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and Communications
Technologies in Post-Primary
Education**

**Practice of INSET in Mathematics and Science Teachers
and its Impact on Quality of Basic Education in Kenya**

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LIST OF ACRONYMS AND ABBREVIATIONS

ADEA	Association for Development of Education in Africa
ASEI	Activity, Student, Experiment and Improvisation
AU	African Union
BEGIN	Basic Education for Growth Initiative
CEMASTE	Centre for Mathematics, Science and Technology Education in Africa
DAC	Development Assistance Committee
DEO	District Education Officer (Office)
DPC	District Planning Committee
DQASO	District Quality Assurance and Standard Officer
DTC	District Training Centre
EFA	Education for All
FEMSA	Female Education in Mathematics and Science in Africa
GOJ	Government of Japan
GOK	Government of Kenya
ICE	International Conference on Education
INSET	In-service Education and Training
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
KCSE	Kenya Certificate of Secondary Examination
KIE	Kenya Institute of Education
KJSE	Kenya Junior Secondary Examination
KNEC	Kenya National Examination Council
KSSHA	Kenya Secondary Schools Heads' Association
KSTC	Kenya Science Teachers' College
KU	Kenyatta University
M. Ed	Masters in Education
MDG	Millennium Development Goals
M&E	Monitoring and Evaluation
MOE	Ministry of Education
MOEST	Ministry of Education, Science and Technology
NEPAD	New Partnership for Africa Development
NWC	National Working Committee
NCEOP	National Committee on Education Objectives and Policies
PDE	Provincial Director of Education
PDM	Project Design Matrix
PDSI	Plan, Do, See and Improve
PPE	Post Primary Education
PTTC	Primary Teachers Training College
QASO	Quality Assurance and Standards Officer
RECSAM	Regional Centre for Education in Science and Mathematics
SACMEQ	Southern African Consortium for Monitoring Education Quality
SEAMEO	South East Asian Ministers of Education Organization
SMASSE	Strengthening of Mathematics and Science in Secondary Education
SMASE	Strengthening Mathematics and Science Education
SPIAS	SMASSE Project Impact Assessment Survey
SSA	Sub-Saharan Africa
SWAP	Sector Wide Approach
TCE	Third Country Expert
TCTP	Third Country Training Programme
TICAD	Tokyo International Conference for African Development
TIVET	Technical, Industrial Vocational, Entrepreneurship and Training

TSC	Teachers' Service Commission
UPE	Universal Primary Education
UP- NISMED	University of Philippines National Institute for Science and Mathematics Education
WECSA	Western, Eastern, Central and Southern African (Countries)
WGMSE	Working Group on Mathematics and Science Education
WSSD	World Summit for Sustainable Development

1.0 ABSTRACT

The paper presents success of an intervention on capacity development as implemented in Kenya. This is a technical cooperation between JICA and Ministry of Education, Kenya. It is known as the Strengthening of Mathematics and Science in Secondary Education (SMASSE) that was launched in 1998 as pilot project and expanded in 2003 to cover the whole country and has also been launched in a number of African countries.

The SMASSE aims at upgrading capability of youth in mathematics and sciences through in-service education and training (INSET) of teachers in response to poor performance and achievement witnessed in Kenya and across the continent. Because of its success and impact the INSET has been institutionalized and regularized as a part of Kenya Education Sector Support Programme (a SWAP).

The INSET curriculum is based on the findings of baseline study and focuses on: teaching and learning attitudes towards mathematics and sciences, pedagogy, teacher mastery of subject content, interaction among teachers, improvisation and production of instructional material besides mobilisation of resources for mathematics and sciences. The WGMSE holds firmly that teachers are a great asset in the education system for its dynamic evolution.

Since 1999 there has been continuous improvement in the national examination results and other indicators measured by the project designed tools, the SMASSE Project Impact Assessment Survey (SPIAS)¹. SPIAS design is within the framework of existing national syllabi for mathematics, chemistry, physics and biology and on Bloom's taxonomy; and modified to fit SMASSE activities.

