teachers strongly agreed that SMASSE INSET improved their attitude towards Biology, 12% disagreed and 12% were not sure. This indicates that teachers generally agree that SMASSE INSET has improved their attitudes towards Biology. They now view Biology as being more easy and interesting to teach. Figure 9 shows a presentation of this information on a bar graph.

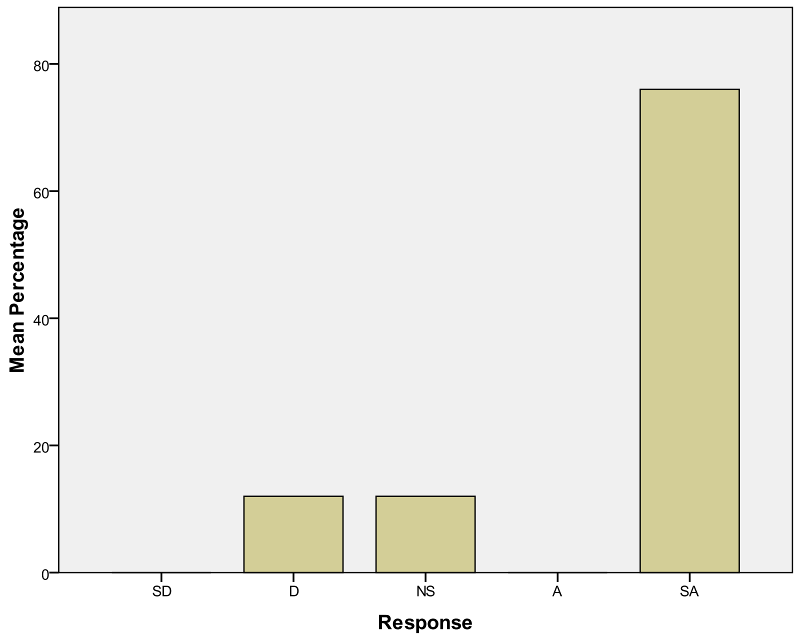

Figure 9: Bar Graph showing Level of Agreement on whether SMASSE INSET has improved Teachers' Attitudes towards Biology

Figure 9 shows that a high percentage of teachers (76%) strongly agree that SMASSE INSET has improved their attitude towards Biology, 12% disagree and 12% are not sure. There are no responses for 'Strongly Disagree' and 'Agree'. This suggests that majority of teachers perceive that SMASSE INSET has improved their attitudes toward Biology teaching.

4.7. Discussion of Results

This section discusses the results obtained under each objective.

4.7.1. Effect of SMASSE INSET on Frequency of Class Experiments organised by Biology Teachers

The results of this study indicate that SMASSE INSET has increased the frequency of class experiments organised by Biology teachers. Seventy percent (70%) of teachers under study indicated that they rarely organised class experiments before undergoing SMASSE INSET. However, 80% of the teachers indicated that they do frequently organise class experiments after SMASSE INSET. This means that they largely taught Biology theoretically before the SMASSE INSET but now largely use practical activities. SMASSE INSET has therefore enabled teachers to appreciate the significance of class experiments and equipped them with necessary skills in organising the experiments.

The finding is in agreement with Benard and Benard (2005). They assert that use of experiments as teaching tools in the classroom has been steadily increasing over the past two decades since their pedagogical advantages have become more apparent. Becker (2000) posits that the primary advantage of experiments is their ability to get the students to be actively involved in the class and in the learning process. According to Kagete and Nthiga (2006), practical work is an essential component of science and vocational subjects. Mwangi and Wachanga (2004) emphasise that teaching methods that allow students to use all their senses also enhance effective learning and students' achievement. They mention this in support of experiment teaching method.

These findings are also in line with the baseline survey conducted by SMASSE Project in 1998 (SMASSE, 1999). The survey established that Science and Mathematics teachers taught the subjects theoretically before SMASSE INSET. In this study only 30% of the teachers indicated that they frequently organised class experiments before undergoing SMASSE INSET. The findings further agree with the findings of a study carried out by CEMASTEA on the extent of ASEI-PDSI in schools (CEMASTEA, 2009). The study revealed that 80.2% of science and mathematics teachers often used practical activities to teach concepts after undergoing SMASSE INSET.

Majority of teachers (80%) believed that Biology cannot always be taught using practical activities. Only 20% believed that Biology teaching can always be done through practical work. This finding is in consonance with SMASSE baseline survey finding in which Biology, like other sciences, was found to be largely taught theoretically (SMASSE, 1999). According to Mwirigi (2011), the largest proportion of Biology teachers still uses the conventional lecture method while teaching Biology. Thirty percent (30%) of them indicated limited resources as the main hindrance to practical activities in Biology.

