

**INFLUENCE OF STRENGTHENING OF MATHEMATICS AND SCIENCE
EDUCATION TRAINING PROJECT ON PUPILS' PERFORMANCE IN
MATHEMATICS IN KENYA CERTIFICATE OF PRIMARY EDUCATION: A
CASE OF PUBLIC PRIMARY SCHOOLS IN EMBU WEST DISTRICT, EMBU
COUNTY, KENYA.**

BY

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DECLARATION

This research project report is my original work and has not been presented for an award in any other university.

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DEDICATION

This work is dedicated to: my dear mother Judy Muthoni, my children Nahashon Thuo, Jane Wangui, Judy Muthoni and Gibson Ileri and my brother Gachiri for their support in my studies.

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ACRONYMS AND ABBREVIATIONS

AFT – American Foundation for Teachers

ASEI - Activity, Student Centred, Experiment and Improvise

CEMASTEА – Centre for Mathematics, Science and Technology Education in Africa

CDE – County Director of Education

CPD – Continuous Professional Development

DEO – District Education Officer

DQASO – District Quality Assurance Officer

DPC – District Planning Committee

EFA – Education For All

GOK - Government of Kenya

INSET - In Service Education and Training

JICA - Japanese International Corporation Agency

KCPE - Kenya Certificate of Primary Education

KCSE – Kenya Certificate of Secondary Education

KNEC – Kenya National Examination Council

KTPCA - Kenya Teacher Colleges Principals Association

MGDs - Millennium Development Goals

MOE - Ministry of Education

OECD - Organization for Economic Cooperation and Development

PISA – Programme for International Student Assessment

PDSI - Plan, Do, See and Improve

P.T.T.C - Primary Teacher Training College

QASOs - Quality and Standards Officers

RECSAM - Regional Centre for Education

ROK - Republic of Kenya

RT – Regional Trainers

SBI – School Based INSET

SD – Sustainable Development

SEAMEO - South East Asian Ministers of Education Organization

SMASE - Strengthening Mathematics and Science Education

SMASSE - Strengthening Mathematics and Science in Secondary Education

TAC - Teacher Advisory Centre

UK – United Kingdom

UNESCO - United Nations Educational, Scientific, and Cultural Organization

UPE – Universal Primary Education

USA – United States of America

USAID - United States Agency for International Development

ZQUASO – Zonal Quality Assurance Officer

ABSTRACT

The purpose of this study was to establish the influence of Strengthening of Mathematics and Science Education training Project on pupils' performance in mathematics in Kenya Certificate of Primary Education in public primary schools in Kenya. The study was carried out in Embu West district, Embu County, Kenya. The study objectives were: to examine the extent to which the number of SMASE trainings attended influence pupils' performance in mathematics in KCPE; to establish the extent to which teacher's perception of SMASE training project influences pupils' performance in mathematics in KCPE and to determine the extent to which practice of ASEI-PDSI in the classroom influences pupils' performance in mathematics in KCPE. The study was guided by constructivists' theory which holds that for a child to expand their learning they need to explore their environment and learn from hands on experiences. A correlation research design was used. Data collection tools used included: questionnaires administered to all the 37 Head teachers and all the 48 SMASE trained mathematics teachers of public primary schools of Embu West District; and a document analysis form which captured mathematics means scores. The data was analysed using descriptive and correlational statistics using Statistical Package for Social Sciences (SPSS). There is a positive correlation between the mean grades obtained after SMASE training. The SMASE training project improved pupils' performance in mathematics in KCPE. The findings of the research contribute to knowledge on ways of addressing challenges encountered during implementation of SMASE project; provide Trainers and other education stakeholders with feedback to improve management of training projects in future; sustain the same as programmes after the donor withdraws; improve pupils' performance in mathematics in KCPE; enhance positive attitude towards science related careers because mathematics cuts across all science subjects and a pass in mathematics is a requirement for most careers. Among the recommendations of the study include: the MOE should: set a fund through the Free Primary Education for supporting SMASE programme because lack of materials/tools is the major challenge in ASEI lessons; put mechanisms in place to ensure all teachers actualize the training content; GoK and JICA should train all teachers in ASEI-PDSI since there is no specialization of teaching subjects in primary schools.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Education is one of the most powerful factors leading to national development. According to UNESCO (2005) report, education is the cornerstone of economic and social development. Education helps to reduce poverty by mitigating its effect on the population, health and nutrition. Education is thus a means to development.

Kenya relies on education to achieve Millennium Development Goals (MDGs) and Vision 2030. The Government of Kenya (GoK) has identified education as one of the strategies for combating poverty. Several policy and structural reforms have been initiated to improve the quality of education and ensure universal primary education (UPE) to strengthen the link between education provided at all levels and the socio-economic development of Kenya. The strategies for ensuring the development include implementation of projects such as Strengthening of Mathematics and Science Education (SMASE) project for primary level.

The GOK through the Ministry of Education (MOE) entered into a joint effort with Japan International Cooperation Agency (JICA) to design and implement the SMASE project. To ensure success of SMASE project, JICA collaborated with Southeast Asian Ministers of Education Organisation Regional Centre for Education in Science and Mathematics (SEAMEO RECSAM) and sponsored training for tutors of mathematics and science from Primary Teacher Training Colleges (PTTCs) (Mee, 2006).

In 2006, twenty tutors of mathematics were trained on enhancing mathematical thinking of primary mathematics students using student-centred approach while a similar number of science tutors including the researcher were trained on enhancing problem solving skills in primary science. A similar number of tutors were trained in 2007. According to Mee (2006) the purpose of the course was to provide opportunities for PTTCs tutors to explore alternative and promising classroom practices. The participants were expected to upgrade their knowledge and skills in developing teaching-learning materials for primary school classrooms in Kenya; upgrade their capabilities of planning SMASE tutors In-service Education and

Training (INSET) programs and curriculum; share and exchange experiences and practices accumulated in Malaysia and Kenya and apply what they learnt in the course to the Kenyan situation. Only one mathematic tutor and two science ones were engaged as national trainers while the rest were rarely involved in planning of the SMASE INSET curriculum.

Mathematics and science are two subjects which can enhance development. According to Government of Kenya (GOK) (2007) report, Kenya vision 2030 aims at making Kenya a newly industrializing income country providing high quality life for all its citizens by the year 2030. Under Vision 2030, Kenya commits itself to provide a globally competitive education, training and research for development. According to JICA and ROK (2008) Science, Technology and Innovation and Human Resource Development were identified as the foundation for achieving Vision 2030.

Education depends on the quality of the teachers. Hayes (2011) asserts that no education system can be better than the quality of its teachers. This implies that national development can only be achieved if teachers are kept abreast of current trends in education so that they can in turn ground learners in all subjects and more so in mathematics which cuts not only across all sciences but is also applicable in all areas of life.

SMASE project was mainly INSET based and aimed at changing the teaching approach from lecture method to learner-centred approach achieved through Activity, Student, Experiment, Improve (ASEI) approach which is achieved by Plan, Do, See, Improve (PDSI) strategy. The ASEI-PDSI approach is an effective way of ensuring the quality of mathematics and science lesson is maintained through improvement after 'seeing' what has happened. The SMASE project was implemented after evaluation of Strengthening of Mathematics and Science in Secondary Educations (SMASSE) had been implemented in Kenyan secondary schools from 1998 to 2008. According to MOE and USAID (2011) Technical Cooperation between Kenya and JICA expanded with primary mathematics and science teachers INSET launched in January 2009 for a period of 5 years.

The purpose of SMASE project was to entrench effective classroom practices in mathematics and science and to extend ASEI-PDSI to primary schools to ensure a strong foundation was laid for the subjects (JICA & ROK, 2008). In their study on

the impact of SMASSE INSETs on students' capacity building through improved teaching- learning in the classroom, Ogwel; Odhiambo and Kibe (2008) indicated that SMASSE had impact on students' capabilities, and that through ASEI-PDSI there was a significant improvement in student cognitive skills. Thus involving learners in activities helps them to understand concepts and improve their performance in mathematics and science.

The SMASE project was implemented through a cascade system so as to bring multiplier effect in dissemination of knowledge, skills and attitudes as shown in Appendix 4. The training targeted primary teacher college tutors followed by primary teachers who would pass the skills to learners. The tutors were expected to pass the same to pre-service teacher-trainees hence introduced a pre-service component. The tutors also trained Teacher Advisory Centre (TAC) tutors who held seminars for head teachers to ensure sustainability of SMASE project practices after end of the project in 2013. The participants actualized the training content at each level before it was passed on to the next one. Actualization was achieved by teaching learners from primary schools near the training centres towards the end of the training.

The INSETs for mathematics and science teachers were conducted from 2010 to 2013 after a need assessment survey conducted in 2009 which established INSET needs. The needs were used to formulate content and programme for enhancing teaching of science and mathematics. The survey was done in 55 districts of the 8 provinces of Kenya. Embu district was not targeted.

Although SMASE INSETs for mathematics and science go hand in hand, the researcher is concerned about the performance of mathematics in KCPE after completion of the project in December, 2013. Performance of mathematics in KCPE is important and can be used as a performance indicator for success of SMASE project for the subject. According to UNESCO (2010) learning achievement was adopted as a key indicator of quality of education during the world conference of Education for All (EFA) in Jomtien, Thailand in 1990 where the third goal was on emphasis on learning outcome. The overall national mean scores for mathematics indicate low improvement in results since 2009 and this raises concerns of how SMASE training project has influenced the grades of pupils in mathematics in KCPE.

Gitogo (2013) pinpointed that the 2012 mathematics examination posted a mean of 28.15 which was the best in the last six years.

Lack of the achievement of SMASE project purpose for mathematics would have negative consequences on learners because it will limit them from choosing science oriented careers. Kenya will therefore not achieve Vision 2030 and MGDs. Donor partners like JICA who have spent a lot of money on it may withdraw future support. At this point, we need to know the problems with all the scenarios based on: number of trainings of SMASE attended by mathematics teachers and head teachers; their opinions or perceptions of SMASE seminars and; involvement of learners in mathematics lessons through practice of ASEI-PDSI in the classroom by use of locally available material.

1.2 Statement of problem

This study, sought to establish the influence of SMASE training project on pupils' performance in mathematics in KCPE in public primary schools. It is expected that the KCPE mathematics results improved from 2009 and became better as teachers were equipped with ASEI-PDSI practices. As shown in the background, the overall national mean scores for mathematics indicate low improvement in results since 2009 and this raises concerns of how SMASE training project has influenced the grades of Pupils' in mathematics in KCPE.

Some mathematics teachers say that the ASEI-PDSI practice is effective in improving performance of mathematics in KCPE while others say that it is time consuming hence use talk and chalk method to cover the syllabus. Various studies have been conducted by Centre for Mathematics, Science and Technology, Education in Africa (CEMASTE) but Embu County was not targeted hence a gap in knowledge. Also influence of SMASE training project on KCPE may not have been effectively determined since the project ended in 2013. The above challenges necessitated the need for this project to find out the influence of SMASE training project on pupils' performance of mathematics in KCPE in public primary schools in Embu West district, Embu County, Kenya.

1.3 Purpose of the study

The purpose of this study was to establish the influence of Strengthening Mathematics and Science Education training project on pupils' performance in mathematics in Kenya Certificate of Primary Education in public primary schools in Kenya.

1.4 Research objectives

The study was guided by the following objectives.

1. To examine the extent to which the number of SMASE trainings attended influence pupils' performance in mathematics in KCPE.
2. To establish the extent to which teacher's perception of SMASE training project influences pupils' performance in mathematics in KCPE.
3. To determine the extent to which practice of Activity, Student, Experiment, Improvise- Plan, Do, See, Improve (ASEI-PDSI) in the classroom influences pupils' performance in mathematics in KCPE.

1.5 Research questions

The study was guided by the following questions:

1. To what extent do the number of SMASE trainings attended influence pupils' performance in mathematics in KCPE?
2. To what extent do Mathematics teachers perception of SMASE training project influence pupils' performance in mathematics in KCPE?
3. To what extent does practice of ASEI-PDSI in the classroom influence pupil' performance in mathematics in KCPE?

1.6 Significance of the study

The findings of the research contribute to knowledge on ways of addressing challenges encountered during implementation of SMASE. It provides Trainers and other education stakeholders with feedback to improve on management of training projects in the future and to sustain the same as programmes after the donor withdraws support. The study findings also lead to improved pupils' performance in mathematics in KCPE and positive attitude towards science related careers because mathematics cuts across all science subjects and passing in it is a requirement in studying most careers.

1.7 Delimitations of the study

This study focussed on the influence of Strengthening Mathematics and Science Education training project on pupils' performance in mathematics in KCPE in Kenya. The study was confined to One County that is Embu out of the forty seven Counties in Kenya to serve as evidence of rolling out of the SMASE project and its influence on pupils' performance in mathematics in KCPE. All schools of Embu West district in Embu County were involved in the study.

Only SMASE trained mathematics teachers and head teachers of public primary schools in the district were involved in the study although science teachers were also trained. The teachers of mathematics were focussed because they are directly involved in classroom implementation. The head teachers were included because they play the support role with some of them teaching mathematics. The pupils who sat for KCPE in the last six years were not involved because it was difficult to locate them. The study took about four months.

1.8 Limitations of the study

The study sought to focus on influence of SMASE training project on pupils' performance in mathematics in KCPE in Embu west District of Embu County and therefore cannot be generalised to Kenya. Logistical constraints could not allow the study to be conducted in all public primary schools of Kenya. Establishing trends in mean scores was subjected to availability of the same in the Embu West District Education office.

1.9 Assumptions of the study

The study assumed that:

1. The research instruments could answer the research questions.
2. The selected sample could represent the population.
3. The Head teachers of public schools were sensitized on importance of SMASE training project hence attended seminars.