This good practice experienced in Kenya has now been adopted in other African countries such as Malawi, Nigeria, Niger, Senegal, Uganda, Zambia, etc.

WGMSE has come to believe strongly that if INSET for mathematics and science teachers would be institutionalized and regularized in African countries, strengthened mathematics and science education in Africa would be achieved in future. In addition, improvement in these subjects will contribute, in the long run, to the development of science and technology in Africa.

2.0 EXECUTIVE SUMMARY

Introduction

The current trend of extending basic education to include lower secondary education is being taken very seriously by many Sub Saharan African countries. This is basically in effort to increase access to post primary education (PPE) following the UPE and EFA/MDGs initiatives that have seen many children attend primary education and are likely to complete it.

In the process of extending the basic education the need to maintain and improve quality of education offered is as important as access to post-primary education and training. In this regard, the quality of teachers and their professional development need no emphasis. This paper mainly discusses a two-level cascade model of in-service education and training (INSET) programme that was successfully piloted in Kenya between 1998 and 2003 and subsequently expanded throughout the country and in other African countries due its impact and demand. The programme aimed at upgrading the capability of Kenyan youth in mathematics and science education through INSET for mathematics and science teachers. The paper also highlights challenges Kenya faced and her effort to address shortage of trained teachers and measures taken towards maintaining quality of education with rapid expansion of both primary and secondary education. It further indicates policy environment that contributed to the registered success, the implementation, lessons and challenges faced. The objective of the paper is to present a practical and promising case of an INSET system that can be adapted and applied for improving and maintaining quality of education as countries extend their basic education systems.

In Kenya, recommendation to extend primary system from 7-years to 9 years was made by NCEOP. However, the Presidential Working Party on Second University recommended the 8-4-4 system which was accepted and implemented with effect from 1985 on account of cost for the 9th year.

The expansion of post-primary education has however been constrained by the level of poverty and cost-sharing policy which led to decline of enrolment and participation at both primary and secondary levels besides lowering quality. Currently the GOK plans to offer tuition free secondary education with effect from 2008.

Quality of Education

The decline in education quality, participation and retention rates have been attributed to high cost of education and rising level of poverty as many households are not able to effectively pay school levies.

Quality of education negatively affects enrolment, participation, retention, and quality of graduates from education system and subsequently the country's development. Hence the demand and need to reverse the trend through teachers' INSET

The adequacy and quality of education inputs and students' learning achievement (as outputs) are generally used as a measure of education quality. The need for quality education is in line with the GOK policy on Vision 2030 which aims at making Kenya middle level economy. The emphasis on quality education therefore is aimed at nurturing and developing students' knowledge and skills in mathematics and sciences towards this end. Teachers of these subjects are therefore targeted so that they deliver lessons with the suitable approaches and methodologies that would translate into upgrading young Kenyans capability in mathematics and sciences.

SMASSE PROJECT

Human resource development has been a top priority for the development of Kenya through education. Therefore, there has been a need for comprehensive training policy that would produce adequate manpower for development. Studies on quality of education in Kenya indicated poor quality and performance especially in mathematics and science compared with that of social science subjects. Due to resource constraints and need to improve quality of mathematics and science education, the GOK/MOE requested assistance from the development partners and the Government of Japan (GOJ) responded positively.

After acceptance by the GOJ to support INSET for mathematics and science teachers, the JICA dispatched project study and implementation missions and JICA-MOE Technical Cooperation on SMASSE Project was launched in July 1998 as pilot project in 9 districts. After successful piloting in the 9 districts the project was expanded to cover the whole country in 2003, with INSET centres established to serve as resource centres for teachers at the district level. The focus has been on the use of ASEI/PDSI as a paradigm shift towards student-centred learning.

