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**Effects of Implementing Strengthening Mathematics and Science Education (SMASE) on Academic Performance of Pupils in National Examinations (KCPE) in Public Primary Schools in Samia Sub-County, Busia County, Kenya**

By

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**Abstract**

The researcher carried out a study on effects of implementing strengthening mathematics and science education (SMASE) on academic performance of pupils in national examination (KCPE) in public primary schools in Samia-Sub-County, Busia County–Kenya. The study was guided by the following objectives; establish the use of ASEI-PDSI approach by teachers in teaching and learning during lesson presentation, the innovativeness of respective teachers in using locally available materials in preparing teaching and learning resources, teachers as well as pupils’ attitude towards the project and finally the effects of teachers’ training on pupils’ performance. The study employed survey research design including quantitative and qualitative tools. This research was guided by Two Factor Theory (the motivator- hygiene theory) whose proponent is Fredrick Hertzberg in1959. Thirteen schools were sampled using simple random sampling. Stratified random sampling was used to select thirteen head teachers from the sampled schools. Three (3) teachers handling classes six, seven and eight from each school were selected using purposive sampling since they were the very classes that SMASE targeted. The head teachers from the thirteen sampled schools were purposively sampled out as key informants. Questionnaires were used to collect data from teachers and pupils while interview guide was used on head teachers. The data collected was analyzed thematically and research reported accordingly. The study also found that pupils participated during mathematics lesson by manipulation and observation and that ASEI-PDSI approach is quite involving as well as quite interesting and that the local materials were the commonly used teaching/learning aids despite being quite hard to obtain. The study established that there was a weak positive correlation ( $R=0.125$ ,  $P=0.033$ ,  $P< 0.05$ ) which was statistically significant as  $P=0.033$  is less than 0.05. The study also found that SMASE training added value on performance despite some teachers not observing the value addition. However, performance in mathematics was generally poor with none of the school head teacher rating it as good or very good. The study concluded that there was a relatively low involvement during the lesson and that ASEI-PDSI approach is significantly valuable as it is either quite involving or interesting. Further locally available materials are not adequately exploited in the teaching and learning of mathematics in public schools in Samia sub-county with lack of continuous involvement could be as a contributing factor in the poor performance of the subject in national examination. The study is significant to the ministry of education as it provides recommendation on the extent of use of local materials in making teaching/ learning aid in public school thus incorporating a guideline for their use.

**Key words:** Kenya, Science Education, National Examinations, Public Primary Schools, Samia Sub-County, Busia County

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**Introduction**

Many African countries are facing common challenges in the teaching of mathematics at school level and especially at the primary level. This challenge led to the creation of the Centre for mathematics, science and technology education in Africa (CEMASTEA) IN 2003. This is a public institute tasked to provide and coordinate in-service education and training (INSET) for practicing teacher of mathematics and science. The strengthening of mathematics and science education- Western, Eastern, southern and central African Association ( SMASE-WESCA) were established comprising eleven countries in Africa including: Botswana, Angola, Niger, Senegal, Zimbabwe among others as a network to share experience among member countries. Japanese International cooperation Agent (JICA) attaches considerable importance to developing countries to deal with their problems on their own. CEMASTEAs continue to implement SMASSE programs for secondary school teachers until 2008, when the programs were extended to primary schools. As a result SMASSE was changed to strengthening mathematics and science Education (SMASE) to accommodate both primary and secondary school activities. SMASE-Africa was born in 2003 based on recognition that challenges in the teaching and learning of mathematics and science cuts across curricula in the African continent.

In Nigeria improving quality of mathematics and science education was essential for national development, more especially forming one of the top industrial countries in the world in accordance with the Vision 2020. The federal ministry of education and JICA conducted a baseline survey in 2005 to ascertain the strategies in use, the needs and challenges facing learning mathematics and science in primary education level. Major findings of the survey presented to stakeholders revealed: poor teacher-pupil strategy, perceived difficult concepts, monotonous use of lecture method of teaching and inadequate and poor utilization of available materials. SMASE project aimed at strengthening teaching paradigm from banking style/ chalk and talk to ASEI and PDSI approach in pilot states (Kaduna, plateau and Niger), Activity, Student experiment, Improvisation-Plan, Do, See, Improve (ASEI and PDSI) approach being the effective approach for ensuring the quality of mathematics and science lessons and their study in improvement. ASEI (Activities, Students, Experiments and Improvisation) is a key word in the SMASE project for lesson innovation. ASEI lesson is made possible through PDSI practice (Plan, Do, See, improve)