1.10 Definition of significant terms

Activity- Actions in which learners are engaged in during the lesson such as discussion in groups, experiments, performing role play, and improvising materials

Do- carrying out of planned activities

Improve-do better

Improvise- use local material in absence of tools or construct tools

Experiment- activity involving controlling of variables

Influence- cause change

KCPE- examination done at the end of primary school course which determines the secondary school the learner will attend in Kenya

Number of SMASE trainings attended- number of seminars or workshops in cycles

Performance in mathematics in KCPE-grades attained in mathematics in KCPE

Practice of ASEI-PDSI- engaging in learner centred teaching whereby the teacher plays the role of a facilitator while learners' do activities

Project- a planned undertaking

Pupil – a learner in primary school in Kenya

'See'-assess then evaluate so as to improve the lesson next time

SMASE – a project funded by JICA and GOK for improving the teaching and learning of mathematics and science which assists teachers through sharing ideas to learn how to be facilitators so as to engage learners in activities for self-discovery of knowledge

Teacher's perception of SMASE training project- Teachers attitude, believe or opinion about the SMASE training project

Training – organized seminar or workshop

1.11 Organization of study

This study has been organized into five chapters. The introduction is in Chapter One and consists of: background to the study; statement of problem; purpose of study; research objectives; research questions; Significance of study; delimitations of the study; limitations of the study; assumptions of the study; definition of significant terms and organisation of study. Chapter Two is the Literature Review and presents introduction and literature related to theme on first objective; theme on second objective; and theme on the third objective; theoretical framework; conceptual framework, and summary and research gaps. Methodology is explained in Chapter Three and consists of introduction, research design; target population; sample size and sampling procedure; data collection instruments; validity of the instruments; reliability of the instruments; data analysis techniques, ethical considerations of research and table of operationalization of variables. Chapter Four presents data

collection procedures and data analysis techniques. Finally, Chapter Five presents the summary of findings, discussions, conclusions, recommendations, suggested areas for further research and contribution to the body of knowledge.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature related to: Strengthening of Mathematics and Science Education training project; teachers perception of SMASE training; and practice of Activity, Student, Experiment, improvise- Plan, Do, See, Improve (ASEI-PDSI); theoretical framework; conceptual framework of the study and summary of the literature. The literature review is important because it examines both theoretical and empirical information about this study and will therefore help to identify gaps in knowledge.

2.2 Strengthening of Mathematics and Science Education (SMASE) training and performance

In the world at large, education is recognized as one of the most powerful means that nations rely on to reduce poverty and achieve social and economic development for improved quality of life. According to UNESCO (2005) education is the cornerstone of economic and social development. It helps to reduce poverty by mitigating its effect on population, health and nutrition.

Education is therefore important for development of a nation and depends on teachers who influence the learners' performance in examinations. According to UNESCO (2010) learning achievement was adopted as a key indicator of quality of education during the world conference of EFA in Jomtien, Thailand in 1990. The third goal emphasized on learning outcome. Hayes (2011) asserts that no education system can be better than the quality of its teachers. According to Siddiqui (2004 cited in Akram 2010) competent teachers apply broad, deep and integrated sets of knowledge and skills as they plan for, implement and revise instruction. AFT (2000) research in United States reported that teacher quality is the single most important variable in determining students' achievement. This forms the rationale for training projects for teachers.

In recognition of the central role of the education sector in achieving the overall development goal of improving the quality of life of Kenyans, the Government of Kenya (GoK) has identified education as one of the strategies of combating poverty.

Several policy and structural reforms have been initiated for improving the quality of education and ensuring Universal Primary Education with a view to strengthening the link between the educations provided at all levels and the socio-economic development of Kenya.

According to JICA & ROK (2008) various Development Policy Documents of the GOK: National Development Plan, Master Plan on Education and Training: 1997-2010, Poverty Reduction Strategy Paper, Economic Recovery Strategy for Employment and Wealth Creation, Sessional Paper No. 1 of 2005 on “Policy Framework on Education and Training”, Kenya Education Sector Support Programme emphasise the importance of mathematics and science education in order to achieve higher economic levels in Kenya. As such the GOK is ready to invest in education including Strengthening of Mathematics and Science Education (SMASE). According to Republic of Kenya (2007) about thirty five to thirty eight per cent of the national recurrent expenditure is spent on education. This is in agreement with Derek Bok who was reported by Vaughan Radio (2011) as having said that “If education is expensive try ignorance”.

Education is valued by the Kenya government and is captured in vision 2030, which is a long term national planning strategy. According to GOK (2007) Vision 2030 aims at making Kenya a newly industrialising income country providing high quality of life for all its citizens by the year 2030. Vision 2030 has 3 pillars: Economic pillar; Social pillar and Political pillar. Education is in the social pillar which is the basis for the other pillars. Education is essential for achievement of the economic pillar. According to GOK (2007) under Vision 2030, Kenya will provide a globally competitive quality education, training and research for development.

GOK (2007) report pinpoints further that after identifying projects and priorities in the social and political pillars; detailed analysis and scrutiny was carried out in a consultative process in order to come up with strategies capable of resolving the social and economic problems faced by Kenyans. To arrive at workable solutions, the Kenyan experts learnt a lot from countries that have achieved rapid growth and improved the lives of their people greatly in a span of 20-30 years with particular reference to South East Asian ‘newly’ industrializing countries. This shows desire to improve through benchmarking with those who have succeeded to ensure

improvement in development. Kenya also, cooperates with its donor partners to ensure success of education projects such as SMASE training project for primary level.

The main characteristics of SMASE Project are: focusing on In-Service Education Training (INSET), ASEI & PDSI Approach; and Cascade Approach. ASEI is an acronym for Activities, Students, Experiments and Improvisation. It is a key word in the SMASE project for lesson innovation. An ASEI lesson is made possible through PDSI practice (Plan, Do, See, and Improve) (JICA, 2014).

SMASE Project addresses improving quality of teachers in terms of attitude, pedagogy, and mastery of content, resource mobilization and utilization of locally available teaching materials. SMASE Project aims to shift teaching paradigm from "banking style/chalk & talk" to "ASEI & PDSI approach." ASEI & PDSI approach is the effective approach for ensuring the quality of mathematics and science lessons and their steady improvement (JICA, 2014). Teachers improve their skills in work planning, achievement, self and collegial evaluation and utilization of feedback to improve subsequent lessons (MOE & USAID, 2011).

Cascade approach is used in SMASE. The cascade approach is in line with McKeown (2002) who observed that the proponents of Sustainable Development had realized there could be no sustainable development in the world if teachers were not trained in such a way that skills, knowledge, attitudes and values that enhanced sustainability were inculcated in teachers during training and these be transmitted to the students and consequently the society at large. Education thus remains the vehicle to achieving sustainable development.

Tutors were trained at the national level, conducted peer-teaching in groups and actualized the content in nearby primary schools. During this training the write ups were refined through sharing. The course duration was two weeks in three cohorts running from February to March in the years 2010, 2011, 2012 and 2013. The tutors used the write-ups and trained cluster trainers for two weeks at regional centres in April. The Cluster trainers in turn did peer-teaching and actualized in nearby primary schools. The cluster trainings were conducted in August for one week and participants were expected to actualize which may not have always occurred in case arrangements

were not made to call learners from the holiday. Teachers were expected to implement the content in third term.

In-service education and training (INSET) is the other approach in SMASE training project. According to Lucie (2004) studies have indicated that in-service education and training or continuing professional development for employees have positive influences on individual job performance and corporate performance. This implies better performance for learners after teachers attend in service training. Roy (2001, cited in Akram, 2010) pinpoints that the performance of individual staff member needs to be most responsive to change and improvement be through in-service education. In-service education or in-service training is used to mean any planned programme of learning opportunities to staff members of schools, colleges or other educational agencies for purposes of improving the performance of the individual in already assigned positions. The purposes of in-service training or education are clearly restricted to learning outcomes related to the improvement of performances of the staff.

In service training comprehends the whole range of activities on which teachers can extend their professional education, develop their professional competence and improve their understanding of educational principles and techniques (Singh and Shan, 2005, as cited in Akram, 2010). Digolo (2002) opines that teaching is a complex activity and its mastery requires systematic training. This is because each teacher is a significant actor in the curriculum process as he or she plays a crucial decisive role. According to a World Bank report (2007) there is belief that the status of teaching as a profession seems to decline during the pre-service teacher preparation and on the early years of experience. This shows that improvements in teacher training and INSETs for those employed are very important and more so in mathematics which cuts across all sciences and is applicable in all areas of life.

In his study on factors affecting the performance of teachers at higher Secondary at Punjab, Akram (2010) recommended that though the factor of teacher's job performance was found on the highest level in the study, teachers should continue their attention and improve their command on the content through self-study and by attending in service refresher courses. He further asserts that teachers are required to

continually improve their teaching methodology by consulting internet media, new informatory literature to bring innovation in their teaching methodology.

To remain effective and for their own professional growth teachers must engage in lifelong learning. Hayes (2011) observed that everyone agrees that teachers require some basic training. This might mean completing different types of on-the-job training and mentoring programmes, or involve undertaking a range of professional and postgraduate courses. Current education policy emphasizes one of the more modest approaches for training teachers that is on-the-job training.

Hayes (2011) was of the opinion that, the hall-mark of a good teacher, and what facilitates good teacher formations, is learning from other professionals in the classroom. As such nobody will deny importance of classroom learning. According to Akram (2010) there are many factors that influence the teachers' job performance such as aptitude, attitude, subject mastery, teaching methodology, personal characteristics, the classroom environment, general mental ability, personality, and relations with students, preparation and planning, effectiveness in presenting subject matters, relations with other staff, self-improvement, relations with parents and community, poise, intellect, teaching techniques, interactions with students, teaching competence demonstrated, motivational skills, fairness in grading and teachers' attitude toward the students.

The teaching profession needs knowledge about the complex and compelling forces that influence daily living in a changing world. This includes understanding political, economic, technology, social and environment factors that shape, to ensure that teachers know what pupils need to learn both in the present and for future. Professionalism, therefore, implies a responsibility to continue development of practical knowledge through reflection and interactions. It means reviewing the nature and effectiveness of practice; continuing to increase understanding of the purposes of education individually and collectively (Hayes, 2011).

Continuous in-service education is needed to keep the profession abreast of new knowledge and release creative abilities (Dasgupta, 2004, as cited in Akram, 2010). According to Hayes (2011), we should acknowledge that experience gives meat to theory and theory gives breadth to experience. This means that experience must be shaped and structured to have the maximum impact on development. Otherwise it

becomes almost a matter of luck whether teachers have the right experience. It is therefore important to keep people on the edge of their comfort zone, to break their range of content and access to appropriate mentors and resources. He further asserts that, expertise in pedagogy is underpinned by teachers' knowledge of their subjects. This implies that knowledge of a subject such as mathematics by a teacher can be improved through in-servicing which is the basic concept of SMASE.

SMASE training project was implemented after a need assessment survey was conducted in 55 primary schools in the 8 provinces of Kenya. The findings of the survey were used to establish INSET content and programme to enhance teaching and learning of mathematics and science education. INSETs for mathematics and science teachers and workshop programmes were implemented in the years 2010, 2011, 2012 and 2013 at National, Regional and Cluster levels. Another survey was done in 2011 in the pilot districts to find the extent of practice of ASEI – PDSI. These findings strengthened practice in 2012. The study in 2013 helped to find the extent of ASEI-PDSI practice in the years 2011 and 2012 (CEMASTE A, 2013b).

The findings of the study in 2013 on extent of practice of ASEI-PDSI in mathematics reviewed that the extent of practice of Activity, Planning, seeing and Improve aspects of ASEI-PDSI had decreased. The extent of practice of Learner/Student Centred-ness, Experiment, Improvisation/ Innovativeness and Doing aspects of ASEI-PDSI had improved slightly. This could have possibly been attributed to weak practices of ASEI-PDSI at the school level or lack of supervision during instruction (CEMASTE A, 2013c). The report further shows that for activity, student centeredness, improvisation, planning and seeing, the more the mathematics teachers attended the INSET, the higher the extent of the practice of ASEI - PDSI.

A report on cluster INSET 2013 reviewed that average attendance was low in most centres and there was inconsistent attendance based on previous SMASE cycles. It recommended that planning for INSET, and notifying the host schools and official invitation of teachers should be done in time. As regards facilitation, trainers in some centre seemed not to have prepared well and were reading from training materials directly. To ensure welfare of participants, it recommended that all pending payments to cluster trainers, teachers and head-teachers be made and feedback sent to CEMASTE A in case District Planning Committee (DPC) did not prepare lunch and

tea for INSET and workshop and teachers took care of themselves (CEMASTEА, 2013c). A gap in knowledge exists on how the SMASE training attendance influenced performance in mathematics in KCPE, more so in Embu West District whose schools were not targeted in the study.

SMASE training project for primary level was implemented after evaluation of strengthening of mathematics and science education in secondary schools (SMASSE) had been implemented from 1998. According to CEMASTEА (2013b), SMASSE project was done in two phases: phase 1 was a pilot phase from 1998-2003 involving teachers in 15 districts while phase 2 was a national phase from 2003-2007 and covered all the other districts in Kenya. JICA & ROK (2008) further asserts that, during Phase 1 and 2 of the SMASSE project, impact was confirmed in the areas: attitude of mathematics and science teachers towards teaching changed positively; and interest of students in mathematics and science was enhanced. Evaluation of SMASSE project Phase 2 conducted in October 2007 recommended a forum for teachers to share good ASEI-PDSI practices.

Based on the above it was expected that SMASE project would have impact in both PTTCs and primary schools. According to JICA & ROK (2008) the positive impact of SMASSE INSET in secondary schools classrooms made Kenya Teachers Colleges Principals Association (KTCPA) to request MOE for adaptation of ASEI-PDSI approach to the teaching and learning of mathematics and science in teacher training colleges and primary schools. This was through a concept paper “Strengthening Mathematics and Science in Primary Education” of 2003. In response to this the Japanese Technical Cooperation assistance was requested by the MOE for a trial adaptation of ASEI-PDSI by Tutors of PTTCs. This was factored in phase 2 of Planning Design Matrix, revised at mid-term evaluation in October 2003. The training of all tutors of mathematics and science of public primary colleges was in place from Feb-March 2007.

JICA & ROK (2008) observed that the college principals in their Concept Paper went beyond classroom-practices of tutors to those of primary schools. They suggested that the trained tutors be used as mentors for the mathematics and science teachers. The aim for training of tutors was to develop them as Regional Trainers for lower cascade level INSET (5600 Cluster Trainers) who would train 60000 primary school teachers.