According to them, teaching and learning resources are scarce in school laboratories and the school environments are not richly endowed with the necessary resources. However, KNEC sets examinations with an assumption that the equipment, apparatus and chemicals have been sufficiently provided and that the learners have been exposed to them (Kagete & Nthiga, 2006). The limitation of the resources is aggravated by the increased enrolment in schools occasioned by the introduction of the Free Day Secondary Education in Kenya in 2006.

Twenty two point five percent (22.5%) of them indicated that organisation of practical activities is time consuming. They argued that setting and executing a practical lesson requires a lot of time which is usually limited, given the large syllabus to be covered. Coupled with too many lessons that they handle (12.5%), the teachers implied that time is a very constraining factor. This finding is supported by CEMASTEA (2010) finding in which teachers cited heavy workload and overloaded syllabi as some of the problems that hinder them from carrying out class experiments.

Fifteen percent (15%) reported the high expenses involved. Acquisition of most teaching and learning resources require a lot of expense normally not affordable by most schools. In the absence of these resources, therefore, the teachers can only teach the subject theoretically. Nwoji (1999) carried out a study on availability and adequacy of teaching and learning resources in Nigerian secondary schools. It revealed that schools lack most essential facilities and resources. Improvisation of resources has been suggested as a panacea to scarcity of resources for practical activities (Kibe et al, 2008). However, 2.5% of the teachers studied still indicated inability to improvise as a hindrance. This finding agrees with Abiona and Olagunju (2008) study which was carried out to investigate production and utilization of resources in Biology education. The finding revealed that less than average number of teachers improvises resources. Some resources, like the microscope, are not improvisable by the teachers. This finding is corroborated by a study by CEMASTEA (2009) which sought to identify factors that hinder implementation of ASEI-PDSI in schools. Lack of skills to improvise teaching and learning resources was reported as a major challenge to teachers seeking to implement ASEI-PDSI.

Ten percent (10%) of the teachers indicated cumbersome preparation as the reason for not always teaching Biology using practical activities. According to them, planning and organisation of practical lessons is cumbersome and tedious. This is especially so for majority of schools without laboratory technicians or assistants. Five percent of teachers studied felt that some concepts in Biology are too abstract to be taught practically. They seemed to insinuate that such concepts are not even applicable to real life situations. However, Okeke (1990) urges teachers to improvise their own teaching resources in order to teach effectively. This factor points to poor attitudes of the teachers towards some areas of the subject as opposed to the expectations of the SMASSE Project. According to SMASSE Project (1999), SMASSE INSET aimed at demystification of mathematics and sciences in secondary schools.

Lastly, 2.5% of teachers under study indicated absenteesm of students as a factor hindering practical teaching of Biology. This finding is supported by CEMASTEA (2009) study which investigated factors hindering the implementation of ASEI-PDSI in schools. In the study, science teachers indicated non-consistency in class as a factor hindering implementation of ASEI-PDSI. The teachers felt that linking the lessons with previously learnt concepts becomes a problem in this case. Practical lessons become particularly difficult without learning consistency since practical activities should be based upon some prior knowledge.

4.7.2. Effect of SMASSE INSET on Effectiveness of Class Experiments Organised by Biology Teachers

The results of the study indicate that effectiveness of class experiments organised by Biology teachers has improved after SMASSE INSET. Before undergoing SMASSE INSET, 30% rated their preparation before practical as effective and 20% rated themselves ineffective. On the other hand, after undergoing SMASSE INSET, 80% rated their preparation as effective while none rated themselves as ineffective. On trying out activities before the actual practical, 30% of the teachers rated their abilities as effective before undergoing SMASSE INSET and 20% rated their skills as ineffective. However, after SMASSE INSET, 80% rated themselves as effective while none rated their skills as ineffective. According to CEMASTEA (2010) and Okere (1996), teachers need to try out the experiments before involving students.

On giving of clear instructions to learners, 50% rated their skills as effective before SMASSE INSET whereas 30% rated their skills as ineffective. After SMASSE INSET, 90% indicated effective. None of the teachers indicated ineffective on this aspect. According to Kagete and Nthiga (2006), the learner is expected to know the requisite apparatus and procedures before carrying out the experiments. This argument is reinforced by Okere (1996) where giving of clear instructions to students has been indicated as being very important before they carry out experiments Thirteen percent (13%) of the teachers rated themselves effective on their abilities to offer proper guidance and supervision of the learners during the practical before undergoing SMASSE INSET. On the same aspect, before SMASSE INSET, 10% of the teachers indicated ineffective. However, after undergoing SMASSE INSET, it was 100% for effective.

On making of group sizes with suitable composition, 25% of the teachers responded with effective before SMASSE INSET while 20% responded with ineffective. However, 90% responded with effective after SMASSE INSET and none responded with ineffective. Sixty percent (60%) of the teachers rated themselves effective in briefing the students on precautions to be taken to avoid accidents before SMASSE INSET and only 10% responded with ineffective. After SMASSE INSET, all the teachers under study (100%) rated themselves effective on this aspect.