Some of the achievements of SMASSE include:

- a) Establishment of a system of training for District Trainers in Pilot Districts in mathematics and sciences at National level
- b) Establishment of a system of INSET in mathematics and sciences in the Districts
- c) Strengthening of the role of National INSET Centre and District INSET Centres as resource centres for teachers.
- d) Large number of beneficiaries. Approximately 20,000 mathematics and science teachers, 1 million secondary students as primary beneficiaries. Other beneficiaries include 110 DEOs, about 800 QASOs and 4,000 principals. When PTTC and TIVET will be incorporated fully into SMASSE, number of beneficiaries will increase by approximately 22,000 trainees and 34,000 students, respectively. The SMASSE INSET system has capacity to reach all the mathematics and science teachers once annually.
- e) Expansion to other African countries such as Uganda, Malawi, Nigeria, Zambia, Senegal, Niger and Rwanda.

In 2001, technical exchanges were made to several African countries and it was established that they had similar problems in mathematics and science education. This led to the formation of SMASSE-WECSA Association and subsequent adoption of SMASSE-type of INSET with Japan technical cooperation. With the expansion of the project the GOK/MOE established the Centre for Mathematics, Science and Technology Education in Africa (CEMASTE) as a centre for enhancing dialogue and cooperation among mathematics and science educators in Africa. SMASSE also collaborates with ADEA as a Working Group for Mathematics and Science Education and plays the role of capacity building, networking, analytical work, information dissemination and advocacy.

This paper aims at presenting the SMASSE experience as a promising approach to improving and maintaining education quality in the process of extending basic education to lower secondary education and beyond.

Objectives and Rationale for INSET

Studies on how to improve education quality indicate that this could be done through improvement of quality of teachers by making them more effective in their teaching. The MOE strategy for improvement of education quality gives in-service education and training (INSET) of teachers a top priority in order to enhance the quality of teaching and learning. This has been done in the course of education expansion in Kenya. With rapid expansion of both primary and secondary education there was serious shortage of qualified teachers in the late 1960s and early 1970s and in-service training programmes were organized during the holidays to supplement the number of teachers graduating from teacher pre-service programs.

The basis for INSET is capacity development for teachers with the aim of enhancing their capacities in effective classroom practices to facilitate learning and therefore high retention of knowledge and skills, and learners' acquisition of positive attitudes. To this end all stakeholders in education need to be involved in developing policy, recommendations and way-forward to guide the programmes on how education quality and relevance could be maintained and improved.

Challenges in Mathematics and Science Education in Kenya

Challenges which are negatively affecting the performance of mathematics and science education in Kenya were established during the SMASSE baseline study in 1998. The findings were categorized into those which SMASSE could address and those beyond SMASSE. The former category which is the basis for SMASSE INSET curriculum includes:

- a) Negative attitude – head teachers, teachers and subsequently pupils and parents.
- b) Inappropriate teaching methodologies.
- c) Inadequate mastery of subject content

- d) Inadequate assignments to students
- e) Few or non-existent interactive fora for teachers
- f) infrequent inspection by subject inspectors
- g) Weak link between primary and secondary school (syllabuses) content levels
- h) Weak collaboration between schools and communities

Capacity Development

The technical cooperation for capacity development for SMASSE has been effected through long-term training, short-term exchange visits, study tours, seminars, workshops, and mentoring by short-term and long-term Japanese experts. SMASSE has been acknowledged as an appropriate and suitable example of technical cooperation in capacity development for developing countries.

The JICA training of Kenyan personnel in Japan started in July 1998 after the baseline study for implementation of SMASSE INSET. From 2002, training in the Philippines and later in Malaysia, opened up more opportunities for capacity development for teachers, teacher trainers and education managers.

Impact of INSET

Towards the objective of upgrading learners' capability in mathematics and sciences, SMASSE has had a positive impact as evidenced in lesson participation and increased enrolment in science subjects, especially Physics which is an elective subject. This has been particularly observed in the case of girls. Lesson observation carried out from time to time show changes from teacher-centred towards learner-centred methods. In particular, students' activities and participation were more frequent as a result of the INSET.