In line with the above, twenty mathematics and twenty sciences PTTC tutors were trained in Malaysia in preparation for rolling out of the SMASE programme. In 2006, twenty tutors of mathematics were trained on enhancing mathematical thinking of primary mathematics students using student-centred approach while a similar number of science tutors including the researcher were trained on enhancing problem solving skills in primary science. A similar number of tutors were trained in 2007. The training took place in SEAMEO RESCAM, Penang, Malaysia. According to Mee (2006) the course was conducted to strengthen mathematics and science in Secondary Education project Phase II (SMASSE project) which was to be implemented in the Republic of Kenya under the technical cooperation programming of Japan International corporation Agency (JICA). The training was made possible through the collaboration and sponsorship between SEAMEO, RESCAM and JICA. The purpose of the course was to provide opportunities for Kenya PTTC tutors to explore alternative and promising classroom practices. The participants were expected to upgrade their knowledge and skills in developing teaching/learning materials for primary school classrooms in Kenya. In addition, they would upgrade their capabilities of planning SMASE PTTC tutors INSET programs and curriculum besides sharing and exchanging experiences and practices accumulated in Malaysia and Kenya. It was hoped that the participants would be able to apply what they learnt in the course, to situations in Kenya.

It is important for teachers to share good practices learnt during INSETs and also to sustain them at the school level. According to CEMASTEIA (2013c) one of the best strategies to sustain ASEI-PDSI is for teachers to work together and help each other through Continuous Professional Development. The goal of SMASE was to enhance existing cluster system to promote school based INSET. Frequent opportunities for school based INSET is one of the strategies to sustain ASEI-PDSI in school. School based INSET (SBI) is a form of continuous professional development that should benefit all teachers in schools. However, some of the teachers have not fully benefited from this because of various challenges.

It is not clear how INSETs for teachers influence learners' performance in a subject and more so in KCPE mathematics. According to Harris and Sass (2008) one reason for the uncertainty regarding the effects of teacher training is that, past studies have been unable to overcome three methodological challenges in estimating the effects of

training on teacher quality. First, it is difficult to isolate productivity, especially in teaching where a student's own ability, the influences of a student's peers, and other characteristics of schools also affect measured outcomes. The problem is exacerbated by the fact that assignment of students and teachers to classrooms is usually not random, leading to possible correlations between observed teacher attributes and unobserved student characteristics. Second, like in Harris and Sass (2007) and Jacob and Lefgren (2005), as cited in Harris and Sass (2008) there is an inherent selection problem in evaluating the effects of education and training on teacher productivity. Unobserved teacher characteristics, such as "innate" ability, may affect the amount and types of education and training they choose to obtain as well as subsequent performance of teachers in the classroom. Third, it is difficult to obtain data that provide much detail about the various types of training teachers receive and even more difficult to link the training of teachers to the achievement of the students they teach. However, according to Ogwel et al (2008), SMASSE had impact on student's capabilities, and that through ASEI-PDSI there was a significant improvement in student cognitive skills.

Performance of students in an examination is indicated by grades. The sole purpose of grades is to accurately communicate to others the level of academic achievement that a student has obtained (Snowman & Biehler. 2003). It has also been shown that grades are used as a motivational tool as well as to develop good study habits (Oosterhoof, 2001).

The end-of-course grades assigned by instructors are intended to convey the level of achievement of each student in the class. These grades are used by students, other faculty, university administrators, and prospective employers to make a multitude of different decisions (University of Illinois, 2009). Many factors influence student grades. According to Tsegay Berhane Reda (2012) determinants of students' performance have been the subject of an on-going debate among educators, academicians, and policy makers. There have been many studies that sought to examine this issue and their findings point out to hard work, previous schooling, parents' education, family income and self-motivation as factors that have a significant effect on the student's grade point average. He further asserts that, most of those studies have focused on students' performance in the different parts of the world. However, since having little or no interest for the field of study may play a role

in shaping the factors that affect students' performance, it is very important to examine those relevant factors so as to enhance students' academic achievement.

2.3 Teachers perceptions and performance

As teachers immerse themselves in the routines of schooling, both perceptions and expectations reflect and determine the goals that they set for achievement, the strategies they use to pursue the goals, the skills, energy, and other resources they use to implement the strategies, and the rewards they expect from making the effort. These should affect standardized scores as well as other measures of achievement (Ferguson, 2003). This shows that the teacher's perception may influence how he or she implements training content and this in turn influences performance of a learner in a subject, such as mathematics, in KCPE after implementation of SMASE training project.

According to Kenya National Examination Council (KNEC), KCPE is considered accurate in measuring the learners' abilities given that majority of learners who do well and proceed to secondary school generally perform well in Kenya Certificate of Secondary Education (KCSE). However, SMASSE noted from INSET experiences that, secondary mathematics and science teachers commonly complained that students entering Form 1 with good grades do not necessarily display a commensurate competency. They relate this to the fact that KCPE is multiple-choice examination that does not necessarily require candidates to demonstrate understanding of the subject matter by showing how they arrive at the answer or explaining their choices (JICA & ROK, 2008).

In their study on impact of SMASSE INSETs on students capacity building through improved teaching/learning in the classroom, Ogwel; Odhiambo and Kibe (2008) observed that the role of attitude in teaching revealed that teachers' disposition to change their practices and embrace more student centred instruction depends on the quality of professional development.

The teacher's expectations from INSET and the way they are treated during the training also influence how seriously they implement the content. Considering teachers' needs, experiences, and contexts as central, valuing their ideas, negotiating content, accepting teachers as experts, and encouraging them to reflect on their current beliefs and behaviours are important factors to induce long-lasting changes in

teacher practices (Atay, 2007; Fullan, 2001; Hayes, 2000, as cited in Uysal, 2012) as these help teachers develop a sense of ownership of the new ideas (Bax, 1997; Wolter, 2000, as cited in Uysal, 2012). Such programs also enhance teachers' consciousness about their teaching, their professional confidence, and quality of instruction as well as student learning (Daloğ Lu, Lu, 2004; Hayes, 2000, as cited in Uysal, 2012). Teachers need a friendly and hospitable atmosphere where openness and collaboration are encouraged and where they can share "their own knowledge of classroom, children, subjects and pedagogy with peers" John & Gravani (2005, as cited in Uysal, 2012). Gale and Yan (2001, as cited in Solso, 2009) found that the beliefs of the teacher had a direct impact on the achievement of the student and that students had better achievement when they were able to relate mathematics to real world situation.

The Plan Do See Improve (PDSI) influences the success of Activity Student Experiment Improve (ASEI) lessons. Through lesson study approach, performance in mathematics may be improved. According to CEMASTEА (2013c) lesson study is a process carried out by teachers to improve teaching and learning in a classroom. The process is continuous and consists of Plan, Do, See, Improve and enhancing improvement of teaching methods. Lesson study is, therefore, a professional development activity for teachers. This shows the importance of team work for successful improvement of mathematics through lesson study. Sagie (2002) cited that for an organization to perform better, it is important that employees are comfortable with each other, share a good rapport and work in close coordination towards a common objective. According to him, people feel responsible and motivated to do good work and enjoy their work other than taking it as a burden.

The focus of the 'improve' aspect in PDSI is on how a teacher uses what he or she gathers from the 'See' aspect to improve learning accordingly. This may entail several approaches which may be before or at the beginning of any lesson activity. It may also be done at regular intervals during the lesson or at the end of an activity (CEMASTEА, 2013a). The term 'See' embraces monitoring of the learning process while assessing or evaluating the entire process with a view to make adjustments that lead to improvement of subsequent lessons.

Support of teachers by head teachers when implementing the training content is very important. According to Ogwel et al (2008) teachers shift in pedagogical skills in

SMASSE depended on principal's support and encouragement. This implies that success of implementation of ASEI-PDSI and how it impacts on performance in KCPE mathematics is influenced by how the head teachers of public primary schools support teachers of mathematics.

Successful implementation of knowledge and skills learnt during INSETs depends largely on the way the head teacher supports the teacher. According to Bousted (2010) we need to remake schools as learning communities for staff as well as for pupils. This transformation will require two things: school leaders who are capable of teaching and learning all provision, school by school, of effective continuing professional development. Involvement of teachers in planning is quite crucial. Fullan (2001) stresses that, mutual trust between school leaders and teaching staff is the single most important factor within a school's culture that will allow for successful changes for improvement to be possible. Without trust, there is no effective communication or collaboration, which hampers the development of commitment to school improvement.

2.4 Practice of Activity, Student, Experiment, improvise- Plan, Do, See, Improve (ASEI-PDSI) and performance in mathematics

Today, everyone is required to use mathematics as a tool in daily life (OECD, 2003). This teaches us that mathematics is considered as a very important subject. According to KNEC (1981, cited in Munithi, 1990) mathematics is the backbone to both Physical and Biological Science. Its emphasis on patterns shapes and symmetry adds to the World of beauty. It helps linguistics development through the need to refine and make precise the language used. Social scientists are using probability and game theory to study politics, crime and economics. Mathematics is very important even to farmers who are practicing. School teachers have to teach all the subjects well, and in particular mathematics, they require to be well grounded at least with the basics of mathematics".

As cited in Mee (2006) one of the major contributions towards life-long learning from mathematics education is the mathematical thinking acquired by students. Primary school students need to be provided with early opportunities to develop mathematical thinking and creative problem solving to enable them appreciate and utilize the power of mathematics later. Through the use of student-centered approach in teaching,

teachers are able to empower their student towards life-long learning. Creative problem solving in mathematics requires higher order thinking skills and processes. It teaches students a way to break from the structures and limitations of the traditional way of solving realistic problems and helps them to become active shapers of their own real-life mathematics problem-solving abilities. As with many good educational strategies, creative problem solving is student-centered learning. The students act as directors of their own thinking and productivity. ‘Problem-based learning in mathematics classes would provide young students more opportunities to think critically, represent their own creative ideas, and communicate with their peers mathematically’ (Roh, 2003, as cited in Solso, 2009).

Teachers should ensure they build self-confidence in their students, apply different active learning strategies so as to increase students’ participation, review students’ attendance in connection with performance, and advise students about gains of attending classes regularly (Tsegay Berhane Reda, 2012). Thus, involving learners in active learning which is the core emphasises in SMASE training project through ASEI-PDSI cannot be underscored.

Effective teaching should be based on the active involvement of the learners (MOE & USAID, 2009). They further assert that, active learning is a process where learners are continuously engaged in the learning process. The learners participate in a wide variety of activities which help them in doing things and thinking about what they are doing. Learning by doing helps learners to apply skills during learning activities. Problem solving skills can be applied to solve similar problems using the same approach. This agrees with the Chinese saying, ‘I hear and forget, I see and I remember, I do and I learn’. Based on the Chinese saying and other researches on active learning, it is possible to conclude that the more senses are used in acquiring knowledge, the deeper the impression that is made on the mind and the more sure we are that the knowledge will be retained (Jacinta and Regina, 1987, as, cited in MOE & USAID, 2009). Engaging learner in activities is, therefore, very important and requires adequate learning resources.

Among the activities learners engage in active learning include: solving problems, role playing, discussing in groups, asking questions, etc. Active learning is learner-centred and the learners are actively involved in learning. It enables learners develop a

‘hands on’ experience. Problem solving and collaborative learning are common practices. Collaborative learning involves learners working together to achieve objectives set. In the process, there is a high level of interaction between the learners, teacher and learning resources; the learner is responsible for his or her own learning while the teacher plays the role of a guide, facilitator, and organiser of the learning process (MOE & USAID, 2009).

Success of ASEI lessons depends on availability of teaching/ learning material. According to JICA & ROK (2008) in Kenya teaching and learning materials are inadequate and at times not available. However, through improvisation, teaching learning materials can be acquired. According to CEMASTEА (2013a) improvisation is the act of creating something in the absence of the ideal tool. This requires teachers to use resources available in the immediate environment. Mathematics teachers often try to teach students through the use of experiments though they do not always have access to resources needed to optimally perform these experiments. Innovative teachers can use cheaper products to simulate experiments. They can also help students learn improvisation as an important life skill. Teachers can work with students to come up with ways to improvise, forcing students to think critically about the mathematics concepts underlying the devices.

The extent of improvisation in mathematics classes in primary schools is not clear. In a study entitled, “Inside the mathematics classroom”, CEMASTEА (2013b) observed that teachers indicated that they often carried materials to class. However, pupils reported little variety in materials used in the class other than geometrical instruments, textbooks and revision texts. In addition teachers, head teachers, quality assurance and standard officers (QASOs), TAC tutor reported that teachers often used improvised resources but lessons observed had minimal use of improvised materials. The study was limiting because some participants had not attended SMASE training. This study will only use those teachers who are trained.

2.5 Theoretical framework

The study will be guided by constructivists’ theory. The main concept of constructivism is that teaching with constructivism methods in mind involves the learners being active participants in the classroom (Solso, 2009). He further asserts

that constructivism is grounded on theories that hold that, for a child to expand their learning, they need to explore their environment and learn from hands on experiences.

There are many constructivist theorists. According to John Dewey (1916, as cited in Mee, 2006) education depends on action where knowledge and ideas emerged only from a situation in which learners had to draw them out of experiences that had meaning and importance to them. Those situations had to occur in a social context like a classroom where students joined in manipulating materials themselves and hence creating a community of learners who built their knowledge.

Jean Piaget's (1973) theory of learning shows that knowledge is a construct of interaction between heredity and the factors of the environment. According to him a child's thinking develops in a particular sequence and learning is an active process. As the child develops and constantly interacts with the world around him or her, knowledge is invented and re-invented. This means that a learner should be allowed to do his or her own learning. Alsop (2004) asserts that 'students being taught using constructivist mathematics methods would become active learners in their environment, develop cognitive thinking and be able to relate mathematics on real world application'.

The purpose of knowing is to adapt to the environment and the learner must be active, not a vessel to be filled with knowledge. As in Mee (2006) the implication of constructivism is not to think that the learner's mind is blank, therefore, learning should build on what the learner knows and also that time is needed for a constructivist mind to be created. Prior knowledge influences the new knowledge and learners will construct from new learning experiences.

Piaget viewed teachers as facilitators of knowledge who should guide and stimulate the learners. The teacher should present learners with materials and guidelines to allow them to discover for themselves. This is the main business of Strengthening of Mathematics and Science Education (SMASE) training through Plan, Do, See, Improve (PDSI) practice. This is a paradigm shift from teacher-centred to learner-centred approach. The learners experiment and do other activities such as discussion in groups and role play instead of just listening to the teacher who uses lecturer method. SMASE training, therefore, prepares the teacher for his or her own role as a facilitator and equips him or her with comprehensive mastery of skills such as

problem solving skills. The teacher in turn also transmits a comprehensive mastery of skills to learners such that they are likely to perform well in mathematics at KCPE level.