The last aspect was the ability of the teachers to establish link/bridge between the practical work and the concept to be learnt. Okere (1996) emphasizes that teachers need to bridge the practical activities with the concepts and theories to be learnt. Fifty percent of the teachers indicated effective before SMASSE INSET and 20% indicated ineffective. All the teachers indicated effective after SMASSE INSET. In all the seven aspects, there are zero scores for ineffective and very ineffective abilities after SMASSE INSET.

4.7.3. Effect of SMASSE INSET on the use of Improvised Teaching and Learning Resources by Biology Teachers

The results of the study indicate that SMASSE INSET has increased the use of improvised teaching and learning resources by Biology teachers. The results also revealed that most schools do not possess adequate teaching and learning resources. This study is in agreement with an empirical study carried out by Nwoji (1999) to establish the availability and adequacy of teaching and learning resources in Nigerian secondary schools. The study revealed that teaching and learning resources are adequately available in schools.This finding is also reinforced by CEMASTEA (2009) in which teachers mentioned inadequate teaching and learning resources as a challenge to ASEI-PDSI implementation. Practical teaching of Biology is dependent upon availability and adequacy of teaching and learning resources.

It was evident that a number of teaching and learning resources have been improvised by the teachers after undergoing SMASSE INSET. Abiona and Olagunju (2008) conducted a study aimed at investigating production and utilisation resources in Biology education. Forty four point seven percent (44.7%) of the teachers studied indicated that they produce Biology teaching and learning resources by themselves. They also established that 74.7% of the teachers do improvise materials from available materials in the local environment. In the current study, improvisation of resources has been seen as a panacea to inadequacy of resources and the impact of SMASSE INSET on teachers' abilities to improvise investigated. A total of 13 improvised resources were listed as having been improvised by teachers since undergoing SMASSE INSET. They include models of the heart, eye, and chest cavity. More complex models like xylem vessels, cockroach, nerve cell and erector pili muscles were less frequently improvised. They were only listed once each by the respondents.

The number of resources improvised by the Biology teachers tremendously increased after SMASSE INSET. This shows that there was very little improvisation of resources by teachers before SMASSE INSET. This finding is in agreement with the findings of the baseline survey conducted by SMASSE Project (SMASSE, 1999). According to the survey, teachers mainly relied on the conventional teaching and learning resources. In the absence of these resources, as is the case in most schools in Nigeria (Nwoji, 1999), teachers resorted to theoretical teaching of mathematics and sciences. Abiona and Olagunju (2008) in their study established that few teachers use microscopes, magnifying lenses, preserved specimens, models, quadrats and aquaria. A study by CEMASTEA (2004) established that 59.4% of SMASSE trained teachers often improvised teaching and learning materials while 7.0% rarely improvised the same.

It seems the teachers only endeavoured to improvise resources in cases where the conventional resources lacked. This argument is in line with the findings of CEMASTEA (2009). In the study, only 33.6% of the teachers under study indicated that they often improvised teaching and learning resources even when conventional materials were available while 28.7% rarely improvised whenever conventional resources were available. Improvisation of teaching and learning resources, however, should be done by teachers even in availability of the conventional materials. Asokhia (2009) emphasises that improvisation tends towards naturalness and helps to make learners vibrant in class. He therefore urges for improvisation even when conventional materials are available. Okeke (1990) urges teachers to produce their own teaching aids in order to teach effectively. He discourages overreliance on conventional teaching and learning resources. Inability or unwillingness to improvise science teaching apparatus has been indicated as a constraint on the teaching of science in Africa (Tsuma, 1998). He stresses that improvisation of equipment develops in students manipulative skills, focusing their attention on the value of local materials and of conserving or recycling materials.

From the results, there is a significant increase in frequency of use of improvised resources in Biology lessons after SMASSE INSET. For majority of teachers, therefore, SMASSE INSET has improved their abilities to use improvised teaching and learning resources. Abiona and Olagunju (2008) hint that issues which could aid adequate training of teachers in production and utilization of Biology resources should be highlighted in teacher education curricula. This would help in building teachers’ capacities to improvise teaching and learning resources.

A significant 37.5% of the teachers, however, indicated that they only teach few lessons using improvised teaching and learning resources. In a study by CEMASTEA (2009), improvisation was lacking in 51.4% of the lessons observed while in only 18% of the lessons was improvisation done to satisfactory and above extents. In the same study, adequacy of improvisation to satisfactory and above extents was only 11.1% and contribution of the improvised materials in achieving the objective of the lesson was only 19.5%.