Since 2004, SMASSE monitoring and evaluation task force has been conducting achievement test known as SMASSE Project Impact Assessment Survey (SPIAS) to find out the impact of INSET on learning achievement. Every year about 6,000 students from 150 schools in 10 districts have been sampled and given a multiple choice type test based on Bloom's taxonomy. Although improvements in KCSE examination grades have been observed, analysis of SPIAS data towards establishing the impact of learning attainment was found INSET as promising to be effective on teaching/learning quality as long as INSET will be continuously offered to teachers. The analytical work conducted on the basis of the following;

- Structural Equation Modelling (Covariance Analysis),
 - Factor analysis and Multiple regression, and
- Analysis of Variance (ANOVA) and independent t-tests (for Subgroup analysis), indicated several encouraging results as listed below.

The significant findings found are as follows:

- 1) "Capability" of students, measured by SPIAS tests score, has been improved by implementation of SMASSE/INSET. Especially, remarkable improvement has been detected in mathematics and biology.
- 2) Students' capacity, measured by test scores, would be improved by "students' attitude to the subject", rather than by the direct effort to mastering the subject contents.
- 3) Principal's encouragement would affect the improvement of teachers' teaching process. Other background factors consists of the some that would affect and the others that would not affect.
- 4) Quality of INSET has given the impact for learning, and then, the impact has gradually come true through the quantity of INSET. It would be safe to indicate both quantity and quality should be well considered in training plan and implementation.
- 5) District schools had more impact than provincial schools. It might indicate that there be more room for improvement at district schools by teacher training. Also respective training suitable to respective subgroups (district schools and provincial schools) should be considered to raise more impact.
- 6) The final comment is that it should be admitted that this study using Structural Equation Modelling (SEM) has large room for improvement partly due to the limitation of data

availability, especially socio-economic background data. Thus, the successive study is recommended to be conducted because the more detailed study is possible.

Impact in Africa

As noted above on technical exchange in regard to the situation of mathematics and science education in Africa, during World Summit for Sustainable Development in 2002, Japan pledged to continue its support in the strengthening of mathematics and science education as stipulated in TICAD and BEGIN policies. Ever since JICA in collaboration with MOE-Kenya has expanded and extended nationally and regionally, the successfully implemented SMASSE Project to several African countries. The Government of Kenya established Centre for Mathematics, Science and Technology Education in Africa to facilitate the strengthening of networking among educators in SMASE-WECSA countries. In order to accelerate the implementation more effectively and efficiently at policy level, ADEA, GOK and JICA jointly established ADEA WGMSE in 2005.

Lessons learnt

Below are challenges faced in the course of implementing the project and lessons learnt as recommendation for countries that may want to adapt SMASSE-type of INSET for effective curriculum delivery and students' learning attainment:

- a. The government and ministry of education should have policy on institutionalized and regularized INSET. The policy should be supported at the highest level in the ministry.
- b. INSET program should be a priority and crucial program for quality delivery of curriculum and improvement of education quality.
- c. There should be sustainable funding mechanism preferably on per capita basis.
- d. It is critical to support teachers in their efforts to upgrade their lesson practices and that the support should be comprehensive with broad outlook of the whole working environment.
- e. School principals, school committees, regional and district officers should be sensitized regularly on the need for continuous support to both teachers and INSET programs.
- f. Continuous monitoring and evaluation of both the program and classroom activities and giving immediate feedback is of critical importance to the teachers and INSET management. There should be understanding and close collaboration between those involved in INSET, M&E and Quality Assurance and Standards Officers (QASO).
- g. Sustained capacity development of the INSET managers and stakeholders at different levels is paramount for timely and effective support and for achieving positive results.
- h. Core INSET trainers at national, and where possible regional/district trainers, should be deployed on full-time basis.
- i. As far as possible district/regional INSET should be held during the school holidays.
- j. Full-time teachers who train others should be given incentives (facilitation fees).
- k. Pre-service programmes should collaborate with INSET programmes.
- l. Trainers in the pre-service and INSET programmes should intermittently be teaching students for the level they train to have up-to-date exposure of the classroom situation.