2.6 Conceptual framework

The variables of this research are conceptualised as in figure 1. It indicates that the performance in mathematics in KCPE as a dependent variable is influenced by the independent variables. The independent variables are: the number of SMASE trainings attended; the teacher's perception of SMASE training; practice of Activity Student Experiment Improve and Plan Do See Improve (ASEI-PDSI). The researcher also identified some moderating and intervening variables which will not be considered in this study. The moderating variables were the government policies. The intervening variables include: strikes and student talents.

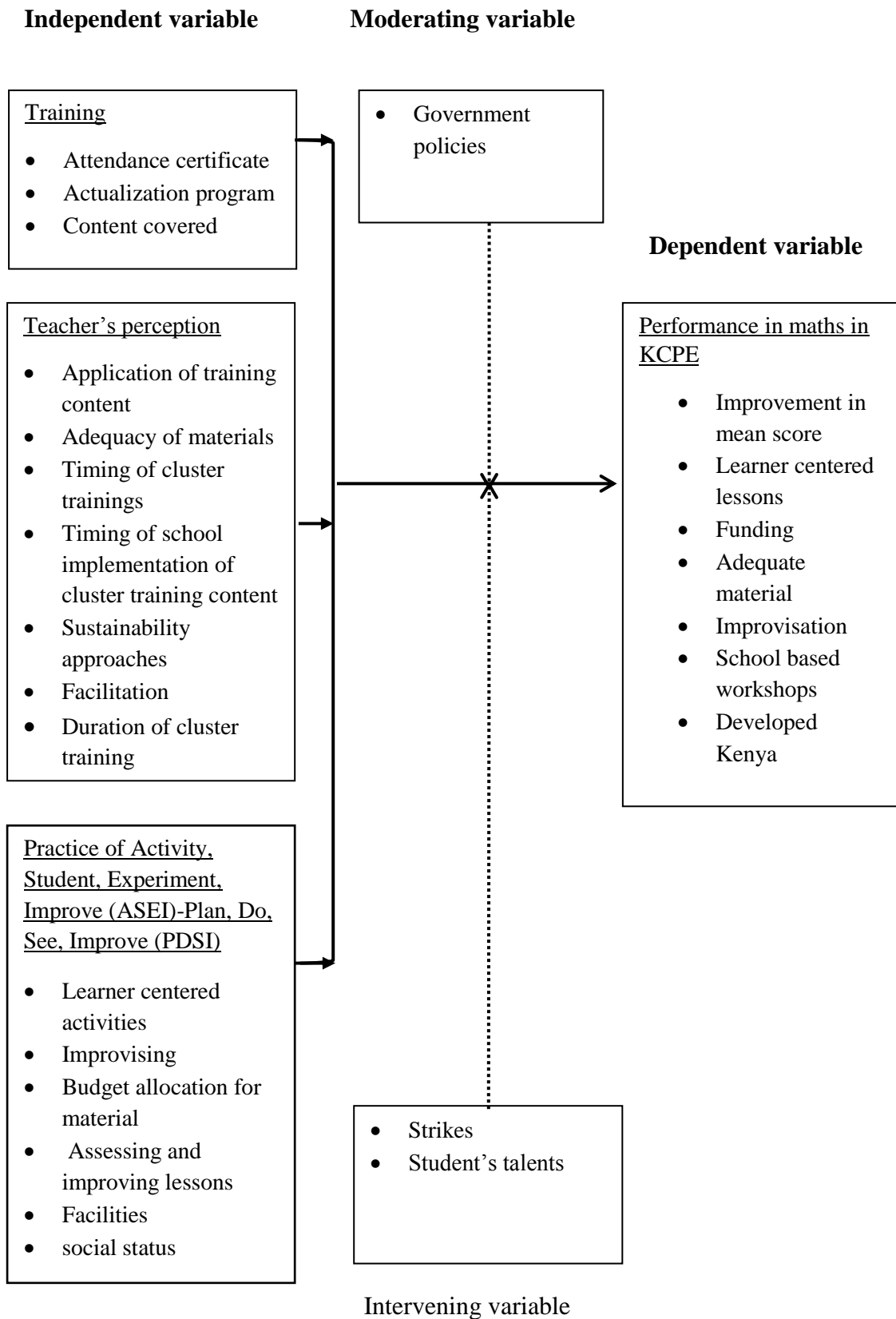


Figure 1: Conceptual framework

2.7 Summary and research gaps

In conclusion, therefore, the review of literature has provided evidence that training improves teacher quality and may influence examination results. It also showed that SMASE training project in the Primary sector was implemented based on successes of SMASSE INSET project in secondary schools in Kenya. However, gaps exist on how pupils' performance in mathematics in KCPE is affected by: number of SMASE training attended; teachers' perception of SMASE training and practice of ASEI-PDSI in classrooms. Previous studies by CEMASTEAs were not done in Embu County and the impact of SMASE training project could not have been determined exhaustively since the last KCPE examination was done at the end of the project period in 2013 hence, gaps in knowledge. The study conducted by CEMASTEAs also indicated as though SMASE had no impact because it targeted teachers who were not trained in SMASE but the current study will target only the trained ones as recommended by CEMASTEAs (2013b).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter dealt with research methodology organized under the following areas: research design; target population; sample size and sampling procedure; data collection instruments; validity of instruments; reliability of instruments; data collection procedures; data analysis procedures; data analysis techniques; ethical considerations of research; and operationalization of variables.

3.2 Research design

According to Kothari (2004) research design is the advance planning of methods to be adopted for collecting the relevant data and the techniques to be used in their analysis. The study adopted the correlation research design because it is expected to investigate the relationship between dependent and independent variables. It investigated the influence of the number of SMASE trainings attended; the teacher's perception of SMASE training; practice of Activity Student Experiment Improve and Plan Do See Improve (ASEI and PDSI) on pupils' performance in mathematics in KCPE. According to Fraenkel and Wallen (1996) correlation research describes an existing relation between variables. Correlational research examines the extent to which two or more variables relate to one another

3.3 Target population

According to Kombo & Tromp (2006) a population is an entire group of individuals, objects or items from which samples are taken. Target population is that population to which a researcher wants to generalize the results of a study (Mugenda and Mugenda, 2003). The target population of the study was head teachers and SMASE trained mathematics teachers in public primary schools in Embu West District, in Embu County.

Embu West district had 37 public primary schools that had 37 head teachers and 48 SMASE trained mathematics teachers. The Embu West district has schools typical of public primary schools in Kenya; specifically urban, rural and semi urban schools. The head teachers and SMASE trained mathematics teachers had characteristics of other trained teachers in Kenyan public schools.

3.4 Sample size and sampling procedure

The respondents were purposively selected. There are 37 public primary schools in Embu West District and an equal number of the head teachers all of whom were included in the study. The SMASE trained teachers in the 37 schools are 48 and were all included.

3.5 Data collection instruments

Data was collected through use of questionnaires as they provided an easy accumulation of data (Mugenda and Mugenda, 2003). A questionnaire is a set of questions or statements that assess attitudes, opinions, beliefs and biographical information (McMillan and Schumacher, 2001). One questionnaire was used for the head teachers and SMASE trained mathematics teachers. The questionnaire for mathematics teachers and head teachers was both structured and unstructured. The former provided options for ease of completion while the latter was open-ended to enable the study to capture in-depth information subjectively from the respondents.

The questionnaires helped to tap information on influence of SMASE INSETS at Embu West district, Embu County. The questionnaire had sections A, B, C, and D. In section A, the respondents provided their bio data by filling or ticking in the spaces provided while sections B, C, and D had questions based on the first, the second and the third objectives respectively. The document analysis form captured school mean scores for mathematics in KCPE for years 2009 to 2013.

3.6 Validity of instruments

Validity of instruments refers to the truthfulness in terms of what it intends to measure. Validity according to Mugenda and Mugenda (2003) is the accuracy and meaningfulness of inferences based on research results. It is the ability of the instruments to measure what it purports to measure. The researcher used the instruments after they were approved by the supervisor who was knowledgeable in this area. The researcher pre-tested them in two primary schools in Embu North District. The instrument was corrected and any ambiguous questions replaced or deleted.

3.7 Reliability of the instruments

Mugenda and Mugenda (2003) define reliability as a measure of degree to which research results yield consistent results with repeated trials. Reliability thus refers to the degree of consistency between two or more instruments in addressing a research problem. To test reliability, a pilot study was carried out in two purposively selected schools in the neighbouring Embu North District. The head teachers and SMASE trained mathematics teachers completed the questionnaire items. Reliability was ensured through split half method. According to Orodho (2009) split half method is a technique of assessing reliability that requires one testing session. For calculating the split half reliability coefficient, the questionnaires items were divided into two equal halves based on odd and even items. The two halves for each person were scored separately and then a correlation coefficient (r) for the two sets of scores was calculated using Spearman rank order correlation yielding r of 0.666.

The reliability of the whole instrument was calculated using the spearman-Brown prophecy formula as shown.

$$\begin{aligned}\text{Reliability of scores on total test} &= \frac{2 \times \text{reliability for half test}}{1 + \text{reliability of half test}} \\ &= \frac{2 \times 0.666}{1 + 0.666} \\ &= 0.799 = 0.8\end{aligned}$$

A correlation coefficient of 0.8 was obtained and hence the instrument was deemed to be reliable and measurable. According to Orodho (2009) a correlation coefficient (r) of about 0.75 should be considered high enough to judge the reliability of the instrument.

3.8 Data collection procedures

Using an introductory letter from the University of Nairobi, permission to collect data was sought from Embu West district education office. The District Education Officer (DEO) wrote a letter (Appendix 6) to all head teachers to allow collection of data in their schools. The researcher then visited the schools, reported to the head teacher to create rapport before collection of data which was done using self-administered questionnaires.

3.9 Data analysis techniques

The researcher checked on questionnaires for incompleteness. The data was compiled, sorted, edited, classified and coded into a coding sheet. Data which was qualitative in nature was categorised into general themes in line with the research objectives and then coded before feeding into the computer's SPSS program for analysis. Such coded data and other quantitative data collected, was analysed using descriptive and correlational statistics and presented in form of tables.

3.10 Ethical considerations of research

To ensure maintenance of ethical standards, permission to conduct research was sought from Education offices in Embu West District. The respondents were assured that the study was strictly academic and that utmost confidentiality would be observed. The data used in this study was anonymously coded and could not therefore be traced back to individual mathematics teachers or head teachers.

3.11 Operationalization of variables

The variables of this research are as operationalized on Table 3.1

Table 3.1 Table of operationalization of variables

| Objective | Variable | Indicators | Measure | Scale |
|---|--|---|--|------------------------|
| To examine the extent to which the number of SMASE trainings attended influenced pupils performance in Mathematics in KCPE. | <u>Independent</u> -Number of trainings attended. | -Attendance certificate -actualization program -Content coverage | -Number of certificates -Presence or absence of actualization -Level of content coverage | Ratio |
| To establish the extent to which teacher's perception of SMASE training project influences pupils' performance in Mathematics in KCPE. | <u>Independent</u> Perception of SMASE training | Application of training content Facilitation Timing of cluster training Timing of school implementation of cluster content Sustainability approaches Adequacy of materials | Number of teachers who applied the training content Rating of quality of facilitation Time in weeks Time in school terms Number of teachers using various sustainability approaches Amount of materials | Ratio Ratio |
| To determine the extent to which practice of Activity Student improvise and plan Do See Improve in the classroom influenced pupils' performance in mathematics in KCPE. | <u>Independent</u> Practice of ASEI-PDSI | Learner centered activities Improvising Budget allocation for material. Assessing and improving of lessons | Number of schemes of work and ASEI lesson plans made Frequency of learner centered activities Number of materials improvised Amount allocated (KSh.) Approach of assessing for improvement of lesson | Ratio Ratio |
| | <u>Dependent</u> Performance in mathematics in KCPE examination | KCPE mean grade | Grades obtained in KCPE from 2009 to 2013 | Ratio |

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter contains data analysis, presentation and interpretation of findings. The study intended to investigate the influence of the strengthening of mathematics and science education training project on pupils' performance in mathematics: a case of public primary schools in Embu West District, Embu County. The chapter discusses results of the study under the following headings: questionnaire return rate and objectives namely number of SMASE trainings attended, teachers perception of SMASE training project and extent to which practice of Activity, Student, Experiment, improvise- Plan, Do, See, Improve (ASEI-PDSI) in the classroom influences pupils' performance in mathematics in KCPE.

4.2 Questionnaire Return Rate

The questionnaire return rate was 82 of the 85 questionnaires used (96.5%). This was possible since the questionnaires were administered, and collected immediately respondents completed. In cases where questionnaires were left behind, they were collected the following day.

4.3 Demographic Characteristics of the respondents

This section discusses the respondent's age, sex, level of education gender, professional course attended, and teaching experience, position in SMASE and type of the school. These social attributes were relevant to the study since they enabled the respondent to provide information that is valid, reliable and relevant to the study.

4.3.1 Study responses by gender

The respondents from SMASE training project in Embu West District were asked to indicate their gender. The responses are shown in Table 4.1.

Table 4.1 Gender of the respondents

| Gender of respondent | Frequency | Percentage |
|-----------------------------|------------------|-------------------|
| Male | 43 | 52.4 |
| Female | 39 | 47.6 |
| Total | 82 | 100.0 |

The study findings indicated that 43 respondents (52.4 %) were males, while 39 respondents (47.6 %) were females. This shows that more male than female teachers attended SMASE training from Embu West.

4.3.2 Respondents by age

The respondents were asked to indicate their ages from among choices of age classes given. The respondents' responses are shown in Table 4.2

Table 4.2 Age of respondents

| Age of respondent in years | Frequency | Percentage |
|-----------------------------------|------------------|-------------------|
| 20-30 | 1 | 1.2 |
| 31-40 | 8 | 9.8 |
| 41-50 | 38 | 46.3 |
| 51-60 | 35 | 42.7 |
| Total | 82 | 100.0 |

The findings show that 38 respondents (46.5 %) were in the age bracket 41-40 years and 35 respondents (42.7%) in age bracket of 51-60 years. This indicates that majority of the teachers 73 (89 %) who attended SMASE training were in the age bracket of 41-60 years.

4.3.3 Education level of the respondents.

The respondents were asked to indicate their education level. Table 4.3 shows the distribution of the respondents by education level.