4.7.4. Extent of Use of Student-Centred Teaching Approaches by SMASSE trained Biology Teachers

The results of this study have shown that SMASSE trained Biology teachers use student-centred teaching approaches to a great extent. Mwirigi (2011) indicates teaching methods applied by teachers as one of the key factors that influence performance in Biology in Kenyan secondary schools. He postulates that teaching methods used by majority of teachers do not elicit satisfactory learner participation in classrooms. After experimenting with different teaching methodologies, Reis (2000) records that students prefer active learning in classes to lectures. He contends that lecturing for the entire class period is one of the least effective teaching methods since students are only passively involved. According to Njuguna (1998), involvement of students in group work is an important aspect of ASEI-PDSI. A high percentage of students studied indicated often involvement on the aspects of student-centred teaching strategies used in this study. Students were often involved in group discussions, asked questions by their teachers, given opportunities to ask questions, given assignments and the assignments often marked and returned to the students.

According to CEMASTEA (2009), failure of teachers to mark assignments is one reason for students' dislike for mathematics and sciences. However, some learner-centred teaching approaches such as class discussion (Cantor, 1946; Okere, 1996) have not been well embraced by the Biology teachers. Zimmerman (1990) and Claxton (1996) assert that the learning process should be organised in such a way that students take responsibility for their own learning. They should be independent and able to make decisions about their learning and then plan accordingly.

In a related study (CEMASTEA, 2009), 85.6% of teachers under study indicated that they involved students in group work. A great majority of the students under study indicated that their teachers often ask questions in class. This is in agreement with the CEMASTEA study where in Biology lessons observed, 72.3% of questions asked by teachers were at satisfactory and above extents. In the same CEMASTEA study, in 92% of the lessons observed, teachers encouraged their learners to ask questions. In a study by Keraro *et al* (2007) conducted to determine the effects of cooperative concept mapping teaching approach on students' motivation, cooperative learning was found to be more effective than individualistic competitive learning. The study was

Ninety four point seven percent (94.7%) of the students indicated that they rarely, very rarely or have never gone for field excursions in Biology. This shows that teachers do not use this teaching method regularly. This is probably due to high costs involved and a lot of time required in planning for field excursions. On this aspect of student-centred teaching, therefore, SMASSE INSET has not succeeded in increasing its frequency of use. The high percentage for often and very often indicates that teachers make good effort in paying attention to students' individual differences. Learning of mathematics and sciences is more enjoyably to students when teachers pay attention to learners' individual differences (CEMASTEA, 2009).

Forty one point two percent (41.2%) of students have not found opportunity to plan for experiments and 26% rarely do. It is, therefore, evident that teachers do not usually grant their students opportunity to plan for experiments. On suggestion of improvements to be made on experiments to obtain better results, 83.3% of students agreed they often give suggestions. According to Kagete and Nthiga (2006), the learner should be able to devise techniques, plan, investigate, observe changes and make conclusions in each practical activity. Bergstrom and Miller (2000) explain that experiments have abilities to enable students answer questions on their own. Eight point four percent (8.4%) were rarely involved while 8.3% were never involved at all. This shows that students usually suggest improvements on experiments. Mwirigi (2011) points out that authoritarian and impersonal teacher-student interaction in class could be the major factor that contributes to negative attitude of the students towards learning of Biology. He emphasises that teaching approaches employed by teachers should be democratic enough so as to allow room for learners to make suggestions for improvement.

A mean score of 2.817 shows that, on average, students' rated their involvement in class discussions as fair. This implies that the class discussions are not as learner-centred as they ought to be. Teachers still exercise a lot of control in these discussions. For 8.3% of students under study, they are never involved in any way in class discussions. This could mean that the discussions are never there at all or, if there, they are totally teacher-centred with students only being spectators. This is in concurrence with CEMASTEA (2009) findings in which out of 16 Biology lessons observed students' involvement in discussion at satisfactory and above extents was 40.3%. There is also an indication of very low involvement of students in class experiments (Mean score = 2.500). In as much as the experiments are carried out, they are largely teacher-centred and the students play very minimal role.

Majority of students (60%) indicated that, in overall, students' level of class participation was good. Fifteen percent (15%) of the students, however, cited that their class participation remained poor. This implies that on average, SMASSE trained Biology teachers involve students in their lessons to a good level. This is in agreement with CEMASTEA (2009) finding in which in the lessons observed, active participation by all the students at satisfactory and above was 55.6%. Results of a study cited by McNergney and Keller (1999) revealed that effective teachers pay attention to students' progress and actively involve them in learning activities. The study was carried out among pre-service teacher trainees and was meant to establish the qualities of effective teachers. According to them, students do take their learning to higher levels and become actively engaged when given opportunity to be creative. Reis (2000) indicates that most effective teaching methods involve active participation by students during class period.