The government of Kenya introduced SMASE (strengthening Mathematics and Science Education) in primary schools as a project. This was a result of poor performance in the very

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subjects. The rationale was to strengthen the performance in those subjects that seemed to be doing dismally across as from 2007. The slogan being ASEI-PDSI (Activity, Student, Experiment, Improvisation-Plan, Do, See, Improve). The ministry of education science and Technology (MOEST) introduced SMASSE (Strengthening mathematics and science in secondary Education) program in 2005 in secondary schools to curb poor performance. It went further to launch SMASE (Strengthening Mathematics and Science Education) project in 2007 in Kenya in conjunction with JICA targeting mainly primary mathematics and science teachers. The overall goal of SMASE primary program was to contribute towards upgrading the capacity of young Kenyans at primary levels of education. The vision being: a program of excellence in teacher capacity development in Africa where as the mission is to transform teaching by continuously developing needs based training programmers for effective curriculum delivery and improved quality education at primary school level. According to effective implementation of SMASE primary activities- head teachers' workshop manual (2010) active participation in activity based learning setup enhances acquisition of required skills, concepts and attitudes. The purpose of using activities in teaching is to enhance understanding, but in most lessons there is a gap between the activity and the intended learning/conceptualization. This happens because of weak support mechanism provided by the teacher to the learner and the belief that the activities on their own results in understanding of concepts. The purpose being to identify how teachers can provide appropriate support to enable the learner to bridge activities with intended learning outcomes/concepts. Teachers are required to improve on traditional approaches to teaching mathematics and science adopts learner centered teaching/ learning approaches like ASEI-PDSI, practice where the focus is the learner (Head Teachers' manual 2010).

### **Statement of the Problem**

Research has demonstrated that teachers of mathematics have a challenge in content delivery, hence affects academic performance. (head teachers' workshop manual 2012) the center for mathematics, science and technology education (CEMASTE) through strengthening mathematics and science education (SMASE) project was initiated to address some of the challenges experienced by teachers of mathematics in primary schools. One of the approaches introduced by CEMASTE is Activity, Student, Experiment, Improvisation Plan, do, see, improve (ASEIPDSI), teachers have seen introduced to ASEI-PDSI approach to teaching where the focus is the learner and the teacher being a facilitator/moderator in learning. Teachers have also been encouraged to foster concepts, skills and attitude acquisition by using learner centered activities, experiments and improvisation where necessary (effective implementation of SMASE primary activities-head teachers workshop manual 2012). The greatest concern through INSETS to teachers was to improve on traditional approaches to teaching mathematics and science and adopt learner centered teachings/learning approaches using Activities, Student, Experiment, Improvisation-Plan, Do, Se and Improve (ASEI-PDSI) practice. As such, the introduction of SMASE in primary schools in Kenya as from 2007 was to enable respective teachers handling mathematics and science improve in teaching/ learning which subsequently leads to

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improvement in performance for both Mathematics and Science in KCPE results. The performance in mathematics among pupils in Samia Sub-County in the National Examinations (KCPE) had been low over the years as indicated in Table 1

**Table 1: Past KCPE Mathematics Mean Score 2014-2018 in Comparison**

YEAR	Samia Sub- County	Bunyala Sub-County	Difference
2014	40.1%	55.01%	14.9
2015	41.2%	54.4%	13.2
2016	40.1%	55.62%	15.02
2017	42.4%	57.3%	14.9
2018	41.6%	58.7	17.1

Source: **Samia Sub-County & Bunyala Sub-County Education Offices respectively.**