The Way Forward

WGMSE intends to pursue the following strategies to;

- i) Establish collaboration and strategic partnerships with organizations involved in capacity development and INSET,
- ii) Continue assisting other African countries to adapt similar capacity development and INSET projects,
- iii) Carry out INSET for improved pedagogical skills and mastery of subject matter for mathematics and science trainers/educators,
- iv) Strengthen the quality of mathematics and science education in African countries,
- v) Establish viable and functional department of research and development,
- vi) Identify and retain highly competent and motivated staff for optimum productivity,
- vii) Develop an Information Communication and Technology (ICT) policy, infrastructure, and networks for mathematics and science educators
- viii) Monitor and evaluate INSET activities.

The WGMSE strongly believes that if INSET for mathematics and science teachers would be institutionalized and regularized in African countries, strengthening of mathematics and science education in Africa could be achieved in future. In addition, improvement in these subjects will contribute, in the long run, to the development of science and technology in Africa.

This paper therefore attempts to address the implications of the challenges of resources, professional development within educational innovations and the need for broadening the involvement of stakeholders in educational policy and practice in Kenya. The rationale of the intervention and its operational structures and content are outlined, and its apparent achievements enumerated. The paper also considers the challenges faced in the implementation of the intervention and suggest possible remedies and implication for similar efforts in other African countries. In the rest of the introduction provides the implication of expansion of quality of education.

3.0 INTRODUCTION

3.1 Education System in Kenya

Until 1985, the education system in Kenya was 7-4-2-3 comprising 7 years of primary, 4-year ordinary secondary, 2-year of advanced secondary education and 3-year basic university degree, besides 2-year certificate and 3-year diploma programmes in tertiary institutions. Recommendations to extend primary education from 7-years to 9-years were made by the National Committee on Educational Objectives and Policies (NCEOP) in 1976 (Republic of Kenya, 1976). However, the Mackay Presidential Working Party recommended the 8-4-4 system of education which came into effect by 1985, i.e. 8 year- primary, 4-year secondary and 4-year university basic degree education. The Working Party evaluated the cost implication of 9-year primary cycle and instead recommended 8 years (Republic of Kenya, 1981; World Bank, 2004).

Unlike the previous system of education, the 8-4-4 was intended to inculcate self-reliance and all roundedness among graduates of every cycle of education through emphasis on vocational subjects. The subjects content also changed with some secondary subject content being moved to primary and A-level content moved to O-level. In addition, the GOK changed its policy of providing teachers and grants only to its maintained and assisted public secondary schools numbering 659 before 1988 and took responsibility of staffing all the public secondary schools numbering 2126. Due to GOK resource constraints GOK officially introduced cost-sharing in education (Republic of Kenya, 1988a; 1988b). The continued growth, Table 1, coupled with resource constraints and curricular changes negatively affected education quality as these were not accompanied by adequate teacher preparation despite challenges of subject content and pedagogical approaches.

3.2 Expansion and Quality Education

Immediately after independence, there was rapid expansion of both primary and post-primary education in Kenya as Table 1 shows. Besides, post-primary education development in Kenya has been pragmatic and based on need to make it accessible to many primary school graduates. Moreover, with the introduction of Free Primary Education (FPE) in 2003, there is an expected steep rise in secondary enrolment with implications on quality of post-primary education. Currently, the GOK plans to offer tuition-free secondary education with effect from 2008.