Topping the list of the suggested aspects that need to be improved is the need to organise more field trips. Field trips offer the learners learning environments different from classroom situations. According to Pierce and Lorber (1977), the logical extension of bringing part of the world into the classroom is by taking the class into the ‘real’ world. Planning and implementation of field trips require a lot of time and resources. It is probably due to these reasons that teachers find it difficult to use as a teaching and learning methodology.

Exposure to more experiments was suggested by 21.05% of the students as an aspect that can improve teaching and learning of Biology. Teachers usually avoid exposing students to more experiments due to several reasons, some of which are discussed in section 4.2 of this report. This is in consonance with Okere (1996) which explains that class experiments are expensive in terms of materials and equipment and time consuming in preparation and implementation. It is, however, evident from the results that students seriously require experiments in their learning of Biology. According to Becker (2005), experiments have a pedagogical advantage of getting students to be actively involved in class and the learning process. In CEMASTEA (2009) findings, students indicated that they enjoy mathematics and sciences when they are involved in practical activities. It therefore means that majority of students do not enjoy Biology lessons since teachers do not always organise class experiments. In the same study, majority of students responded that practical activities were very rare or done once a week. In some schools students cited that in Biology, only the dichotomous key and germination of seeds was done practically.

The percentage of students who suggested increasing of laboratory equipment as a way of improving teaching and learning of Biology was 13.93%. This is based on the understanding that without adequate laboratory equipment, class experiments cannot be regularly and effectively organised. This agrees with a study by Nwoji (1999) which revealed that essential teaching and learning facilities and resources are not available in schools. The easiest remedy to this is improvisation of the teaching and learning resources. However, some resources are not improvisable and, moreover, teachers rarely possess improvisation skills (CEMASTEA, 2009). Inability or unwillingness to improvise science teaching apparatus has been indicated as a constraint on the teaching of science in Africa (Tsuma, 1998).

Sixteen point one percent 16.1%) of the students suggested organisation of more group work as an aspect that can improve teaching and learning of Biology. According to these students, fellow students can explain some concepts better than a teacher by use of a language that the others understand better. This is corroborated by the findings of the study by CEMASTEA (2009) in which students showed a lot of preference to group work in learning of mathematics and science subjects. In the study students taking mathematics and sciences were asked to give learning strategies they liked and those they disliked.

In experiments by Reis (2000), 73% of 111 students surveyed preferred teamwork assignments over individual assignments. The students believed that working homework problems in teams provided a better learning environment and better prepared them for work in industry. In the same survey, 72% of students preferred teamwork in solving in-class problems. The experiments were carried out with various teaching methodologies to establish their effectiveness. In a study by Mwangi and Wachanga (2004), cooperative experiment teaching method yielded higher achievement in chemistry than regular methods. This approach involved students working together in groups with common goals to achieve. Because students tutor one another in cooperative learning, they are likely to acquire greater mastery of the material than in the common individual study.

In a study by Keraro *et al* (2007), cooperative learning approach yielded higher student motivation than the regular teaching approaches. The study was carried out to determine the effects of cooperative concept mapping teaching approach on secondary school students' motivation in Biology. According to them, when students explain and receive explanation from one another in their group, new concepts are retained in memory and related to concepts already in memory. In the current study, group work is seen as a form of cooperative learning that yields higher student motivation hence improves academic performance. Current research in the cognitive sciences supports the idea that most students will learn best when they are actively engaged in working together to understand a concept (Bransford, Brown & Cocking, 2000).

4.7.5. Effect of SMASSE INSET on the Attitudes of Biology Teachers towards Biology

The results of the study have indicated that SMASSE INSET has improved teachers' attitudes towards teaching Biology. There is a statistically significant mean difference between attitudes of teachers towards Biology before and after SMASSE INSET tested at 95% confidence level. The null hypothesis was therefore rejected. The teachers' have more positive attitudes towards Biology after SMASSE INSET with respect to ease and interest of teaching Biology.

This is in consonance with Salend (1984) who asserts that in-service teacher education improves teachers' attitudes towards their learners and the subject matter. The teachers were able to understand better their subject matter after SMASSE INSET and this improved their attitudes towards the subject. Mwirigi (2011) indicates teacher attitudes as one of the key factors that influence performance in Biology in Kenya. He also indicates that career dissatisfaction results in negative teacher attitude towards the students. Oylum (2010) carried out a study to investigate teachers' burnout levels and their attitudes towards teaching profession. The study revealed that teachers' attitudes towards the subject, school, teaching and their burnout levels have an influence on students' learning and attitudes towards discipline and school.The study also established that teachers' attitudes towards teaching profession were high.

