

**INFLUENCE OF STRENGTHENING MATHEMATICS AND SCIENCE  
EDUCATION PROGRAMME ON ENHANCING TEACHING AND EVALUATION  
SKILLS IN BIOLOGY IN PUBLIC SECONDARY SCHOOLS IN NYAMACHE SUB-  
COUNTY, KISII COUNTY, KENYA**

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***Abstract***

Strengthening Mathematics and Science Education (SMASE) was introduced when consistent poor performance in science and mathematics became a matter of serious concern. Although poor performance in these subjects had already been accepted as the norm in some schools, the government of Kenya and other stakeholders felt there had to be an intervention. Although it is acknowledged that there are other factors contributing to the dismal performance, the government chose to focus on the teacher as the teacher is key in the curriculum implementation phase. The INSET Curriculum was thus designed to improve and strengthen the teacher's competence in the teaching of Science and Mathematics subjects. The programme activities are centered on the ASEI (Activity, Student, Experiment, and Improvisation) & PDSI (Plan, Do, See and Improve) approach, which emphasize on learner-centered preparation and presentation of lessons. The main purpose of this study was to investigate the influence of SMASE training on performance of Biology in public secondary schools in Nyamache Sub-County, Kenya. The study focused on gathering from the respondents participating in this research. Sampled school principals and Biology teachers were involved in this research. The study established that enhanced teaching and evaluation skills positively and significantly influence performance in biology, enhanced student's understanding in biology positive and significantly influence performance in biology, it revealed that challenges faced by school principals in managing the implementation of SMASE acquired skills in schools negatively and significantly influence the performance of learners in biology and lastly but not least the study found out that performance in biology after implementation of SMASE programme has significantly improved compared to performance before implementation of SMASE programme. In view of these findings, the study concludes that effective implementation of skills acquired in SMASE is important in schools. This means that to realize implementation of these skills in schools, school principal's management and facilitation for the implementation of these skills must be changed and the ministry must consider retaining teachers trained through SMASE programme when effecting transfers and also consider training teachers with few teaching years so that they can be in position to handle the anticipated change in curriculum.

***Key terms:*** SMASE, evaluation, performance, biology.

**Background of the Study**

The Kenya National Examination Council (KNEC) has continued to raise concerns over the poor performance in Kenya Certificate of Secondary Education (KCSE) examination. KNEC (1996) identified coverage of syllabus and practice, inability to master simple and basic concepts as reasons for poor performance. Provision of quality education is a key pillar for the realization of Kenya's Vision 2030. To make Kenya newly industrialized, the strategy has remained focus on improving performance in science based subjects. In addition to the Kenya's efforts in training, recruiting and employing professional teachers, and availing all the materials needed for the teaching and learning of mathematics and science, SMASE was

introduced by JICA to strengthen the performance in science and mathematics in secondary schools in Kenya. The available data indicators, however, actually reveal that the performance in National examinations remain below average.

According to Klein and Sorra (1996) an organization's failure to achieve the benefits of an innovation it has adopted may reflect a failure of implementation or a failure of the innovation itself. Fullan's (2001) analysis identified implementation failure not the innovation itself as the cause of many organizations' inability to achieve the intended benefits of the innovation they adopt.

For the genuine concern that the performance in sciences remains below National average, coupled with the fact the investment in the programme in terms of human resources and finances is enormous, a thorough evaluation of the effectiveness of SMASE programme in performance of mathematics and science in Kenyan secondary schools is inevitable. Studies on quality of education in Kenya indicated poor quality and performance especially in mathematics and science compared with that of social science subjects (KNEC REORT 2013). Due to resource constraints and need to improve quality of mathematics and science education, the GOK/MOE requested assistance from the development partners and the Government of Japan (GOJ) responded positively. SMASSE INSET is delivered through a two system in which training is conducted at national and district levels. At national level, the national trainers facilitate INSET for district trainers, who in turn train all the other mathematics and science teachers in their respective districts throughout the country (SMASSE Newsletter, 2001).