This trend was a source of worry to education stakeholders in Samia Sub-County. The concern was raised during the Education Day which was held in March 2019 at Nambuku Primary School. The stakeholders felt for the children for the dismal performance in Mathematics as a subject in KCPE. They demanded for an immediate intervention so as to salvage the situation. They attributed the role that Mathematics play towards determining competitive career selection and that Samia had been known for producing high profiled professionals like doctors citing the late Prof. Hillary Ojiambo who happened to be the first heart specialist in both East and Central Africa among others (Samia Sub-County Education Office.) The introduction of ASEI-PDSI was to improve on academic performance in the view of that poor academic performance in both Mathematics and Science was a source of concern. Some of the contributing factors to the poor performance were poor teacher-pupil strategy in both teaching and learning, inadequate teaching and learning aids monotonous lecture method and poor utilization of locally available materials for teaching and learning. Since the implementation of the SMASE programme in Samia Sub-County in 2007, there was limited evidence to show that the area had been researched upon by any researcher in Samia Sub-County. Therefore the study concentrated on establishing the effect of SMASE programme in terms of ASEI-PDSI approach, teacher innovativeness, training and attitude of teachers and pupils on Mathematics as a subject towards academic performance in the national examination (KCPE) in public primary schools.

### **Objective of the Study**

The study was guided by the following objectives: Establish how ASEI-PDSI approach had affected academic performance in public primary schools, examine how teacher innovativeness in using locally available materials affected academic performance, and determine the effect of training on the academic performance of Mathematics among the public primary schools and last but not least establish the attitude of both the teachers and pupils towards Mathematics as a subject, in Samia Sub-County, Busia County, Kenya.

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### **Literature Review**

This article addressed the information related to the research problem being investigated. According to Mugenda and Mugenda (1990) the purpose of the literature review is to determine what has been done already related to the research problem being studied. SMASE had the following objectives; improve Mathematics and Science Education through Education and Training (INSET) for teachers with innovative approach in order to upgrade the capability of young Kenyans in Mathematics and Science and strengthening the quality of Mathematics and Science education in WESCA(Western, Eastern, Central and Southern Africa) member countries to enhance classroom activities for quality teaching and learning mathematics and science, to develop teaching and learning materials for mathematics and science and to develop innovative lesson pedagogy -ASEI-PDSI(Activity, Student, Experiment and Innovation- Plan, Do, See Improve) (Ogwel, 2011). Khayati (2014) in his study examined the effect of the ASEI-PDSI approach in the teaching and learning of Mathematics in selected secondary schools in Vihiga County, Kenya. The research objectives of the study sought to achieve were; (i) to determine the effect of the ASEI-PDSI on student achievement in mathematics, (ii) to determine the effect of ASEI-PDSI approach on the student views and attitudes towards the learning of mathematic. The study was based on the processing theoretical construct. According to this theory, the learner during instruction is involved in active information processing that engage him or her to directly attend to conditions and using his thought process, act and react to this information. The approach embraces three primaries of learning; hands- on activities, minds- on and mouths –on activities, questionnaires, interview schedule and video randomly as assigned to four groups. The study was a true experimental research design based on Solomon Four -Fold design. The study recommended that teachers should apply ASEI-PDSI approach in their teaching to help students be actively involved in the lesson to have a better understanding and interest in the subject.

According to Momanyi (2010), instructional materials or sources used in any teaching exercise are to promote greater understanding of the learning experiences. They are used to provide the richest possible learning environment which helps the learner and the teacher to achieve specific objectives. Koto (2011), in his study on the influence of instructional materials on the academic performance of students in agricultural science in secondary schools in Kwara estate in Nigeria indulged in examining the availability of the instructional materials, importance of instructional materials on students' performance in agricultural science. The study used survey research design, thirty government and private secondary schools were used. 8142 agricultural science students and 73 agricultural science teachers were included. Questionnaires were instruments used for data collection. A sample of 206 students was randomly selected and 30 agricultural science teachers. Four research questions and four hypotheses (HO) were formulated to guide the study. Contingency chi-square statistical tool was used in the testing the hypothesis at 0.05 level of significance. The findings were the instructional materials available to be used to influence students' academic performance in agricultural science. Those instructional materials should possess characteristics of visibility, simplicity, attraction and clarity. That instructional

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material is important to influence students' academic performance in agricultural science. The teachers' qualification and experience were the major factors affecting the use of instructional materials to influence students' academic performance in the agricultural science in secondary schools.