With teachers' positive attitudes, students can obtain high academic achievement in Biology. Igwe (2002) stipulates that for teaching and learning of science to be interesting and stimulating, there has to be motivation on the part of both the teacher and the learner so as to ensure the development of positive attitudes and subsequently maximum academic achievement. In the same vein, Yara (2009) reported in one of his findings that teachers' attitude towards science is a significant predictor of pupils' science achievement as well as their attitude. Also Igwe (1985) showed that the effect of teachers' attitudes to mathematics was stronger on the students' mathematical achievement than on their attitudes. He carried out a study on causes and implications of poor performance in chemistry. In the current study, poor attitude of the teacher towards Biology has been viewed as a cause of low achievement by the students and SMASSE INSET found to improve the teachers' attitudes towards Biology.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter presents the summary of findings of the study, draws conclusions from the findings and gives recommendations based on the findings. Section one gives the summary of findings and section two the conclusions of the findings. Section three presents the recommendations that were made from the findings while the last section gives suggestions for further research to be conducted on SMASSE INSET, teachers' pedagogical skills and attitudes towards the subjects they teach.

5.2. Summary of Findings

The main purpose of this study was to investigate the effect of SMASSE INSET on the Biology teachers' pedagogical skills and attitudes towards teaching Biology in Rachuonyo South district. Results showed that SMASSE INSET has improved the Biology teachers' pedagogical skills and attitudes towards teaching Biology.

The study established that SMASSE INSET has increased the frequency of class experiments organised by Biology teachers. Seventy percent (70%) of the teachers under study indicated that they rarely organised class experiments before undergoing SMASSE INSET. However, after undergoing SMASSE INSET, 80% of the teachers indicated that they now frequently organise class experiments. The mean score of 4.000 shows that, on average, Biology teachers frequently organise class experiments after SMASSE INSET.

The results have shown that effectiveness of class experiments has improved afte SMASSE INSET. The aspects of experimental planning and execution used in this study revealed improvement in effectiveness of class experiments organised by Biology teachers after SMASSE INSET. Before the INSET, teachers indicated that the class experiments organised were only slightly effective (mean = 3.371) while after the INSET, the class experiments organised are now very effective (mean = 4.600).

The study has established that SMASSE INSET has increased the use of improvised teaching and learning resources by Biology teachers. All teachers reported that before SMASSE INSET, they taught few weekly lessons using improvised teaching and learning resources. However, after undergoing SMASSE INSET, 62.5% of teachers reported they teach many weekly lessons using improvised teaching and learning resources. The number of teaching and learning resources improvised by the Biology teachers increased after SMASSE INSET. Before SMASSE INSET, only 10% of teachers indicated they improvised many teaching and learning resources while, after SMASSE INSET, 64% of the teachers improvised many teaching and learning resources.

SMASSE trained Biology teachers use student-centred teaching approaches. An aggregate mean of 3.590 implies that students are often involved in the teaching and learning process. However, certain aspects of students' participation, especially field trips, were still very weak and irregular. In some student-centred approaches, like class experiments and discussions, the extent of students' involvement was found to be inadequate even though frequencies were either average or good.

The mean difference in teachers' attitudes towards teaching Biology before and after SMASSE INSET is significant. There is therefore a statistically significant difference between teachers' attitudes towards Biology before and after undergoing SMASSE INSET. Teachers have positive attitudes towards Biology after SMASSE INSET.

5.3. Conclusions

i. SMASSE INSET has increased the frequency of class experiments organised by Biology teachers. Biology teachers frequently organise class experiments after SMASSE INSET whereas they rarely organised class experiments before SMASSE INSET.

ii. SMASSE INSET has improved the effectiveness of class experiments organised by Biology teachers. The class experiments organised by Biology teachers are now very effective whereas the experiments were slightly effective before

SMASSE INSET. SMASSE INSET has equipped the Biology teachers with better skills in planning and executing class experiments.

iii. SMASSE INSET has increased the use of improvised teaching and learning resources. SMASSE trained Biology teachers use improvised teaching and learning resources better and more frequently. The number of resources improvised by Biology teachers after SMASSE INSET has increased tremendously. The number of weekly lessons taught by Biology teachers also increased after SMASSE INSET.

iv. SMASSE trained Biology teachers use student-centred teaching approaches. SMASSE trained Biology teachers scored well on aspects of students' participation such as giving of assignments, asking of questions and responsiveness to individual differences. However, students were not satisfactorily involved in aspects such as field trips, group discussions and experiments.

v. Biology teachers' attitudes towards teaching of Biology has improved after SMASSE INSET. The t-test revealed significant statistical differences in the means of attitudes of teachers before and after SMASSE INSET. SMASSE trained Biology teachers, therefore, have more positive attitudes toward teaching Biology than before SMASSE INSET.