### **Statement of the Problem**

The Kenya National Examination Council (KNEC) has continued to raise concerns over the poor performance in Kenya Certificate of Secondary Education (KCSE) in Biology. KNEC (2018) identified coverage of syllabus and practice, inability to master simple and basic concepts as reasons for poor performance. Provision of quality education is a key pillar for the realization of Kenya's Vision 2030. To make Kenya newly industrialized, the strategy has remained focus on improving performance in science based subjects. In addition to the Kenya's efforts in training, recruiting and employing professional teachers, and availing all the materials needed for the teaching and learning of mathematics and science, SMASE was introduced by JICA to strengthen the performance in science and mathematics in secondary schools in Kenya. However, it was still notable that Biology performance in national examinations has been declining from 2010 to 2019 Nyamache Sub-County, Kisii County.

### **Literature Review**

Education is a fundamental human right (Wolfenson, 2000). The key to sustainable development, peace and stability within and among countries is the provision of education to the populace of such countries. In any innovation geared towards improving the quality of education, all educational professionals are change agents. However, Burnes (2004); Lunenberg and Irby (2006), have singled out school principals as the key players in implementing innovations. Research has indicated that the degree of implementation in school change is related to what the principal does (Hall & Hord, 2001). Studies on the role of the principal in school change (Fullan, 1991); on school improvement (Kowalski, 1982), all emphasized the critical importance of the principal as a variable in the implementation of innovations. The role of the Principals, according to SMASE (2006), is to support teachers where necessary, provide teaching and learning materials on time, and if science based, attending SMASSE INSET, and monitoring of classroom activities.

Availability of teaching/learning resources enhances the effectiveness of schools as these are basic things that can bring about good academic performance in the students. Maicibi (2003) opined that all institutions or organization are made up of human beings (workers) and other non-human resources. He further asserts that when the right quantity and quality of human resources is brought together, it can manipulate other resources towards realizing institutional goals and objectives. Consequently, every institution should strive to attract and retain the best of human resource.

The implication of these opinions is that well trained teachers in Biology if well deployed to the secondary schools will bring about well-rounded students who will perform academically well in Biology.

Another challenge that principals undergo when facilitating the implementation of SMASE skills is low student motivation. Students should be motivated through various ways which may include advising them on career choices, providing the required physical facilities like laboratories and verbal encouragements. This would go a long way in improving the performance in the subject under study. Biology as a subject can be made practical and enjoyable if there are Biology laboratories where some of the theories and theorems in the subject can be made practical. This can be done with the help of the government and parents/guardians who can financially support the schools in realizing this but more importantly by school principals through managing and facilitating the implementation of SMASE acquired skills. However, the cost of facilitating the implementation is still high and unaffordable to some schools.

According to World Bank report (2007), in most developing countries, not enough Biology teachers are being produced by Universities and Colleges. Therefore, College and Universities graduates are being encouraged to pursue these courses purposely to fill the gap. Recent visits to schools by personnel from Ministry of Education Science and Technology in Kenya revealed that most teachers do not have the expertise in their subjects. One of the consequences of this is that students fail examinations and fewer of them pursue Biology courses at tertiary level leading to an even greater shortage of Biology teachers. The other consequence is low teachers to student ratio especially in most of the public schools. The few teachers on the government payroll are poorly remunerated as a result most of them take up part time employment or private business enterprise in order to make ends meet. This greatly reduces their commitment to the teaching of Biology (which demands for sacrifice).

However, it may not true that increase in teachers' salary will make them to be totally dedicated to teaching work as advocated by teachers unions. Poor performance is as a result of teachers not being dedicated to their duties.

Some of them are traders while others are drunkards. Recent inspection in one of the schools in Nyamache Sub County showed that teachers report to duty late, come drunk and utter unprintable words. The various teacher unions should therefore rise to the occasion by not only championing better pay for teachers but also advocating for proper conduct among its members. The purpose of this study therefore was to establish the extent to which teaching/learning resources affects performance of Biology in secondary schools in Nyamache Sub County.