Table 4.3 Education level of the respondents

| Education level | Frequency | Percentage |
|------------------------|------------------|-------------------|
| Certificate/Diploma | 57 | 69.5 |
| Undergraduate | 22 | 26.8 |
| Graduate-masters | 3 | 3.7 |
| Total | 82 | 100.0 |

The findings indicate that 57 respondents (69.5%) had Certificate or Diploma certificates while 22 (26.8%) had acquired a Bachelor's degree. This implies that even some teachers who had certificates during entry in education sector have gone for further studies and attained a Diploma, a Bachelors or a Master's degree.

4.3.4 Professional courses attended by respondents

The respondents were asked to indicate the professional course attended. The responses are shown in Table 4.4.

Table 4.4 Professional course attended by respondents

| Professional course | Frequency | Percentage |
|--|------------------|-------------------|
| Diploma in School Management | 16 | 19.5 |
| Diploma in ECD | 4 | 4.9 |
| Degree (B.Ed. science) | 3 | 3.7 |
| SBEP, KEMI, Special Needs in Education | 32 | 39.0 |
| None | 25 | 30.5 |
| Not applicable | 2 | 2.4 |
| Total | 82 | 100.0 |

The study findings indicated that 32 respondents (39.0 %) had attained professional training in School Based Education Program, Kenya Education Management Institute and Special Needs in Education while 16 respondents (19.5%) had by attained Diploma in School Management by KEMI.

4.3.5 Teaching experience

The respondents were asked to indicate their teaching experience. They responded as shown in Table 4.5

Table 4.5 Teaching experience of respondents

| Teaching experience | Frequency | Percentage |
|---------------------|-----------|--------------|
| 1-5 years | 4 | 4.9 |
| 6-10 years | 5 | 6.1 |
| 11-15 years | 2 | 2.4 |
| 16-20 years | 11 | 13.4 |
| Over 20 years | 60 | 73.2 |
| Total | 82 | 100.0 |

The research findings show that 60 respondents (73.2%) had a teaching experience of over 20 years while 11 respondents had an experience of 16-20 years. This implies that most teachers attending SMASE training had adequate experience in the teaching of mathematics.

4.3.6 Position in SMASE

The respondents were asked to indicate their Position in SMASE. Table 4.6 shows their Positions in SMASE.

Table 4.6 Position in SMASE

| Position in SMASE | Frequency | Percentage |
|-----------------------------|-----------|------------|
| Head teacher | 35 | 42.7 |
| Mathematics cluster trainee | 38 | 46.3 |
| Mathematics cluster trainer | 8 | 9.8 |
| Not applicable | 1 | 1.2 |
| Total | 82 | 100 |

The findings indicate that 38 respondents (46.3%) were mathematics cluster trainees, 35 respondents (42.7%) were head teachers and 8 respondents (9.8%) were

mathematics cluster trainers. Involvement of head teachers ensured that the SMASE trainings are passed on to pupils.

4.3.7 Type of the school

The respondents were asked to indicate the type of the school they were in. Their responses are shown in Table 4.7

Table 4.7 Type of the school

| Type of the school | Frequency | Percentage |
|--------------------|-----------|--------------|
| Mixed day | 78 | 95.1 |
| Mixed boarding | 4 | 4.9 |
| Total | 82 | 100.0 |

The findings show that 78 respondents (95.1%) teach in mixed day schools while 4 respondents (4.9%) teach in mixed boarding schools. This implies that most teachers who attended SMASE training came from mixed day schools.

4.4 Influence of number of SMASE trainings on pupils' performance in mathematics in KCPE.

The number of SMASE trainings held and their influence on pupils' performance in mathematics in KCPE.

4.4.1 Number of training cycles of SMASE training attended

The respondents were requested to indicate the number of training cycles of SMASE they had attended. Their responses are in Table 4.8.

Table 4.8 Number of training cycles of SMASE attended

| Number of trainings of training cycles | Frequency | Percentage |
|--|-----------|--------------|
| 1 | 16 | 19.5 |
| 2 | 17 | 20.7 |
| 3 | 22 | 26.8 |
| 4 | 24 | 29.3 |
| Others | 1 | 1.2 |
| None | 2 | 2.4 |
| Total | 82 | 100.0 |

The study showed that 24 respondents (29.3 %) had attended four training cycles, 22 respondents (26.8 %) had attended three training cycles, 17 respondents (20.7 %) had attended two training cycles and 16 respondents (19.5%) had attended one training cycle. This shows that only 29.3% of the teachers were fully equipped with skills attitudes and knowledge of SMASE training.

4.4.2 Actualization

The respondents were asked to indicate whether actualization of training content was done. Their responses recorded in Table 4.9.

Table 4.9 Whether actualization of the training content was done

| Whether actualization done | Frequency | Percentage |
|----------------------------|-----------|--------------|
| Yes | 64 | 78.0 |
| No | 18 | 22.0 |
| Total | 82 | 100.0 |

The study showed that of 64 respondents (78 %) did actualization while 18 respondents (18%) did not do actualization. Actualization enabled the trainees to understand the SMASE trainings better.

4.4.3 Challenges hindering actualization

The respondents were asked to indicate the challenges hindering actualization. Table 4.10 shows their responses.

Table 4.10 Challenges hindering actualization

| Challenges hindering actualisation | Frequency | Percentage |
|--|-----------|--------------|
| Lack of children during holidays | 7 | 8.5 |
| Teachers were on strike | 1 | 1.2 |
| Poor communication, logistics and inadequate orientation | 4 | 4.9 |
| Time factor in attending college and short training period | 6 | 7.3 |
| Not applicable | 64 | 78.0 |
| Total | 82 | 100.0 |

The findings show that, 7 respondents (8.5 %) did not undertake actualization because they lacked children during holidays while 6 respondents (7.3%) did not undertake actualization because of time factor in attending college and short training period.

4.4.4 Why school based workshops were not organized

The respondents were asked to indicate reasons of not organizing school based workshops. Table 4.11 shows their responses

Table 4.11 Reasons of not organizing school based workshops

| Reasons of not organizing school based workshops | Frequency | Percentage |
|--|------------------|-------------------|
| Time factor , lack of time, syllabus coverage | 17 | 20.7 |
| Understaffing, few teachers attended due to payment delays | 2 | 2.4 |
| Moved to special school(unit) | 1 | 1.2 |
| No power to organize as a classroom teacher | 1 | 1.2 |
| Not yet trained | 2 | 2.4 |
| Not applicable | 59 | 72.0 |
| Total | 82 | 100.0 |

The findings show that 17 respondents (20.7 %) did not organize school based workshops because of time factor, lack of time and lack of syllabus coverage while 2 respondents (2.4 %) stated that there was understaffing and only a few teachers attended trainings due to delay in payments.

4.4.5 Improving mean scores in mathematics in KCPE by attending training cycles

The respondents were asked to indicate whether attending more training cycles improve mean scores in mathematics in KCPE and Table 4.12 shows the responses

Table 4.12 Whether attending more training cycles betters mean scores in KCPE

| Whether more training cycles attended betters the mean scores in KCPE | Frequency | Percentage |
|--|------------------|-------------------|
| Strongly agree | 25 | 30.5 |
| Agree | 43 | 52.4 |
| Disagree | 14 | 17.1 |
| Total | 82 | 100.0 |

The findings showed that 43 respondents (52.4%) agree that attending training cycles better performance in KCPE while 25 respondents (30.5%) strongly agree that attending training cycles better performance in KCPE. This implies 68 respondents (82.9%) believed that attending more training cycles betters performance in KCPE.

4.5 Influence of teachers perception of SMASE training on pupils' performance in mathematics in KCPE.

4.5.1 Rating of the SMASE trainings attended

The respondents were asked to indicate the rating of the trainings attended. Table 4.13 shows the responses.

Table 4.13 Rating of the SMASE trainings attended

| Rating of SMASE training | Frequency | Percentage |
|---------------------------------|------------------|-------------------|
| Relevant | 45 | 54.9 |
| Very relevant | 24 | 29.3 |
| Fairly relevant | 11 | 13.4 |
| Others | 2 | 2.4 |
| Total | 82 | 100.0 |

The findings showed that 45 respondents (54.9%) believed that the trainings attended were relevant while 24 respondents (29.3 %) believed that the trainings attended were very relevant. This implies the SMASE trainings improved pupils' performance of mathematics in KCPE.

4.5.2 Rating the themes and topics in SMASE training according to teaching needs

The respondents were asked to indicate the rating of the themes and topics in SMASE training according to teaching needs. Their responses are in Table 4.14.

Table 4.14 Rating the themes and topics in SMASE training according to teaching needs

| Content | Frequency | Percentage |
|-----------------|------------------|-------------------|
| Very relevant | 28 | 34.1 |
| Relevant | 49 | 59.8 |
| Fairly relevant | 5 | 6.1 |
| Total | 82 | 100.0 |

The findings indicated that 49 respondents (59.8%) believed that the themes and topics in SMASE training were relevant to teaching needs. 28 respondents (34.1 %) believed that the themes and topics in SMASE training were very relevant to teaching needs.

4.5.3 Rating of quality of facilitation of SMASE training for mathematics

The respondents were asked to indicate the rating of quality of facilitation of SMASE training for mathematics. Their responses are in Table 4.15.

Table 4.15 Rating of quality of facilitation of SMASE training for mathematics

| Quality of facilitation | Frequency | Percentage |
|-------------------------|-----------|--------------|
| Excellent | 10 | 12.2 |
| Very Good | 20 | 24.4 |
| Good | 40 | 48.8 |
| Fair | 12 | 14.6 |
| Total | 82 | 100.0 |

From the study, 40 respondents (48.8%) indicated that the quality of facilitation of SMASE training for mathematics was good, 20 respondents (24.4%) indicated that the quality of facilitation of SMASE training for mathematics was very good while 12 respondents (14.6%) indicated that the quality of facilitation of SMASE training for mathematics was excellent.

4.5.4 When SMASE INSET content should be implemented in primary schools

The respondents were asked to indicate the period of the year when SMASE INSET content should be implemented in primary schools so as to improve pupils' performance in mathematics in KCPE. Their responses are in Table 4.16.

Table 4.16 When SMASE INSET content should be implemented

| Period | Frequency | Percentage |
|--------------|-----------|--------------|
| Term one | 81 | 98.8 |
| Term two | 1 | 1.2 |
| Term three | 0 | 0 |
| Total | 82 | 100.0 |

From the study, 81 respondents (98.8%) indicated that term one was the best period SMASE INSET content should be implemented in primary schools so as to influence pupils' performance in mathematics in KCPE positively. Term one is the start of the year and the best time to implement SMASE INSET content in primary schools.

4.5.5 Duration which is appropriate for cluster training so as to maintain quality grades in mathematics in KCPE

The respondents were asked to indicate the duration which is appropriate for cluster training so as to maintain quality grades in mathematics in KCPE. Their responses are in Table 4.17.

Table 4.17 Duration which is appropriate for cluster training to maintain quality grades in mathematics in KCPE

| Appropriate duration | Frequency | Percentage |
|-----------------------------|------------------|-------------------|
| One week | 34 | 41.5 |
| Two Weeks | 42 | 51.2 |
| Others | 1 | 1.2 |
| Not applicable | 5 | 6.1 |
| Total | 82 | 100.0 |

From the study, 42 respondents (51.2%) believed that to maintain quality grades in mathematics in KCPE, cluster training should take two weeks. 34 respondents (41.5%) believed that cluster training should take one week. Two weeks training would enable the trainees to learn theory and practical and thus improve on their job performance.

4.5.6 Suggested improvements required in SMASE trainings

The respondents were asked to suggest improvements required in SMASE trainings. They responded as shown in Table 4.18.

Table 4.18 Suggested improvements required in SMASE trainings

| Improvements required in SMASE trainings | Frequency | Percentage |
|---|------------------|-------------------|
| Include all science teachers, H/Teachers and deputies | 4 | 4.9 |
| Train during school time | 4 | 4.9 |
| Improve payments | 26 | 31.7 |
| Award certificates | 6 | 7.3 |
| Choose mathematics conversant trainers | 35 | 42.7 |
| Provide/improve materials training materials | 3 | 3.7 |
| None | 4 | 4.9 |
| Total | 82 | 100.0 |

From the study, 35 respondents (42.7%) indicated that SMASE trainings can be improved by choosing trainers who are conversant with mathematics content. 26 respondents (31.7%) indicated that time taken to pay allowances should be reduced. These improvements would raise the quality of SMASE training.

4.5.7 Sustenance of SMASE trainings to maintain quality grades in mathematics in KCPE

The respondents were asked to indicate how SMASE trainings can be sustained to maintain quality grades in mathematics in KCPE. Their responses are in Table 4.19.

Table 4.19 Sustenance of SMASE trainings to maintain quality grades in mathematics in KCPE

| Sustenance of SMASE training | Frequency | Percentage |
|-------------------------------------|------------------|-------------------|
| Team teaching | 22 | 26.8 |
| Subject INSET/workshops | 58 | 70.7 |
| Others | 2 | 2.4 |
| Total | 82 | 100.0 |

The study showed that 58 respondents (70.7%) indicated that sustenance of SMASE trainings to maintain quality grades in mathematics in KCPE can be achieved through subject workshops while 22 respondents (26.8%) indicated that the same can be achieved through team teaching. This implies that through collaboration among teachers programmes can be sustained hence maintain quality grades in mathematics in KCPE.

4.5.8 Influence of SMASE trainings on pupils' performance in mathematics in KCPE

The respondents were asked to indicate the influence of the trainings on pupils' performance in mathematics in KCPE. Their responses are in Table 4.20.

Table 4.20 Influence of the SMASE trainings on pupils' performance in mathematics in KCPE

| Influence of training | Frequency | Percentage |
|------------------------------|------------------|-------------------|
| Very positively | 10 | 12.2 |
| Positively | 53 | 64.6 |
| Fairly | 13 | 15.9 |
| Not at all | 6 | 7.3 |
| Total | 82 | 100.0 |

This study showed that, 53 respondents (64.6%) believed the SMASE trainings had a positive influence on pupils' performance in mathematics in KCPE while 10 respondents (12.2%) believed the influence was very positive.

4.6 Influence of ASEI-PDSI (practice of Activity, Student, Experiment, Improve - Plan, Do, See, Improve) in the classroom on pupils' performance in mathematics in KCPE

4.6.1 How ASEI-PSDI helps teachers focus more on set lesson objectives

The respondents were asked to indicate how the practice of ASEI PSDI helps them focus more on set lesson objectives. Their responses are in Table 4.21.