Table 1: Growth in Enrolment, Transition Rate and Number of Teachers in Kenya

	1963	1975	1985	1990	2002	2004
Primary Enrolment	892,000	2,881,155	4,702,414	5,392,319	6,062,900	7,394,700
Aided Secondary enrolment	22,200	98,100	All <i>harambee</i> secondary schools became public secondary schools in 1988.			
Unaided Secondary Enrolment	5,900	110,600				
Total Secondary Enrolment	28,100	208,700	437,207	618,461	632,399	922,759
Transition to Form 1 (%)	18	34	--	--	46	51
Secondary teachers	1,610	8,050	--	41,280	45,901	47,594

Source: a) Republic of Kenya(1976); b) Our Problems, Our Solutions, an economic and public policy agenda for Kenya- Institute of Economic Affairs, 1998;c) Republic of Kenya (1988b); d) Republic of Kenya (2000—2007)

Quality of education negatively affects enrolment, participation, completion rate and quality of graduates from the education system, and subsequently, the country's development (ADEA 1997; World Bank, 1988). Low grades in mathematics and sciences are interpreted to mean that the students have not learnt well or the subjects are either difficult to teach or learn, regardless of other factors affecting teaching and learning including school and home environment (Heneveld and Craig, 1996; World Bank, 2004). Other factors include shortage of teachers, inadequate and poor facilities; shortage of instructional material and low teachers' morale due to low remuneration and poor terms of service. Studies on how to improve education quality indicate that this could be done through improvement of quality of teachers - making them more effective in the way they teach (World Bank, 1995; 2004; 2006).

In Kenya, the decline in education quality, participation and retention rates have been attributed to high cost of education and rising levels of poverty as many households are not able to effectively pay school levies (Ministry of Education Science and Technology, 2003a; 2003b). Previous attempts to improve quality at secondary level included the introduction of Kenya Junior Secondary Education (KJSE) examinations to ensure that those who joined community (*harambee*) schools received quality education before proceeding to Form III or joining the world of work (Republic of Kenya, 1981; 1988b).

Moreover, in response to rapid expansion of both primary and secondary and acute shortage of qualified teachers, especially in the late 1960s and early 1970s, the MOE has had in-service training of teachers as a top priority so as to enhance the quality of teaching and learning (Republic of Kenya, 1982). This has been done through different types of in-service courses mounted during the school holidays to supplement the number of teachers graduating from teacher training colleges. The focus of these courses was on untrained teachers, under-qualified teachers or orienting teachers to new curricula. However, none of these was institutionalized nor aimed at general professional and capacity development in the teaching profession.

4.0 STRENGTHENING MATHEMATICS AND SCIENCE IN SECONDARY EDUCATION PROJECT

4.1 Rationale and Objectives of SMASSE Project

The role of secondary education and that of mathematics and science in industrial and technological development of a nation need no emphasis. Moreover, the GOK planned to be industrialized by the year 2020 and so needed to upgrade the capability of Kenyan youth in mathematics and science through INSET for teachers of these subjects (Republic of Kenya, 1982). The current initiative is based on a need for effective classroom practices, existing policy indications and demands by critical stakeholders in education.

Results in these mathematics and sciences have been poor, Table 2 although efforts have been made to ensure qualified teachers are employed, increased remuneration and improvement of terms of service for teachers, provision of science equipment and even construction of laboratories. However, even where there are qualified teachers or adequate equipment and materials, student achievement in the subjects has not been necessarily high. On the contrary, there are schools with minimum facilities, instructional material and where teachers teach effectively, and examination results have been relatively better. This indicates that achievement of learning is directly linked to what goes on in the classroom - the approaches and methodologies used to deliver subject content. Therefore, in order to also complement pre-service teacher preparation, there is need to provide teachers with opportunities to share and gain skills and experiences on approaches and methodologies that can address the issue of quality delivery of content.