According to UNESCO (2005), the attitude the stakeholders have towards an innovation is critical to its success. In this study in particular, the attitude or perceptions that the teachers, the principals and the students hold towards the ASEI-PDSI classroom practices have a significant impact on the quality of implementation of this innovation.

During the implementation of an innovation, individuals have concerns. George et al. (2006) identify concerns as an individual's set of feelings, perceptions, preoccupations, thoughts, considerations, motivations, satisfactions, and frustrations, related to the target of innovation. Concerns towards an object or ideas have been linked to an individual's willingness to adopt classroom innovations. Related research (Isaac, C.I.O. et al, 2014) has confirmed the teachers' perspectives is critical and need to be addressed for the successful implementation of SMASE.

This study was guided by the Bruner's Constructivist theory (Bruner 1966). Constructivism theory is based on observation and scientific study and about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. Constructivism explains how human beings learn. Learning is constructing understanding or knowledge by fitting the new phenomena, ideas or activities to the existing knowledge and believe already learned; (Canella&Reff, 1994; Jong & Groomes, 1996; Kaufman, 1996, Richardson, 1997; Wolfe and McMullen 1996).

Most Kenyan teachers are trained and have clear goals to guide their teaching, but good teaching and learning materials seem not to be seen in most Biology lessons. As a result, there has been a public outcry about poor performance in Biology at secondary school level. In Kenya, Biology is a compulsory subject up to secondary school level. During the last couple of years, performance in Biology in National examination has dropped significantly and this has been a major concern for the society. The Kenya National Examination Council (KNEC) has continued to raise concerns over the poor performance in Kenya Certificate of Secondary Education (KCSE) examination. KNEC (1996) identified coverage of syllabus and practice, inability to master simple and basic concepts as reasons for poor performance. However, a report by the Teacher's Service Commission (TSC) revealed that there is shortage of Biology teachers due to high attrition rate than in other subjects. Many teachers have left teaching in public schools for greener pastures in better paying private schools. The National Development plan of the Republic of Kenya sets the goal of industrialization by the year 2030.

However, the education to develop human resources needed is not given much attention. In particular, low quality education in Science including Biology is an urgent issue to be addressed. In response to the request of the government of Kenya, the government of Japan began the project for Strengthening Biology and other Sciences in Secondary Education (SMASSE) in 1998 which provides assistance to Science including Biology education through in-service training of teachers. In line with the Kenyan government policy on education, the SMASSE project was launched to enhance Biology and other Science education in secondary schools in the country with the assistance of Japan International Cooperation Agency (JICA). The project is also tasked with the provision of teaching/learning materials and training of teachers on how to improvise these materials where necessary through Activity, Student, Experiment and Improvisation (ASEI) and Plan, Do, See and Improve (PDSI). ASEI (Activity, Students, Experiments, Improvisation) movement emphasizes student's participation from the start to the end of the lesson. The teaching activity should be student centered, based on experiments and improvisation if necessary.

For instance, the teaching/learning of Longitudes and Latitudes in Biology can be accompanied by improvising a metallic or plastic globe and using it in locating the position of an object along the equator. For the students to participate in the lesson, the teacher must

plan the lesson well. Similarly, the teacher must also evaluate every aspect of the lesson during teaching.

PDSI (Plan, Do, See, Improve) approach stresses on the need for the learners to carry out a well-planned learning activity that involves seeing for themselves and improving the activity even further for effective learning to take place. This is based on the findings of Yadar (2007) and UNESCO (2008) which postulate that an object well handled practically impresses itself more firmly in the mind than the object merely seen from a distance or in an illustration.