Table 4.21 Practice of ASEI PSDI helps us focus more on set lesson objectives

| Practice of ASEI PSDI | Frequency | Percentage |
|------------------------------|------------------|-------------------|
| Strongly agree | 29 | 35.4 |
| Agree | 52 | 63.4 |
| Disagree | 1 | 1.2 |
| Total | 82 | 100.0 |

From the study, 52 respondents (63.4%) agreed that the practice of ASEI PSDI helped them focus more on set lesson objectives while 29 respondents (35.4%) strongly

agreed on the same. Thus, 81 respondents (98.8%) believed that the practice of ASEI PSDI helped them focus more on set lesson objectives.

4.6.2 How often learners were involved in activities through ASEI PSDI

The respondents were asked to indicate how often they involved learners in activities through ASEI PSDI approach. Their responses are in Table 4.22.

Table 4.22 How often learners were involved in activities through ASEI PSDI

| Learners involvement | Frequency | Percentage |
|-----------------------------|------------------|-------------------|
| Very Often | 26 | 31.7 |
| Often | 51 | 62.2 |
| Rarely | 5 | 6.1 |
| Total | 82 | 100.0 |

The study shows that, 51 respondents (62.2%) involved learners in activities through ASEI-PSDI approach often, while 26 respondents (31.7%) involved learners very often. That is, 77 respondents (93.9%) involved learners in activities through ASEI PSDI.

4.6.3 Activities learners are engaged in

The respondents were asked to indicate the activities learners are engaged in. Their responses are in Table 4.23.

Table 4.23 Activities learners are engaged in

| Learners activities | Frequency | Percentage |
|----------------------------|------------------|-------------------|
| Discussion in groups | 70 | 85.4 |
| Improvisation of materials | 9 | 11.0 |
| Performing role play | 3 | 3.6 |
| Total | 82 | 100.0 |

70 respondents (85.4%) indicated that they involved learners in activities through ASEI-PSDI by way of group discussion, 9 respondents (11%) involved learners through improvisation of material while 3 respondents (3.6%) indicated by way of role playing. These practical activities enhance understanding, cooperative learning

and critical thinking. They further show teachers' shift from banking method to learner centred approaches through ASEI-PDSI whereby the teacher plays the role of a facilitator.

4.6.4 Challenges encountered during ASEI lessons

The respondents were asked to indicate the challenges encountered during ASEI lessons. Their responses are in Table 4.24.

Table 4.24 Challenges encountered during ASEI lessons

| Challenges | Frequency | Percentage |
|--|-----------|--------------|
| Inadequate materials/tools | 40 | 48.8 |
| Inadequate textbooks | 3 | 3.7 |
| Inadequate allocated funds for buying tool | 23 | 28.0 |
| Lack of skills to improvise local materials in some topics such as algebra | 14 | 17.1 |
| Lack of skills to improvise others | 2 | 2.4 |
| Total | 82 | 100.0 |

From the study, 40 respondents (48.8%) indicated that inadequate materials/tools is their major challenge during ASEI lessons while 23 respondents (28.0%) indicated that their main challenge was inadequate allocated funds for buying tools. These challenges hampered delivery of ASEI lessons.

4.6.5 Solving the problem of funding to improve pupils' performance in mathematics in KCPE

The respondents were asked to indicate how the problem of funding can be solved to improve pupils' performance in mathematics in KCPE. Their responses are in Table 4.25.

Table 4.25 How the problem of funding can be solved

| Solving of funding problem | Frequency | Percentage |
|---|-----------|--------------|
| A specific fund be allocated through the free primary education project | 26 | 31.7 |
| Not applicable | 56 | 68.3 |
| Total | 82 | 100.0 |

From the study, 26 respondents (31.7%) indicated that a specific fund can be created through free primary education to enhance teaching of SMASE lessons. This fund would be used to pay facilitators and buy materials for teaching of SMASE lessons.

4.6.6 Lesson assessment methods to help “See” so as to improve the lessons

The respondents were asked to indicate the methods of assessment employed in the lesson to help “See” so as to improve the lessons. Their responses are in Table 4.26.

Table 4.26 Methods of assessment employed in the lesson to help “See”

| Methods of assessment | Frequency | Percentage |
|--|-----------|--------------|
| Oral questions | 22 | 26.8 |
| Written exercises | 33 | 40.2 |
| Reflection | 10 | 12.2 |
| Observing finished products made by learners | 17 | 20.7 |
| Total | 82 | 100.0 |

From the study, 33 respondents (40.2%) employed written exercises, 22 respondents (26.8%) employed oral questions, and 17 respondents (20.7%) employed observation of finished products made by learner while 10 respondents (12.2%) employed reflection to help ‘See’ so as to improve the lessons. Written exercises, oral questions, observing finished products made by learners and reflection help to ‘See’ so as to improve the lessons. Assessment improves teaching and learning in a classroom because it helps to tell whether the objectives were achieved.

4.6.7 Improvement of KCPE mathematics performance through SMASE trainings.

The Embu Sub County staffs were asked to give the mean scores of mathematics performance from 2009 to 2013. Table 4.27 shows the rank correlation coefficients based on data in appendix 5.

Table 4.27 Spearman’s rank correlation coefficients for schools mean score after SMASE trainings

| Years | Correlation coefficients | Improvement |
|-----------|--------------------------|-------------|
| 2009-2010 | 0.52 | Positive |
| 2010-2011 | 0.92 | Positive |
| 2011-2012 | 0.92 | Positive |
| 2012-2013 | 0.95 | Positive |
| 2009-2013 | 0.88 | Positive |

From the study, there is a positive correlation between the grades obtained after SMASE training as shown by Spearman's Rank correlation coefficients. This positive correlation was observed in grades obtained in: 2009 and 2010; 2010 and 2011; 2011 and 2012; 2012 and 2013; and those obtained in 2009 and 2013. The rank correlations coefficients between the respective years were 0.52, 0.92, 0.92, 0.95 and 0.88. This implies that SMASE project had improved pupils' performance in mathematics in KCPE in Embu West District, Embu County.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the summary of findings, discussions, conclusions and recommendations. It also includes suggested areas for further research and contributions to the body of knowledge.

5.2 Summary of Findings

The summary of findings presented here is based on the three objectives of the study. With regards to objective one, the study revealed that 24 respondents (29.3%) had attended four training cycles and 22 respondents (26.8%) had attended three training cycles. The study showed that 64 respondents (78%) did actualization while 18 respondents (18%) did not do actualization. Actualization enabled the trainees to understand the SMASE trainings better. The findings also showed that 7 respondents (8.5%) did not undertake actualization because they lacked children during holidays while 6 respondents (7.3%) did not undertake actualization because of time factor in attending college for other studies and the short training period. The findings show that 17 respondents (20.7%) did not organize school-based workshops because of time factor, and lack of syllabus coverage while 2 respondents (2.4%) stated that there was understaffing and only a few teachers attended trainings due to delay in payments of allowances. The findings also showed that 43 respondents (52.4%) agreed that attending more training cycles makes mean scores in mathematics in KCPE better while 25 respondents (30.5%) strongly agreed that attending more training cycles make mean scores in mathematics in KCPE better. This implies 68 respondents (82.9%) believed that attending more SMASE training cycles improved pupils' performance in mathematics in KCPE.

The findings based on the second objective showed that: 45 respondents (54.9%) believed that the trainings attended were relevant while 24 respondents (29.3 %) believed the trainings were very relevant. This implies 64 respondents (84.2%) believed that the trainings attended were relevant. This further implies the SMASE trainings improved pupils' performance in mathematics in KCPE. The findings also showed that 49 respondents (59.8%) believed that the themes and topics in SMASE

training were relevant to teaching to needs while 28 respondents (34.1%) believed that the themes and topics in SMASE training were very relevant to teaching needs.

From the study, 40 respondents (48.8%) rated the quality of facilitation of SMASE training for mathematics as good while 20 respondents (24.4 %) rated it as very good. The study also showed that 81 respondents (98.8%) indicated that term one was the best period for implementing SMASE INSET content in primary schools so as to influence performance in mathematics in KCPE positively. Term one is the start of the year. From the study, 42 respondents (51.2 %) indicated that to maintain quality grades in KCPE cluster training should take two weeks while 34 respondents (41.5 %) indicated one week for the training. Two weeks training will enable the trainees to learn the theory and practical aspects and thus improve on their job performance.

From the study, 35 respondents (42.7%) indicated that SMASE trainings should be improved by choosing trainers who are conversant with content in mathematics while 26 respondents (31.7%) indicated need to improve on the time taken to be paid after training. These improvements would raise the quality of SMASE training. The study also showed that 58 respondents (70.7%) indicated that sustenance of SMASE trainings to maintain quality grades in mathematics in KCPE can be achieved by organizing subject workshops while 22 respondents (26.8%) indicated that sustenance of SMASE trainings to maintain quality grades in mathematics in KCPE can be achieved through teaching in teams. From the study, 53 respondents (64.6%) indicated that the influence of the SMASE trainings on performance in mathematics in KCPE was positive while 10 respondents (12.2 %) indicated it was very positive.

With regards to third objective, the following revelations were made. The study showed that 52 respondents (63.4%) agreed that the practice of ASEI PSDI helps them focus more on the set lesson objectives while 29 respondents (35.4 %) strongly agreed to the same. Therefore 81 respondents (98.8%) believed that the practice of ASEI- PSDI helps them focus more on the set lesson objectives.

From the study, 51 respondents (62.2%) indicated that they involve learners in activities through ASEI- PDSI areas very often while 26 respondents (31.7%) involved them often. In total, 77 respondents (93.9%) involved learners in activities through ASEI- PDSI. The study further showed that 70 respondents (85.4%) involved learners in activities in ASEI- PDSI areas through discussion in groups, 9 respondents

(11%) involve learners through improvisation of materials and 3 respondents (3.6%) involved learners in activities through ASEI PDSI areas through performance of role plays. These practical activities enhance understanding and imply shift from lecture method to learner centred lessons through ASEI-PDSI approach.

From the study, 40 respondents (48.8%) indicated that lack of adequate materials/tools is the major challenge they face during ASEI lessons while 23 respondents (28.0%) indicated that their main challenge was lack of funds for buying tools. These challenges hampered delivery of ASEI lessons. From the study, 26 respondents (31.7%) indicated that the problem of funding could be solved through creation of a specific fund through the free primary education programme to enhance teaching of SMASE lessons. This fund would be used to pay facilitators and buy materials for teaching of SMASE lessons.

From the study, 33 respondents (40.2%) indicated that they employ written exercises, 22 respondents (26.8%) employ oral questions while 17 respondents employ observation of finished products made by learners in the lesson to help 'See' so as to improve the lessons. Written exercises, oral questions, observing finished products made by learners and reflection helped to 'See' to improve the lessons. Assessment improves teaching and learning in a classroom.

In the study, there is a positive correlation between the grades obtained after SMASE training as shown by Spearman's Rank correlation coefficients. This positive correlation was observed in grades obtained in: 2009 and 2010; 2010 and 2011; 2011 and 2012; 2012 and 2013; and those obtained in 2009 and 2013. The rank correlations coefficients between the respective years were 0.52, 0.92, 0.92, 0.95 and 0.88. The training improved the performance of mathematics in the schools continually from 2009 to 2013.

5.3 Discussion of Findings

A discussion of the findings of this study is presented based on the three objectives of the study.

5.3.1 Influence of SMASE trainings attended on pupils' performance in mathematics in KCPE.

The study revealed that 24 respondents (29.3%) had attended four (4) SMASE training cycles while 22 respondents (26.8%) had attended three (3) SMASE training cycles. The training had enhanced pupils' performance in mathematics in KCPE. This is supported by JICA & ROK (2008) who reported that Kenya Education Sector Support Programme emphasised on the importance of mathematics and science education in order to achieve higher economic levels in Kenya and therefore, the Government of Kenya was ready to invest in education including Strengthening of Mathematics and Science Education (SMASE).

The study showed that 64 respondents (78%) did actualization while 18 respondents (18%) did not do actualization. Actualisation improves the quality of teachers. This collaborates with the study by JICA (2014) which held that SMASE Project addresses improving quality of teachers in terms of attitude, pedagogy, and mastery of content, resource mobilization and utilization of locally available teaching materials. SMASE Project aims to shift teaching paradigm from "banking style/chalk and talk" to "ASEI & PDSI approach." ASEI & PDSI approach is the effective approach for ensuring the quality of mathematics and science lessons and their steady improvement. This also agrees with Hayes (2011) who stated that the hallmark of a good teacher and what facilitates good teacher formations, is learning from other professionals in the classroom. The findings indicated that 68 respondents (82.9%) believed that attending more training cycles improves pupils' performance in mathematics in KCPE. These training cycles impart practical and sustainable knowledge and skills in teaching mathematics and sciences. This agrees with McKeown (2002) who observed that the proponents of Sustainable Development (SD) had realized there could be no sustainable development in the world if teachers were not trained in such a way that skills, knowledge, attitudes and values that enhanced sustainability were inculcated in teachers during training and these be transmitted to the students and consequently the society at large. Education remains the vehicle to achieving sustainable development.

5.3.2 Influence of teachers perception of SMASE training project on pupils' performance in mathematics in KCPE.

The findings showed that while 45 respondents (54.9%) believed that the trainings attended were relevant, 24 respondents (29.3%) believed that the trainings attended were very relevant. This implies that the teacher's perception on SMASE trainings improved pupils' performance in mathematics in KCPE. This agrees with Ferguson (2003) who stated that 'as teachers immerse themselves in the routines of schooling, both perceptions and expectations reflect and determine the goals that they set for achievement, the strategies they use to pursue the goals, the skills, energy, and other resources they use to implement the strategies, and the rewards they expect from making the effort. These should affect standardized scores as well as other measures of achievement'.

The findings also showed that 49 respondents (59.8%) believed that the themes and topics in SMASE training were relevant to teaching needs while 29.3% believed they were very relevant hence improved the quality of teachers. This agrees with Hayes (2011) who asserted that no education system can be better than the quality of its teachers. It further collaborates with the study by Siddiqui (2004) who reported that competent teachers apply broad, deep and integrated sets of knowledge and skills as they plan for, implement and revise instruction. It also agrees with AFT (2000) research in United States who reported that teacher quality is the single most important variable in determining students' achievement. This further agreed with Uysal (2012) who stated that considering teachers' needs, experiences, and contexts as central, valuing their ideas, negotiating content, accepting teachers as experts, and encouraging them to reflect on their current beliefs and behaviours are important factors to induce long-lasting changes in teacher practices.