Table 2 KCSE Examination Scores as Percentages, 1989-1995

Subject	Year Gender	1989	1990	1991	1992	1993	1994	1995
English	Male	28.5	24.2	25.4	32.4	32.8	28.0	27.8
	Female	28.4	24.0	24.9	32.5	32.8	28.3	27.8
Mathematics	Male	13.6	15.5	19.3	24.4	17.0	12.9	15.3
	Female	9.0	10.3	13.2	9.3	11.3	9.0	10.3
Physics	Male	34.6	25.3	19.9	26.1	30.9	29.1	35.7
	Female	29.4	21.1	15.7	20.0	24.9	25.4	31.1
Chemistry	Male	32.4	28.5	28.6	33.6	32.4	33.5	32.1
	Female	30.0	25.9	25.9	30.5	28.9	29.6	28.3

Source: Ministry of Education, Master Plan on Education and Training 1997-2010

In addition, in the Kenya's 1994-1996 Development Plan, the human resource development strategy recognized the need to develop a "comprehensive training policy that would, among other things encompass:

- ◆ Institutionalization of training function in GOK ministries
- ◆ Establishing funding mechanism for in-service training of public servants, have in-service training in the public sectors".

Moreover, the Third Teacher Education Conference held in December 1994 emphasized the need for institutionalized and regularized INSET for teachers as a means of improving the education quality and performance. The Kenya Secondary Schools Heads Association was also urging its members and MOE to organize INSET for teachers on a continuous basis (ADEA, 2005; World Bank, 2007). This was also in line with the 45th Session of International Conference (ICE) held in October 1996 which recommended among others, that "in-service training should be organized to a greater extent within educational establishments and through teamwork, with the active participation of teachers themselves in defining the programme" (UNESCO, 1996).

Due to resource constraints, the GOK/MOE requested assistance from the development partners and the Government of Japan (GOJ) responded positively. After acceptance by the GOJ to support INSET for mathematics and science teachers, Japan International Cooperation Agency (JICA) dispatched Project Study and Implementation Missions. Consequently, JICA-MOE Technical Cooperation on SMASSE Project was launched as a pilot project in 9 districts in July 1998. The Kenya Science Teachers College (KSTC) was identified as the implementing institution.

The SMASSE project went national following the successful implementation of the pilot phase (1998-2003), and in line with the perceived relationship between quality of education and economic development, the government's policies and stakeholders' needs for INSET as highlighted below and the GOJ/ JICA-Kenya policy on Human Resource Development (JICA, 2007):

- i) The in-service training for teachers has been a priority in education as stipulated in the GOK Public Investment Programme 1999-2002, Economic Recovery Action Plan 2003-2007 (Republic of Kenya, 2003b) that "conducting in-service training for teachers annually.
- ii) The institutionalization of training on continuous basis is considered essential for those who are newly appointed and professional development for those in service (Ministry of Education, 2003c).
- iii) The demand by secondary school principals as a result of successful implementation and impact of Pilot Phase.
- iv) The need to consolidate gains and spread benefits made to all school schools in the country

With the expansion of the project, the GOK/MOE established the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) as a centre for enhancing dialogue and cooperation between mathematics and science educators in Africa.

Based on the above, SMASSE Project uses a well thought out system of INSET for mathematics and science teachers. The project's overall goal and purpose are to upgrade the capability of young Kenyans in mathematics and sciences and enhance the quality of mathematics and science education at secondary level through INSET of teachers.

4. 2 SMASSE IMPLEMENTATION

4. 2. 1 Administrative Structure

The structure of administration of SMASSE Project includes three committees: the Joint Coordinating Committee (JCC), the National Working Committee (NWC) and the District Planning Committee (DPC). The JCC is chaired by the Permanent Secretary MOE and its membership include: Education Secretary; Director of Higher Education; Director of Policy and Planning, MOE; Director of Quality Assurance and Standards (QAS); Chief Finance Officer, MOE; Director, Kenya Institute of Education (KIE); Secretary, Teachers' Service Commission (TSC); Secretary, Kenya National Examinations Council (KNEC); Representative of

universities-from Kenyatta University (KU); Kenya Secondary Schools’ Heads Association (KSSHA); Provincial Directors of Education (PDE); and Director, CEMASTE A.

The National Working Committee chaired by the Director, CEMASTE A is responsible for coordination of all the day-to-day activities of SMASSE INSET programmes throughout the country. The DPC is composed of District Education Officer (DEO) as the chairperson; District Quality Assurance and Standards Officers (DQASO); the chairman of principals’ association (sponsor) who is also the DPC treasurer; SMASSE district trainers’ representative; and INSET Centres’ principals. The DPC is responsible for selection and training of district trainers in collaboration with the national office; raising funds, budgeting and general management of district INSET, besides preparation of training materials in consultation with the national office.