The legacy of colonial education and political economy of post independence Kenya have led to an education that favors the most advantaged students. Students in most public schools are disadvantaged in that the classes are overcrowded and they do not have adequate learning facilities. Consequently, they do not get individual attention from their teachers. In some instances, they lack adequate textbooks and laboratory equipments. As a result, the students may lose hope in performing well in academic work. This is in sharp contrast to private schools where the numbers of students are few as there are adequate facilities and the teachers are willing to go an extra mile to ensure that the students perform well in examination. In regard to this, the government in conjunction with World Bank, International Monetary Fund, together with Japanese government has initiated several approaches namely Strengthening Biology and other Sciences in Secondary Education (SMASSE) and Constituency Development Fund (CDF) among others. SMASSE project is tasked with the provision of teaching/learning materials in Biology and Science by improvisation where necessary besides in-servicing secondary school teachers in the country. Similarly, CDF allocate infrastructural funds to school. The funds are used to purchase teaching/learning materials such as stationeries, laboratories and equipments, teaching aids such as models, blackboard ruler and protractor, construction of classrooms and so on. If these two projects are well managed, teaching/learning materials will be adequately provided to learning institutions. Yadar (2007) opines that no course in Science including Biology can be considered as complete without including some practical work. The practical work ought to be carried out by individuals either in Science laboratories or in classes. At school level, practical work is even more important because of the fact that we learn by doing. Scientific practices and applications are thus rendered more meaningful. It is an established truth that an object handled impresses itself more firmly on the mind than the object merely seen from a distance or in an illustration. Thus practical work forms an important feature in any Science including Biology Course (UNESCO, 2008).

The SMASE projects are aimed at the improvement of mathematics and science education through In-Service Education and Training (INSET) for teachers with innovative approach in order to upgrade the capability of young Kenyans in mathematics and science and strengthening of the quality of mathematics and science education in WECSA member countries.

Secondary education is the level of basic education at which learners are expected to acquire proficiency in both academic and some applied subjects. The students are expected to take the first recognized national examination that will usher them to higher education at various fields of training or direct entry into the world of work (Koech, 2006). The ultimate purpose of this segment is to fulfill objective of providing equal opportunities to every individual up to a minimum of 12 years in school so that at the terminal level of basic education, every individual shall have been exposed to essential education for future life choices. However, the current secondary school curriculum in Kenya is examination oriented with great emphasis laid on passing examination at the expense of

acquisition of skills, values and attitudes. The argument is that there is a problem in the way young people are socialized by their parents on one hand and how they are taught at school on the other hand. The parents are not teaching important life lessons while teachers are over teaching on book knowledge. The implication of this is that there is imbalance in the education and socialization of young people that is causing them to protest either violently in school or by locking themselves in their own world of mobile phones, computers and other electronics that offer games and other forms of entertainment. In response to this, the government through the Ministry of Education in

Kenya and other stakeholders proposed the introduction of Life Skills Education in secondary education in the revised curriculum. The curriculum also emphasized that the time set aside for Physical Education (PE) and games should not be used for purpose of covering examinable subjects. According to the Kenyan Institute of Education (KIE, 2008), Life Skills Education is the study of abilities for adaptive and positive behavior change that enable individuals to deal effectively with the demands and the challenges of everyday life. Teaching of life skills is therefore aimed at equipping the learner with psycho-social competencies that would help him/her make informed decision, solve problems, think creatively and critically, communicate effectively, build healthy relationships, empathize with others and manage his/her life in a healthy and productive manner.

**Methodology**

The study adopted a descriptive survey research (Best 1970) conducted in a sample of schools selected from the 48 secondary schools in Nyamache Sub-County. Descriptive studies are not only restricted to fact finding, but may often result in the formulation of important principles of knowledge and solution to significant problems (Kerlinger, 2000). Descriptive design is used when collecting information about attitudes, opinions, habits or any of the variety of education or social issues (Orodho, 2002). The target population in this study consisted of all 47 public secondary school in Nyamache sub-county. The respondents included 188 biology teachers and 47 principals. Stratified random sampling will be used to select public secondary schools in the study. All schools in the sub-county were categorized according to their educational administrative units. In this sub-county, there were two academic divisions: Nyamache and Nyacheki having 28 and 20 schools respectively. A stratified random sample was a useful blend of randomization and categorization, thereby enabling both a quantitative and qualitative piece of research to be undertaken. Nyamache sub-county had 48 public secondary schools. According Mugenda and Mugenda (2003), the smallest sample should comprise of at least 30% of the target population. Based on the administrative units 9 and 6 schools were sampled in this study from Nyamache and Nyacheki divisions respectively.