In this study, 40 respondents (48.8%) rated the quality of facilitation of SMASE training for mathematics as good while 20 respondents (24.4%) rated it as very good. This collaborates with the study by Ogwel, Odhiambo and Kibe (2008) who observed that the role of attitude in teaching revealed that teachers' disposition to change their practices and embrace more student centred instruction depends on the quality of professional development.

The study also showed that 81 respondents (98.8%) indicated that term one, which is the start of the year was the best time to implement SMASE INSET content in primary schools if it was to positively influence performance in mathematics in KCPE. Term one is the start of the year and the best time to implement SMASE INSET content in primary schools.

From the study, 42 respondents (51.2%) indicated that to maintain quality grades in KCPE cluster- training should take two weeks. Two weeks in service training would enable the trainees to learn theory, practical and share ideas with peers and thus improve on their job performance. This collaborates with the study by Lucie (2004) who held that in-service education and training or continuing professional development for employees have positive influences on individual job performance and corporate performance. This further agrees with Akram (2010) who recommended from his study on factors affecting the performance of teachers at higher secondary at Punjab that though the factor of teacher's job performance was found to be the highest in the study, teachers should continue their attention and improve their command on the content through self-study and by attending in service refresher courses.

This study revealed that 35 respondents (42.7%) indicated that SMASE trainings should be improved by choosing trainers who are conversant with mathematics content while 26 respondents (31.7%) felt need for SMASE trainings to be improved by reducing the time taken to be paid after training. These improvements would raise the quality of SMASE training. This agrees with CEMASTE (2013) who recommended that planning for INSET, notification of host schools, official invitation of teachers and payments be paid in time.

The study also showed that 58 respondents (70.7%) indicated that sustenance of SMASE trainings to maintain quality grades in mathematics in KCPE can be achieved through carrying out of subject workshops while 22 respondents (26.8%) indicated that the same can be achieved through team teaching. This agrees with Ogwel et al (2008), who stated that SMASSE had impact on learner's capabilities and that through ASEI-PDSI there was a significant improvement in learner cognitive skills. It also agrees with Hayes (2011) who opines that the hall-mark of a good teacher, and what facilitates good teacher formations, is learning from other professionals in the classroom. It further collaborates with Sagie (2002) who observed that for an

organization to perform better, it is important that employees are comfortable with each other, share a good rapport and work in close coordination towards a common objective. As a result, people feel responsible and motivated to do good work and enjoy their work other than taking it as a burden.

5.3.3 Influence of practice of ASEI-PDSI (Activity, Student, Experiment, improvise- Plan, Do, See, Improve) on pupils' performance in mathematics in KCPE.

The study showed that 81 respondents (98.8%) believed that the practice of ASEI PSDI helps them focus more on set lesson objectives. This agrees with Siddiqui (2004) who opined that competent teachers apply broad, deep and integrated sets of knowledge and skills as they plan for, implement and revise instruction. It further collaborates with MOE and USAID (2011) that through SMASE, teachers improve their skills in work planning, achievement, self and collegial evaluation and utilization of feedback to improve subsequent lessons. From the study, 77 respondents (93.9%) involved learners in activities through ASEI PSDI approach. The respondents used various activities. 70 respondents (85.4%) involved learners through discussion in groups, 9 respondents (11%) through improvisation of material while 3 respondents (3.6%) used performance of role plays. These practical activities enhance understanding. This agrees with MOE & USAID (2009) who stated that effective teaching should be based on the active involvement of the learners and further asserted that active learning is a process where learners are continuously engaged in the learning process. The MOE & USAID (2009) further said that learners engage in active learning by solving problems, role playing, discussing in groups and asking questions.

From the study, 40 respondents (48.8%) indicated lack of adequate materials/tools as the major challenge during ASEI lessons. This agrees with JICA and ROK (2008) who stated that success of ASEI lessons depends on availability of teaching/ learning materials. From the study, 26 respondents (31.7%) indicated that the problem of funding can be solved through creation of a specific fund through the free primary education programme to enhance teaching of SMASE lessons. Such a fund would be used to pay facilitators and buy materials for teaching of SMASE lessons.

The study revealed that 33 respondents (40.2%) employed written exercises, 22 respondents (26.8%) employed oral questions, 17 respondents (20.7%) employed observation of finished products made by learners in the lesson while 10 respondents (12.2%) employed reflection to help 'See' so as to improve the lessons. This agrees with JICA (2014) who reported that ASEI lesson is made possible through PDSI practice (Plan, Do, See, and Improve).

This study showed that there is a positive correlation between the grades obtained after SMASE training as shown by Spearman's Rank correlation coefficients. This positive correlation was observed in grades obtained in: 2009 and 2010; 2010 and 2011; 2011 and 2012; 2012 and 2013; and those obtained in 2009 and 2013. The rank correlations coefficients between the respective years were 0.52, 0.92, 0.92, 0.95 and 0.88. This agrees with Snowman and Biehler (2003) who stated that the sole purpose of a grade is to communicate to others the level of academic achievement that a student has obtained.

5.4 Conclusions of the study

The following conclusions were made from the study: The number of SMASE trainings attended influence pupils' performance in mathematics in KCPE. The SMASE training attended need to be actualized to enhance trainees understanding. The teacher's perception of SMASE training project influences pupils' performance in mathematics in KCPE. The themes and topics in SMASE training should always be in accordance with the teaching needs. The SMASE INSET content should be implemented in primary schools in the first term so as to positively influence pupils' performance in mathematics in KCPE. Two weeks is the appropriate time for cluster training so as to maintain quality grades in KCPE.

It is also concluded that the practice of ASEI-PDSI (Activity, Student, Experiment, Improvise- Plan, Do, See, Improve) in the classroom influences pupils' performance in mathematics in KCPE. The practice of ASEI PSDI helps teachers to focus more on the set lesson objectives. Learners should be involved in the training activities through discussions, role play and improvisation of materials. To help "See" so as to improve the lesson, written exercise is the most important method of assessment.

There is a positive correlation between the grades obtained in 2009 all through to 2013 through SMASE training. The training improved the performance of KCPE mathematics in the schools continually from 2009 to 2013.

5.5 Recommendations of the study

The following policy recommendations were made from the findings of this study:

1. The study showed that all mathematics teachers, sciences teachers, head teachers and deputy head teachers should attend SMASE trainings in order to improve pupils' performance in mathematics in KCPE and some trained teachers were moved to lower primary classes. Therefore, the Kenya government and its donors such as JICA should plan to train all teachers in ASEI – PDSI approach since there is no specialization of teaching subjects in primary schools.
2. Only 78% of the respondents were able to do actualization. This was attributed to planning to call learners from holiday. The MOE should put mechanisms in place to ensure that all teachers actualize the SMASE training content.
3. The study indicated that SMASE INSET content should be implemented in primary schools in the first term so as to influence pupils' performance in mathematics in KCPE positively. Two weeks is appropriate for cluster training so as to maintain quality grades in KCPE as supported by 98.8% of the respondents. The MOE should change the training period for Regional and Cluster trainings so that primary school based implementation of INSET content is done in term one.
4. Learners should be involved in the SMASE training activities through discussions, role play and improvisation of materials. The head teachers and quality assurance officers should support teacher through provision of teaching/ learning material.
5. Only 29.3% of the respondents had attended all the training cycles. The MOE and The Teachers Service Commission should ensure that all the participants attend all the training cycles by motivating them positively.
6. Cluster training should take two weeks to ensure adequate coverage of INSET content or it should be made residential. The GOK and JICA should allocate more funds for training in future
7. Lack of adequate materials/tools is the major challenge in ASEI lessons as indicated by 48.8% of the respondents while 28% indicated lack of allocated

funds for buying tools. The MOE should set a fund for supporting SMASE through Free Primary Education programme.

5.6 Suggested areas for further Research

From the results of this study, the following areas are suggested for further studies.

1. Conduct research on the influence of Strengthening Mathematics and Science Education training project on pupils' performance in mathematics in KCPE in other public primary schools in other districts in Embu County.
2. Carry out a study to establish the influence of low funding on the implementation of SMASE project in Kenyan primary schools.

5.7 Contribution to the body of knowledge

| Objective | Contribution to knowledge |
|---|--|
| To examine the extent to which the number of SMASE trainings attended influence pupils' performance in mathematics in KCPE. | <p>SMASE training cycles enhanced good academic performance in mathematics and enables achievement of higher economic levels in Kenya. These training cycles impart practical and sustainable knowledge and skills in teaching mathematics and sciences.</p> <p>SMASE training actualisation improves the quality of teachers in terms of attitude, pedagogy, and mastery of content, resource mobilization and utilization of locally available teaching materials.</p> |
| To establish the extent to which teachers' perception of SMASE training project influences pupils' performance in mathematics in KCPE. | Teachers' perceptions reflect and determine the goals that they set for achievement, the strategies they use to pursue the goals, the skills, energy, and other resources they use to implement the strategies, and the rewards they expect from making the effort. Competent teachers apply broad, deep and integrated sets of knowledge and skills as they plan for, implement and revise instruction. Cluster-training should take two weeks since in-service training enables the trainees to learn the theory and practical aspects and thus improve on their academic performance. Teachers should continue to improve their command of the content by attending in- service refresher courses and through self-study. |
| To determine the extent to which practice of ASEI-PDSI (Activity, Student, Experiment, Improvise- Plan, Do, See, Improve) in the classroom influences pupils' performance in mathematics in KCPE. | <p>Success of ASEI lessons depends on availability of teaching/ learning material. Learners need to be involved in activities through ASEI PDSI approach through discussion in groups, improvisation of material and through performance of role plays. These practical practices enhance understanding since the grade attained is a reflection of the level of basic mathematics skills that a learner has achieved.</p> <p>To help "See" so as to improve the lesson, a written exercise is the most important method of assessment.</p> |

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APPENDICES

APPENDIX 1

INTRODUCTION LETTER TO RESPONDENTS

SUSAN W. MUGO

P.O. BOX 2516-60100

EMBU

DATE

Dear Sir/Madam

RE: Letter of Introduction for data collection

I am a postgraduate student at the University of Nairobi carrying out a research on influence of the Strengthening of Mathematics and Science Education training project on pupils' performance in mathematics in KCPE: a case of public primary schools in Embu West district, Embu County, Kenya. The research report will be presented for the award of a Master of Arts degree in Project Planning and Management. The completion of the proposed research will benefit education stakeholders by helping them to understand the influence of the strengthening of Mathematics and Science Education training project on pupils' performance in mathematics in KCPE.

Attached please find the questionnaire to be used for data collection. Your honest and truthful opinions will be indeed highly appreciated.

Thank you in advance

Susan Wangui Mugo.

L50/ 75014/ 2012

APPENDIX 2

QUESTIONNAIRE FOR SMASE TRAINED MATHEMATICS TEACHERS AND HEAD TEACHERS

This questionnaire seeks to collect data for the purpose of this research on influence of the Strengthening of Mathematics and Science Education training project on pupils' performance in mathematics in KCPE: a case of public primary schools in Embu West district, Embu County, Kenya. You have been selected as a respondent for the study. Kindly provide the information given and be assured that the information given will be only for the purpose of research. It will be treated with maximum confidentiality. Thank you in advance for your honest responses.

SECTION A

Please tick or provide the answer

1. Age bracket in years:

[20-30] ()

[31-40] ()

[41-50] ()

[51-60] ()

2. Gender:

Male ()

Female ()

3. Highest education level achieved:

Diploma; { }

Undergraduate; { }

Graduate; { }

Doctorate { }

4. Professional courses attended in the last five years other than SMASE training.

.....

5. Teaching experience.....

6. Indicate your position in SMASE

Head teacher ()

Mathematics cluster trainer ()

Mathematics cluster trainee ()

7. What other responsibilities do you hold in the school other than SMASE implementation if not a head teacher?

Deputy Head teacher ()

Senior teacher ()

Others Specify.....

8. Kindly indicate the type of the school

Mixed Day ()

Mixed Boarding ()

Girls Boarding ()

Boys Boarding ()

SECTION B: SMASE TRAINING

1. How many training Cycles of SMASE training did you attend?

A. 1

B. 2

C. 3

D. 4.

E. Others specify.....

2. If you attended less than four training cycles, tick on the training cycles you attended
- A. Cycle 1
 - B. Cycle 2
 - C. Cycle 3
 - D. Cycle 4
 - E. Others; head teachers seminars by TAC Tutors
3. Was all the training content covered?
- Yes ()
- No ()
4. Was actualisation performed at cluster level?
- Yes ()
- No ()
- If No what were the challenges
-
5. In your school, did you get a chance of in servicing other teachers on SMASE content learnt?
- Yes
- No
- If your answer was No, what were the reasons why you didn't organize school based workshops?
-
6. The more the training cycles attended the better the mean scores in mathematics in KCPE?
- A. Strongly agrees
 - B. Agrees
 - C. Disagrees
 - D. Strongly disagree

SECTION C: PERCEPTION OF SMASE TRAINING

7. How do you rate the training(s) you attended?
- A. Relevant ()
 - B. Very relevant ()
 - C. Fairly relevant ()
 - D. Others specify
.....
8. How do you rate the content that is themes and topics in SMASE training to your teaching needs?
- A. Very relevant ()
 - B. Relevant ()
 - C. Fairly relevant ()
 - D. Not relevant ()
9. What is your rating of quality of facilitation of SMASE trainings for mathematics?
- A. Excellent ()
 - B. Very good ()
 - C. Good ()
 - D. Fair ()
10. At what time of the year should SMASE INSET content be implemented in primary schools so as to influence performance in mathematics in KCPE positively?
- A. Term 1
 - B. Term 2
 - C. Term 3
11. Would you wish to continue attending SMASE trainings
- Yes ()
 - No ()
- If yes, what duration is appropriate for cluster training so as to maintain quality grades in KCPE?

- A. One week ()
- B. Two weeks ()
- C. Others.....specify.

Suggest improvements if you were to attend SMASE trainings again.....

12. How can the SMASE trainings be sustained so as to maintain quality grades in mathematics in KCPE?

- A. Team teaching
- B. Subject INSETs/ Workshops
- C. lesson study
- D. Others specify

.....