Recommendations included making agricultural science teachers to endeavor to use ad try to improvise instructional materials for effective teaching of agricultural science in secondary schools. Secondly, the government to ensure the adequate employment of dedicated and qualified agricultural science teachers and makes funds available and sponsor teachers' attendance at conferences, seminars and workshops on utilization of agricultural science instructional materials. In conclusion the appropriate and improvised be made available and utilized in the teaching of agricultural science. The researcher recommended that the teachers should improvise instructional materials for effective teaching and also request the government to adequately employ dedicated and qualified agricultural science teachers in secondary schools. Secondly, the governments of Kenya to sponsor teachers for conferences, seminars and workshops which will in turn assist them understand how to use instructional materials. Thirdly, ensure that the improvised and appropriate instructional materials are utilized. The research topic offers relevant information on the improvisation and utilization of instructional materials which supports the researcher's area of study, however the previous research topic targeted the secondary and also the subject in question was agricultural science while the current study focused on mathematics and in public primary schools.

Ngaruya (2013), in the study to investigate the underlying factor for poor state of K.C.P.E. performance, the study was based on the contemporary organization theory which states "all systems are characterized by an assemblage or communication of parts whose function is interdependent. The study adopted descriptive survey design; the population included the AEO, head teachers, teachers and pupils. Both purposive and simple sampling designs. The sample size was composed of one AEO, 12 head teachers, 12 teachers and 550 pupils. Three types of research instruments were used; questionnaire, linear schedule and observation schedules. The content validity was tested. Test – retest method was used to test the reliability of the instruments. The data were analyzed by descriptive statistics (frequency and percentages). The fractions were presented in frequency distribution tables and bar graphs. The findings were; teachers prepared the professional document but rarely used them in the actual teaching and learning process, handling of the curriculum was not effective, physical teaching and teaching resources were available but not adequate, pupils had a negative attitude towards learning, teachers had negative attitude towards teaching. Recommendations were made that, schools to initiate income generating activities to raise funds to supplement resources donated by the free primary program, external and internal supervision should be enhanced in all schools in the district and schools should improve their relationship with the immediate community.

Suzzy (2015), in her study where an exploratory qualitative case study research design was adopted for the study. The target population was 33 respondents which comprised of five teachers and 22 learners from grade one to seven in the selected schools in Groot hetaba circuit.

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The data for research was collected by means of semi-structured interviews. The study revealed that many factors which contributed to the negative attitude. Improving in these factors and sensitization of the local community to discard practices which prohibit students' effective participation in learning mathematics could improve performance in mathematics. It is anticipated that the findings of this study would give curriculum developers a new insight into emerging issues on performance and Influence the Ministry of Education on policy formulation. Learners were also expected to benefit from the findings; because improved mathematics performance would give them opportunities to pursue science related courses in higher institutions of learning and middle colleges. The situation is worsened by the Inability of the heads of department and principals to guide and support education. Finally, research recommended for improving the attitudes of learners towards learning mathematics.

The study was conducted in Samia Sub-County, Busia county- Kenya. Where 13 schools out of 64 were sampled. According to Kombo & Trump (2005), the researcher used a systematic random sampling technique during the exercise of identifying the schools within the sub-county of which a 20% of the total population was sampled providing a total of 13 schools using a stratified random sampling technique was applied as recommended by Gay (1992) that 20% minimum threshold is sufficient. Mugenda and Mugenda's (2003) approach was used by the researcher hence the use of questionnaires and the interview guide during data collection. Questionnaires that were administered to the teachers contained 5 sections, having both open and closed ended questions. The ones for the pupils had closed ended questions bearing 3 sections to be responded to. The interview guide was an instrument that was used for head teachers. The interview guide had a total of 3 sections, where both open and closed ended questions were used for data collection.