**Results**

The study collected data through questionnaires and interviews. Items captured in instruments of data collection are presented, analyzed and interpreted below.

**Table 1: Influence of SMASE in enhancing teaching and evaluation skills**

Statement	Frequency	Percent	Mean	Std. dev
SMASE has enhanced teachers’ practical skills in biology	55	78	4.123	.958
SMASE has enhanced teachers’ learner centered	60	84	4.305	.863

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teaching method				
SMASE has enhanced teachers' skills in integrating ICT in teaching	53	75	4.207	.096

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**Source: Field Data 2019**

**Key: 5-strongly agree, 4-agree, 3-neutral, 2-disagree, 1- strongly disagree**

The results in tables 1 show that 55 (78%) the respondents agree (mean 4.123) that SMASE has enhanced teachers' practical skills in biology, 60 (84%) agree (mean 4.305) that SMASE has enhanced teachers' learner centered teaching method, 53 (75%) agree (mean 4.207) SMASE has enhanced teachers' skills in integrating ICT in teaching. These results therefore imply that SMASE has enhanced teaching and evaluation skills of the teacher to deliver content effectively to the learners. This consequently improves the performance of students in biology at all levels of the secondary school cycle.

**Table 2: Correlation between teaching and evaluation skills variables and performance in Biology**

		<b>Performance in biology</b>
SMASE has enhanced teachers' practical skills in biology	Pearson Correlation	.432**
	Sig. (2-tailed)	.000
	N	135
SMASE has enhanced teachers' learner centered teaching method	Pearson Correlation	.453**
	Sig. (2-tailed)	.000
	N	135
SMASE has enhanced teachers' skills in integrating ICT in teaching	Pearson Correlation	.365**
	Sig. (2-tailed)	.05
	N	135

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\*\*Correlation is significant at the 0.05 level (2-tailed).

The results in table 2 show that there is appositve and significant relationship between enhanced teachers' practical skills in biology acquired through SMASE and performance in biology, enhanced teachers' learner centered teaching method and performance in biology and enhanced teachers' skills in integrating ICT in teaching and performance in biology at (r=.432\*\*, P<.01), (r= .453\*\*, P<.01) and (r=.365\*\*, P<.05) respectively.

These implies that practical skills, use of learners centered teaching methods and integration of ICT in teaching are essential factors in improving performance of learners in the subject of biology.

The practical skills, learners centered teaching methods and integration of ICT in teaching were then merged together using computer transformation technique to make teaching and evaluation skills factors. These factors were then correlated to performance in biology as shown in table 3.

**Table 3: Correlation between teaching and evaluation skills factors and performance in Biology**

		Performance in biology
<b>Enhanced teaching and evaluation skills in biology</b>	Pearson Correlation	.632**
	Sig. (2-tailed)	.000
	N	135

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The results in table 3 reveal that enhanced teaching and evaluation skills positively and significantly influence performance in biology at  $r=.632$ ,  $p<.01$ . Calculating the coefficient of determinant  $R=r^2$ , enhanced teaching and evaluation skills contributes 39.9% variability to students performance in biology when other factors are held constant.

SMASE enhances students’ understanding leading to improved performance in Biology. This is evident in table 4.

**Table 4: Enhancing students’ understanding**

Statement	Frequency	Percent	Mean	Std. dev
SMASE has enhanced students understanding in asking of questions	61	86	4.224	.456
SMASE has enhanced students understanding in Answering questions	56	79	4.105	1.062
SMASE has enhanced students understanding in Caring out practical	55	77	4.214	.097
SMASE has enhanced students participation in discussion	60	85	4.311	.088

**Source: Field Data, 2019**

**Key: 5-strongly agree, 4-agree, 3-neutral, 2-disagree, 1- strongly disagree**

The results in table 4 show that 61 (86%), agree (mean 4.224) that SMASE enhances students’ understanding in asking of questions, 56 (79%) agree (mean 4.105) that SMASE has enhances students understanding in Answering questions, 55 (77%) agree (mean 4.214) that SMASE has enhanced students understanding in Caring out practical and 60 (85%) agree (mean 4.311) that SMASE enhances students participation in discussion.