5.4. Recommendations

Based on the findings of this study, the researcher made the following recommendations that could be implemented to improve the SMASSE INSET and the practice of ASEI-PDSI in schools:

i. The MoE and JICA need to solicit more funding necessary for sustaining SMASSE INSET and mainstreaming it as an in-service teacher education programme for practicing science and mathematics teachers. The practice of

ASEI-PDSI should be infused into pre-service teacher education curricula so that trainee teachers understand the principles before recruitment as teachers.

ii. The school administrators and quality assurance officers should regularly carry out supervision in schools to ensure that ASEI-PDSI principles are implemented. They should be inducted on the practice of ASEI-PDSI so as to carry out effective supervision of its implementation.

iii. The MoE should promote teachers who attend SMASSE INSET and implement the practice of ASEI-PDSI. This will be a motivating factor for attendance and implementation.

iv. All mathematics and science teachers should be encouraged to attend all SMASSE INSET cycles and other future INSETs by the school administrators. The administrators should also ensure that newly recruited science and mathematics teachers are fully inducted to the practice of ASEI-PDSI.

v. The schools should be able to provide facilities and resources necessary for the implementation of ASEI-PDSI. The teachers should also make efforts to carry out more improvisation of teaching and learning resources given that the resources are usually inadequate in schools and ASEI-PDSI is a resource-based approach.

vi. The teachers should use varied student-centred teaching approaches in their lessons to make learning more participatory and expose students to learning environments other than the classroom.

5.5. Suggestions for Further Research

In this study some factors have not been properly accounted for due to its scope. It is therefore suggested that further research should be done on some topics related to this one. In this view, the following are recommended for further research in the area of teacher education, SMASSE INSET, pedagogical skills and attitudes of teachers:

i. Whether teachers' pre-service qualification levels (diploma or degree) influence their pedagogical skills and attitudes towards the subjects they teach.

ii. The effect of teachers' workloads on implementation of ASEI-PDSI.

iii. The influence of teachers' teaching experience on attendance of SMASSE INSET and implementation of ASEI-PDSI.

iv. The relationship between teachers' pedagogical skills and attitudes towards the subject taught.

v. The influence of level of subject mastery on pedagogical skills and attitudes of teachers towards the subject.

vi. Teachers' attitudes towards SMASSE INSET in particular and INSETs in general.

vii. Whether class sizes influence implementation of ASEI-PDSI in schools.

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APPENDIX A

Biology Teachers' Questionnaire (BTQ)

Introduction

I am Joseph O. Abong'o, a postgraduate student at Egerton University. The purpose of this questionnaire is to collect data used to examine the effect of SMASSE in-service education and training on attitudes and pedagogical skills of Biology teachers. The information required by this questionnaire shall purely be used for research purposes. Your response is voluntary and shall strictly remain confidential. You are requested to be as truthful and objective as possible. Fill in all the blank spaces or use a tick (√) in the parentheses.

A. Frequency of Class Experiments.

1. Before undergoing SMASSE INSET, how often did you organise class experiments?

1. Very Rarely ( ) 2.Rarely ( )
3. Not Sure ( ) 4.Frequently ( )
5. Very Frequently ( )

2. After undergoing SMASSE INET, how often do you now organise class experiments?

1. Very Rarely ( ) 2.Rarely ( )
3. Not sure ( ) 4.Frequently ( )
5. Very Frequently ( )

3. In your own opinion, can Biology be always taught by practical work? If no, what are some of the factors that hinder practical activities in teaching of subject?

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B. Effectiveness of Class Experiments.

Please consider each of the following statements and indicate the response that reflects the effectiveness of class experiments you organised BEFORE and AFTER undergoing

SMASSE INSET. Write the appropriate numbers in the parentheses that follow every statement using the following scale:

Very ineffective (1) Ineffective (2) Slightly effective (3) Effective (4) Very effective (5)

	BEFORE	AFTER
1. Preparation before the practical period	( )	( )
2. Trying out activities before the practical to ensure materials used will give expected results	( )	( )
3. Giving of clear instructions to learners	( )	( )
4. Proper guidance and supervision of the learners by the teacher during the practical	( )	( )
5. Making good group sizes with suitable composition	( )	( )
6. Briefing the students on any precautions to be taken to ensure the safety of the students and equipment	( )	( )
7. The ability of the teacher to establish link/bridge between the practical work and the concept to be learnt	( )	( )

C. Use of Improvised Teaching and Learning Resources.

1. Indicate the degree of adequacy of Biology teaching/learning resources in your school using the rating scale below:

1. Very inadequate ( ) 2. Inadequate ( ) 3. Average ( )
4.Adequate ( ) 5. Very Adequate ( )

2. How many improvised learning resources did you have in the school laboratory before undergoing SMASSE INSET?

1. None ( ) 2.Very Few ( ) 3. Few ( )
4. Many ( ) 5. Very Many ( )

3. How many improvised learning resources do you now have in the school laboratory after undergoing SMASSE INSET?

1. None ( ) 2.Very Few ( ) Few ( )
4. Many ( ) 5. Very Many ( )

4. List any three teaching/learning resources you have improvised after SMASSE INSET.

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5. Before undergoing SMASSE INSET, how many weekly lessons did you teach with improvised resources?