## **Methodology**

### **Results and Discussion**

Based on the first objective, the study found that majority of the pupils consider that they are frequently involved during lesson while a significant proportion consider that they get involved throughout the lesson. However, a significant group of the pupils noted that they were never involved. The study also found that pupils participate during mathematics lesson by manipulation and observation. The study found that teachers see ASEI-PDSI approach to be quite involving as well as quite interesting. However, some of the teachers see that ASEI-PDSI approach does not make any difference. Thus, the approach is generally applied differently by the teachers with some when it is convenient, others when necessary and some others indicating that they apply it throughout. On the second objective, the study found that local materials were the commonly used teaching and learning aids although there was a moderately high reliance on commercial teaching/learning aids while there are no teaching and learning aids used in Mathematics. The study found that the teachers considered it to be quite hard to obtain locally available materials although they find it easily in some cases.

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The study also found that improvisation of teaching and learning resources is rarely done despite some teachers improvising teaching and learning aids. The study established that there was a weak positive correlation ( $R = 0.125$ ;  $p = 0.033$ ,  $p < 0.05$ ) which was statistically significant as  $p = 0.033$  is less than 0.05. On the third objective, the study found that SMASE training added value on performance despite some teachers not observing the value addition. The study found that the workshops should be organized more frequently. The study also found that performance in Mathematics was general poor with none of the school heads rating it as good or very good. This could be attributed to the finding that Mathematics syllabus was not adequately covered in the public primary schools in Samia Sub County.

The study found that there was a strong positive correlation between textbook ratio and pupils' academic performance in Mathematics which was statistically significant. Similarly, there was moderate positive relationship between syllabus coverage and performance in Mathematics. The study established a weak positive correlation ( $R = 0.342$ ) between teachers SMASE training and performance in Mathematics ( $p = 0.002$ ). On the fourth objective, the study found that majority of the pupils find Mathematics to be interesting despite a significant proportion considering it to be only somehow interesting. Similarly, the study found that majority of pupils would want the subject to be taught every day with a significant others not open to having it taught every day. The study also found that majority of the pupils in public primary schools in Samia Sub-County like Science (38.4%) as a subject followed by Mathematics (27.4%). The study also demonstrated that teachers who attended the SMASE INSET voluntarily had a positive attitude towards SMASE INSET, in the desire to improve methodology, certification and promotion. However, teacher's attitude on ASEI PDSI strategies has been identified to have a strong influence on students' attitude towards the mathematics as a subject.

## **Conclusion**

Based on the findings of the first objective, the study concludes that there was a relatively low involvement during the lesson among a significant proportion of pupils. Thus, there is need for increased manipulation on pupils during mathematics lesson to ensure their sustained participation. Overall, ASEI-PDSI approach is significantly valuable as it either quite involving or interesting. Lack of continuous involvement could be a contributing factor in the poor performance of the subject in national examination. From the findings of the second objective, the study concluded that locally available materials are not adequately exploited in the teaching and learning of mathematics in public primary schools in Samia Sub-County. This is because teachers find it difficult to obtain locally available materials for use as teaching and learning aids. Thus, there is need for improvisation of teaching and learning aids in mathematics from locally available materials, which at the moment is not done by nearly half of the teachers. The third objective, the study concludes that there is need for increased organization of SMASE trainings, workshops so as to increase its effect on value addition in the pupils' academic performance. Further, the poor performance in mathematics could be attributed to inadequate training and

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inadequate syllabus coverage. The inadequate syllabus coverage could be attributed to inadequate training from workshop which are rarely organized thus affecting performance in mathematics on the fourth objective, the study concludes that the more than one quarter of the pupils in public primary schools do not find mathematics all that interesting which ultimately affects their performance, consequently mathematics ,it's not most liked subject among the pupils hence portraying negative attitude which ultimately affects their performance.

### **Recommendations**

Based on the study findings and conclusions, the following were made; SMASE training should focus on equipping teachers with skills to continuously involve their teachers throughout the lessons as this will enhance their performance in mathematics and other science subjects, the ministry of education, through its quality assurance departments should encouraged acquisition and use of locally available materials as well as regular inspection to ensure application of the same. The study focused on SMASE training and application of ASEI-PDSI approach in teaching of Mathematics as determinants of Academic performance. However, other interrelated factors working within the whole system were not considered. Thus future studies should incorporate the moderating influence of pupils' attitude as well as textbook ratio and syllabus coverage on the relationship between training and performance. This will highlight the effect of the other factors which were not investigated in the article.

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