This implies that students understanding in asking of questions, students understanding in Answering questions, students understanding in Caring out practical and students participation in discussion are essential factors in improving performance of learners in the subject of biology.

**Table 5: Correlation between enhancing students’ understanding**

				Performance in biology
SMASE has enhanced students understanding in asking of questions			Pearson Correlation	.734**
			Sig. (2-tailed)	.000
			N	135
SMASE has enhanced students			Pearson Correlation	.734**

understanding in Answering questions	Sig. (2-tailed)	.000
	N	135
SMASE has enhanced students understanding in Caring out practical	Pearson Correlation	.855**
	Sig. (2-tailed)	.000
	N	135
SMASE has enhanced students participation in discussion	Pearson Correlation	.833**
	Sig. (2-tailed)	.052
	N	135

\*\* Correlation is significant at the 0.01 level (2-tailed).

\*\*Correlation is significant at the 0.05 level (2-tailed).

The results in table 5 reveals that there was appositve and significant relationship between enhanced students understanding in asking of questions due SMASE, enhanced students understanding in answering questions due SMASE, enhanced students’ understanding in caring out practicals in the laboratory and enhanced students participation in discussion due SMASE at ( $r=.734^{**}$   $P<.01$ ), ( $r=.734^{**}$   $P<.01$ ), ( $r=.855^{**}$   $P<.01$ ) and ( $r=.833^{**}$   $P<.05$ ) respectively.

The asking of questions, answering questions, caring out practicals and discussion due SMASE were then merged together using computer transformation technique to form enhancing students’ understanding. These factors were then correlated to performance in biology as shown in table 4.10 below

**Table 6: Correlation between enhanced students’ understanding and performance**

		<b>Performance in biology</b>
<b>Enhanced students’ understanding of biology.</b>	Pearson Correlation	.932**
	Sig. (2-tailed)	.000
	N	135

The results in table 6 reveal that enhanced student’s understanding in biology positive and significantly influence performance in biology at  $r=.932^{**}$ ,  $P<.01$  significant. Calculating the coefficient of determinant  $R=r^2$ , enhanced student’s understanding in biology contributes 85% variability to the performance in biology

**Conclusion**

The study established that enhanced teaching and evaluation skills positively and significantly influence performance in biology, enhanced student’s understanding in biology positive and significantly influence performance in biology, it revealed that challenges faced by school principals in managing the implementation of SMASE acquired skills in schools negatively and significantly influence the performance of learners in biology and lastly but not least the study found out that performance in biology after implementation of SMASE programme has significantly improved compared to performance before implementation of SMASE programme.

In view of these findings, the study concludes that effective implementation of skills acquired in SMASE is important in schools. This means that to realize implementation of these skills in schools, school principal’s management and facilitation for the implementation of these skills must be changed and the ministry must consider retaining teachers trained through SMASE programme when effecting transfers and also consider training teachers with few teaching years so that they can be in position to handle the anticipated change in curriculum.

## Recommendations

Despite its limitations, this study findings should be used for policy formulations in public secondary schools. Basing generalization on the findings of this study, the researcher recommends that:

- All Teachers of science and mathematics should be re-trained through SMASE programme so as to enhance their teaching and evaluation skills in their respective subjects.
- SMASE teaching skills should be implemented by all science and mathematics teachers so as to enhance students' understanding in these subjects.
- School principal's management and facilitation for the implementation of these skills must be impressed and the ministry must consider retaining teachers trained through SMASE programme when effecting transfers and also consider training teachers with few teaching years so that they can be in position to handle the anticipated change in curriculum.
- In order for schools to improve performance in biology they should ensure that most of their teachers are re-trained through SMASE programme.

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