13. How were the amounts of training materials

- A. Adequate ()
- B. Inadequate ()

14. In your opinion, how have the trainings attended influenced performance in mathematics in KCPE?

- A. Very Positively ()
- B. Positively ()
- C. Fairly ()
- D. Not at all ()

SECTION D: PRACTICE OF ASEI-PDSI

15. Practice of ASEI-PDSI helps us focus more on set the lesson objectives

- A. Strongly agrees
- B. Agrees
- C. Disagrees
- D. Strongly disagrees

16. Have you been practising what you learnt during SMASE INSETs?

- Yes ()
- No ()

If yes how often did you involve learners in activities through ASEI-PDSI?

- A. Very often ()
- B. Often ()
- C. Rarely ()

Which activities did you engage learners in?

- A. Discussion in groups ()
- B. Improvising of materials ()
- C. Performing role play ()
- D. Others specify

17. ASEI lesson plan focuses learners on activities

- Yes ()
- No ()

If yes, how often did you make ASEI lesson plans?

- A. Always
- B. Sometimes

18. Did you implement the cluster training content learnt in august in third term?

- Yes ()
- No ()

If No, what did you concentrate on?

- A. Revision in preparation for KCPE
- B. Completion of the syllabus
- C. Others..... specify

19. Did you encounter any challenges during ASEI lessons?

- Yes ()
- No ()

If yes, what challenge did you encounter?

- A. Lack of adequate materials/ tools ()
- B. Lack of enough textbooks ()
- C. Lack of allocated funds for buying tools ()

D. Lack of skills to improvise locally available materials in some topics such as algebra ()

E. Others specify

If your answer above is C, how can the problem of funding be solved so as to improve performance in mathematics in KCPE?

A. A specific fund be allocated through free primary education

B. MOE request for donor assistance

C. Others.....specify.

20. What were some of the ways you used to solve the problem above other than funding?

A. Involving learners in improvising ()

B. Group work activities ()

C. Team teaching ()

D. Lesson study ()

E. Borrowing ()

others.....specify

21. Which methods of assessment did you employ in the lesson to help “See” so as to improve the lesson?

A. Oral questions

B. Written exercises

C. Reflection

D. Observing finished products made by learners

E. Others specify

.....

THANK YOU.

APPENDIX 4

CASCADE LEVELS OF SMASE TRAINING PROJECT ACTIVITIES AND FACILLITATORS

| Venue | Training Level | Facilitators | Participants | Monitoring and Evaluation | Implementation Time of the Year |
|------------------|----------------|---------------------------------|--|-------------------------------|---------------------------------|
| CEMASTE Karen | National | National trainers | Regional trainers | MOE & JICA | February- March |
| PTTC | Regional | Regional trainers (PTTC) tutors | Cluster trainers Mathematics and science primary teachers TAC tutors | National Trainers | April holiday |
| Selected schools | Cluster | Cluster trainers | Selected primary school teachers and head teachers | National and Regional trainer | August holiday |
| Classroom | Primary school | Trained teachers | Mathematics and science teachers of standards 6,7 and eight | Not clear | September- November |

Source: Modified from SMASE project document (Appendix 7)

APPENDIX 5

MEAN GRADES FOR MATHEMATICS IN THE LAST FIVE YEARS IN EMBU WEST DISTRICT PUBLIC PRIMARY SCHOOLS AND SPEARMAN'S RANK CORRELATION COEFFICIENT.

| Name of School/ year | 2009 mean | 2010 mean | 2011 mean | 2012 mean | 2013 mean |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| Kamuthatha | 66.5 | 68 | 68.62 | 65.81 | 66.72 |
| Embu county | 54.14 | 56.36 | 56.67 | 56.05 | 54.61 |
| Kiangima | 43.43 | 44.21 | 45.09 | 51.34 | 49.19 |
| Gatunduri | 44.64 | 40.85 | 55.38 | 45.94 | 52.06 |
| Gakinduriri | 60.44 | 52.38 | 56.58 | 48.91 | 46.83 |
| Keruri | 52.15 | 51.47 | 47.37 | 50.13 | 45.93 |
| Igumo | 40.93 | 42.6 | 41.3 | 43.79 | 46.45 |
| Kamiu | 42.1 | 45.82 | 44.41 | 48.71 | 46.56 |
| Gatituri | 40.98 | 42.93 | 49.0 | 46.83 | 47.38 |
| Kiandundu | 42.07 | 42.12 | 44.65 | 45.66 | 42.67 |
| St Peter Runganga | 44.94 | 41.37 | 39.45 | 42.67 | 49.13 |
| Kangaru | 43.9 | 44.34 | 43.3 | 47.10 | 47.88 |
| Mbukori | 39.14 | 36.24 | 43.13 | 42.00 | 42.04 |
| St Michael | 50.51 | 48.36 | 46.11 | 49.72 | 46.31 |
| St Andrews | 48.08 | 44.38 | 47.6 | 48.92 | 44.21 |
| Nthambo | 42.61 | 46.37 | 39.95 | 47.85 | 50.7 |
| Gatondo | 52.24 | 54.83 | 52.82 | 51.68 | 47.32 |
| Nembure | 39.38 | 42.76 | 45.32 | 47.52 | 43.1 |
| Njukiri | 37.79 | 44.81 | 41.53 | 39.91 | 45.75 |
| St Joseph Kevote | 40.1 | 40.36 | 40.75 | 42.64 | 45.65 |
| Tende | 38.06 | 43.33 | 40.53 | 48.29 | 45.94 |
| Kimangaru | 43.61 | 42.8 | 43.85 | 47.95 | 45.96 |
| Embu Urban | 52.35 | 45.82 | 50.22 | 47.82 | 47.97 |
| St Philip Makengi | 40.87 | 42.1 | 41.25 | 40.27 | 45.69 |
| Rukira | 39.32 | 42.22 | 41.58 | 38.72 | 42.51 |
| CCM Kevote | 42.53 | 45.57 | 43.47 | 41.72 | 43.3 |
| Kithegi | 38.31 | 38.0 | 41.7 | 40.80 | 41.06 |
| Consolota Kevote | 38.33 | 37 | 36.56 | 39.06 | 39.95 |
| Nguire | 41.17 | 38.7 | 39.6 | 46.81 | 42.7 |
| Itabua | 45.57 | 47.68 | 44.52 | 48.01 | 45.74 |
| Ithangawe | 39.5 | 41.46 | 36.67 | 43.55 | 42.44 |
| Kihumbu | 35.13 | 39.04 | 41.63 | 45.89 | 42.72 |
| St Marks Karue | 37.22 | 38.57 | 40.0 | 40.04 | 42.69 |
| Allamano | 36.6 | 38.81 | 45.08 | 44.67 | 39.97 |
| Kithimu | 37.5 | 33.27 | 39.55 | 42.00 | 37.04 |
| Iveche | 63.9 | 63.34 | 60.69 | 60.84 | 61.6 |
| District mean Score | 44.3 | 44.7 | 45.4 | 46.7 | 46.3 |

Source: Embu West District Education office

Note: Embu Special school's results were not available as it doesn't sit for KCPE.

Spearman's formula was used to find the rank correlations from 2009-2013.

1. Rank correlation coefficient from 2009 and 2010

$$r_s = 1 - (6\sum d^2)/(n(n^2-1))$$

$$r_s = 1 - (6 * 375.9835) / (36(1296-1))$$

$$r_s = 1 - 0.48$$

$$r_s = 0.52$$

From the study, there is a positive correlation between the grades obtained in 2009 and grades obtained in 2010 after SMASE training. The training improved the performance of mathematics in the schools.

2. Rank correlation coefficient from 2010 and 2011

$$r_s = 1 - (6\sum d^2)/(n(n^2-1))$$

$$r_s = 1 - (6 * 600.136) / (36(1296-1))$$

$$r_s = 1 - 0.08$$

$$r_s = 0.92$$

From the study, there is a positive correlation between the grades obtained in 2010 and grades obtained in 2011 after SMASE training. The training improved the performance of mathematics in the schools.

3. Rank correlation coefficient from 2011 and 2012

$$r_s = 1 - (6\sum d^2)/(n(n^2-1))$$

$$r_s = 1 - (6 * 595.6729) / (1295)$$

$$r_s = 1 - 0.08$$

$$r_s = 0.92$$

From the study, there is a positive correlation between the grades obtained in 2011 and grades obtained in 2012 after SMASE training. The training improved the performance of mathematics in the schools.

4. Rank correlation coefficient from 2012 and 2013

$$r_s = 1 - (6\sum d^2)/(n(n^2-1))$$

$$r_s = 1 - (6 * 398.0931) / (36 * (1296-1))$$

$$r_s = 1 - 0.05$$

$$r_s = 0.95$$

From the study, there is a positive correlation between the grades obtained in 2012 and grades obtained in 2013 after SMASE training. The training improved the

performance of mathematics in the schools.

5. Rank correlation coefficient from 2009 and 2013

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

$$r_s = 1 - \frac{6*922.2167}{36(1296-1)}$$

$$r_s = 1 - 0.12$$

$$r_s = 0.88$$

From the study, there is a positive correlation between the grades obtained in 2009 and grades obtained in 2013 after SMASE training. The training improved the performance of mathematics in the schools continually from 2009 to 2013

APPENDIX 6

LETTER TO COLLECT DATA FROM EMBU WEST PUBLIC PRIMARY SCHOOLS

REPUBLIC OF KENYA



MINISTRY OF EDUCATION, SCIENCE & TECHNOLOGY

STATE DEPARTMENT OF EDUCATION

Telegrams:

Telephone: EMBU 30962/30502

E-Mail: deoembuwest@gmail.com

EMBU WEST SUB-COUNTY

EDUCATION OFFICE

P. O. BOX 8-60100

EMBU

When replying please quote

Ref.NO. EDU/EBU/W/R/3/70

And date

4th July, 2014

**To All Head teachers
Public Primary Schools
EMBU WEST SUB-COUNTY**

RE: PERMISSION TO COLLECT DATA FROM PUBIC PRIMARY SCHOOLS IN EMBU WEST SUB-COUNTY

The bearer of this letter, Susan W. Mugo is pursuing her studies at University of Nairobi.

The purpose of this letter is to request you to accord her all the support she may require from your school as she collects data.

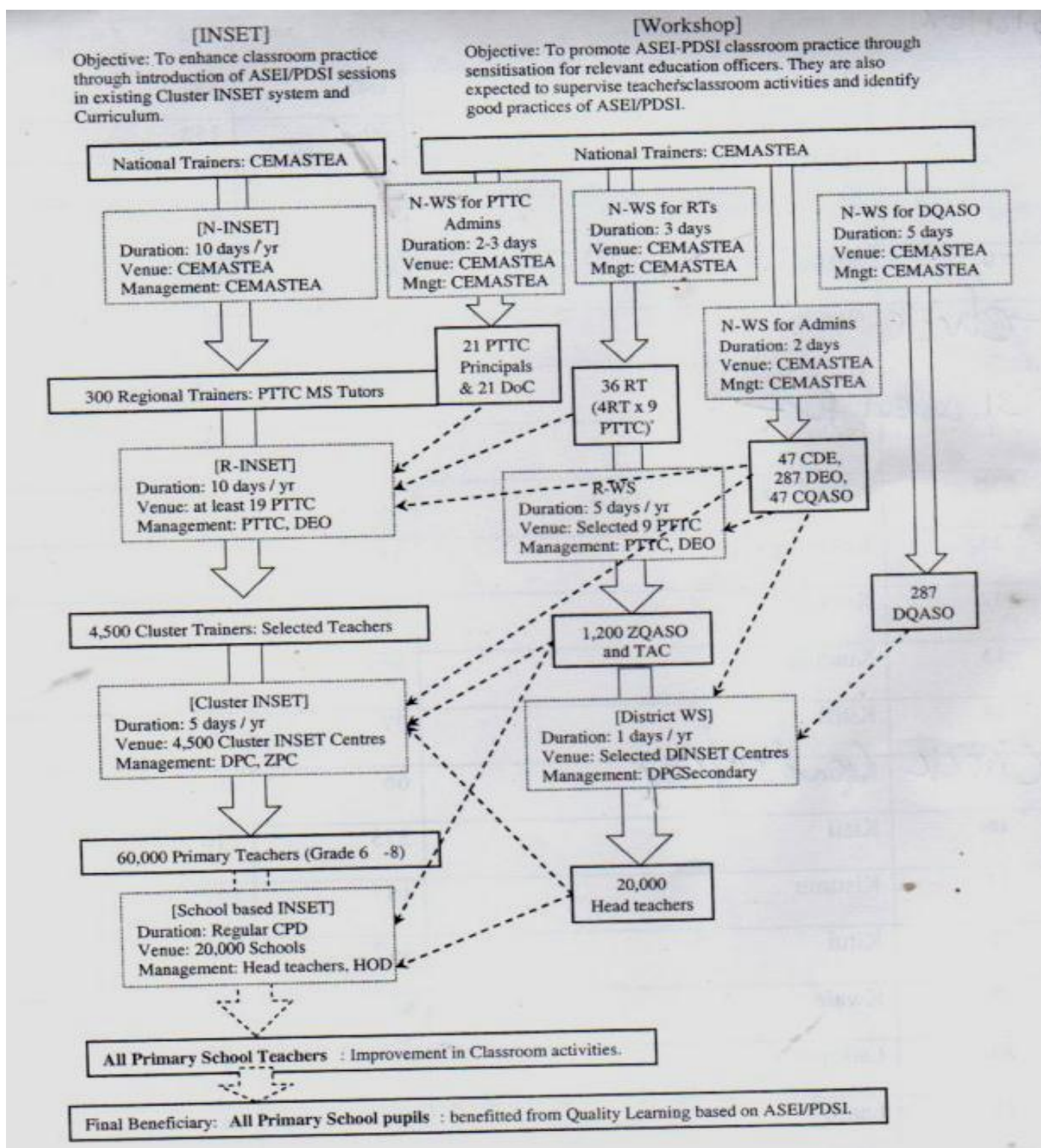
Thank you in advance.

A handwritten signature in black ink, appearing to be 'W. M. M'birichi', written over a horizontal line.

**WILLIAM M. M'BIRICHI
SUB-COUNTY EDUCATION OFFICER
EMBU WEST**

APPENDIX 7

INSET AND WORK SHOP STRUCTURE AT PRIMARY LEVEL.



Source: SMASE project document JIKA & ROK (2008)