1. None ( ) 2.Very Few ( ) 3. Few ( )
4. Many ( ) 5. All ( )

6. After undergoing SMASSE INSET, how many weekly lessons do you now teach with improvised resources?

1. None ( ) 2.Very Few ( ) 3. Few ( )
4. Many ( ) 5. All ( )

D. Teacher's attitude towards teaching/learning of Biology

Please consider the following statements and indicate your level of agreement with them using the scale provided. Write the number indicating your level of agreement inside the parenthesis after the statement.

Strongly Disagree (1) Disagree (2) Not Sure (3) Agree (4) Strongly Agree (5)

1. Before undergoing SMASSE INSET, Biology was easy to teach. ( )
2. After undergoing SMASSE INSET, Biology is now easy to teach. ( )
3. Before undergoing SMASSE INSET, teaching of Biology was interesting. ( )
4. After undergoing SMASSE INSET, teaching of Biology is now interesting. ( )
5. SMASSE INSET has improved your attitude towards teaching of Biology. ( )

THANK YOU FOR PARTICIPATING

APPENDIX B

Biology Students' Questionnaire (BSQ)

Introduction

I am Joseph O. Abong'o, a postgraduate student at Egerton University. The purpose of this questionnaire is to collect data used to examine the effect of SMASSE in-service education and training on attitudes and pedagogical skills of Biology teachers. The information required by this questionnaire shall only be used for academic research purposes. Your response is voluntary and shall strictly remain confidential. You are therefore required to be as truthful and objective as possible in your responses. Attempt all the questions by filling in blank spaces or by use of a tick (√) in the boxes and parentheses.

A. General Information.

Form: ______________ Stream: __________ (Whenever applicable)

Gender: Male ☐ Female ☐

B. Class Participation

1. Please consider each of the following questions and indicate the response that reflects your opinion about level of participation in class by writing the appropriate number in the parenthesis that follows every statement using the following scale:

Not At All (1) Very Rarely (2) Rarely (3) Often (4) Very Often (5)

i. How often do you work in groups during Biology lessons? ( )
ii. How often does your Biology teacher ask questions in class? ( )
iii. How often do students get opportunity to ask questions in class during Biology lessons? ( )
iv. How frequent does your Biology teacher give assignments? ( )
v. Are the assignments marked and returned in time? ( )
vi. How frequent do you have class discussions? ( )
vii. Does the teacher allow for different opinions during class discussions? ( )
viii. How frequent are experiments organised in Biology? ( )
ix. Do you ever go for Biology field excursions? ( )

x. Does the Biology teacher ever deal with the students individually? (   )

xi. Are students given opportunity to plan for experiments? (   )

xii. Do you suggest improvements to be made in experiments in order to get better results? (   )

2. How much do you enjoy Biology lessons?

1. Not At All (   ) 2.Slightly (   )
3. Fairly (   ) 4.Much (   )
5. Very Much (   )

3. How much do you enjoy group work during Biology lessons?

1. Not At All (   ) 2. Slightly (   )
3. Fairly (   ) 4. Much (   )
5. Very Much (   )

4. To what extent do students get involved in class discussions?

1. Not At All (   ) 2.Slightly (   )
3. Fairly (   ) 4.Much (   )
5. Very Much (   )

5. In your opinion, to what extent are students involved in class experiments?

1. Not At All (   ) 2. Rarely (   )
3. Fairly (   ) 4. Much (   )
5. Very Much (   )

6. In general, how do you rate students' participation in Biology lessons?

1. Very Poor (   ) 2.Poor (   )
3. Fair (   ) 4.Good (   )
5. Very Good (   )

7. What do you think needs to be improved so that you can better enjoy your Biology lessons?

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THANK YOU FOR PARTICIPATING

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

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Website: www.ncst.go.ke

Our Ref: **NCST/RCD/14/012/40/4**

Date: **20th February, 2012**

Joseph Otieno Abongo
Egerton University
P. O. Box 536 – 20115
EGERTON, NJORO

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Impact of SMASSE in-service education & training on Biology teachers' pedagogical skills & attitudes towards Biology in Rachuonyo South, Homa Bay County***" I am pleased to inform you that you have been authorized to undertake research **in Rachuonyo South district** for a period ending ***31st April 2012.***

You are advised to report to **the District Commissioner & the District Education Officer, Rachuonyo South District** before embarking on the research project.

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

DR. M. K. RUGUTT, PhD, HSC
DEPUTY COUNCIL SECRETARY

Copy to:
The District Commissioner
Rachuonyo South District

The District Education Officer
Rachuonyo South District