4. 2.2 Baseline Study

The team of national trainers conducted baseline study (questionnaire and interview of teachers, pupils, head teachers, laboratory assistants, parents and lessons’ observations and lessons’ video recording) to identify the factors that contribute to poor performance in mathematics and science. The causes of poor performance and participation in mathematics and sciences identified by the baseline study were similar to those identified by Female Education in Mathematics and Science in Africa (FEMSA) studies in both Anglophone and Francophone countries in Africa, JICA study of basic education in Kenya (Deloitte and Touche, 1995) and other studies. The baseline findings were categorized into: problems affecting (i) the schools, (ii) the students and (iii) teachers. These were further categorized into factors SMASSE could address and those beyond SMASSE as shown in

Table 3.

The INSET programmes and stakeholders’ workshops enumerated below address these factors and others which emerged during subsequent needs assessment (SMASSE, 2002). Although SMASSE does not provide infrastructure and instructional materials to all schools, it sensitizes on prudent management of funds and improvisation of substitutes to conventional resources. The Japanese government through JICA provides equipment to facilitate effective and efficient implementation of in-service education.

Table 3: Findings from Baseline Survey

Factors that SMASSE can handle	Factors the SMASSE cannot handle
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a) Attitude – head teachers, teachers and subsequently pupils and parents.	a) Lack of: staff houses and other facilities and/or equipment textbooks; water, electricity
b) Lack of appropriate teaching methodology-Pedagogical teacher-centeredness.	b) Poor communication and funding of school activities and programmes
c) Mastery of Subject content	c) Parents and communities’ attitude
d) inadequate assignments to students	d) Interrupted school programmes –fees collection and arrears
e) Few or non-existent interactive fora for teachers	e) Food, child labour, and other family problems
f) Infrequent inspection from subject inspectors	f) Teachers’ poor working conditions and terms of services including incentives
g) Missing link between primary and secondary school (syllabuses) content levels	g) Overloaded syllabi and timetables –work load
h) Lack of information about schools by communities	h) Unfair transfers
	i) Stagnation in one job group,
	j) Provision of infrastructure and instructional material and equipment to schools

4.2.3 Activities of SMASSE Project

The activities of the Project are aimed at changing traditional teacher-centred teaching methods and equipping teachers with necessary skills for classroom practices that put emphasis on activity-oriented ways of teaching and learning that include:

- Creating opportunity for learners to take responsibility for their own learning;
- Employing inquiry-based approach as opposed to recipe-type experiments;
- Encouraging improvisation not only to augment conventional equipment, apparatus/materials but also to arouse interest & curiosity among learners;
- Encouraging teachers to draw content and examples from the learners’ real life experiences in order to capture their interest and imagination;
- Foster teachers’ ability and appreciation for work planning;
- Systematic execution of the learner-centred teaching/learning process;
- Evaluation of the teaching-learning process against lesson objectives & outcomes;
- Use of feedback obtained to improve ongoing lessons and in subsequent ones.

After being in-serviced, teachers are expected to use student-centeredness, activity-based teaching experiment and research approaches in their teaching as indicated on Table 5.

4.2.4 Capacity Development for Effective Management of INSET

4.2.4.1 Staff

The rationale for effective management of SMASSE INSET is to operate within existing educational structures. Similarly, assignment of staff whose salaries do not raise recurrent costs enhances ownership and sustainability of in-service education and training. Furthermore, in order ground professional development in classrooms, assignment of experienced and practising teachers ensures familiarity with targeted educational contexts and professional growth through peer-mentoring, unlike if the programs were facilitated by university staff. The characteristics of staff at the national and district in-service centres enhance their confidence in facilitation of workshops and motivate them to be part of change agents in mathematics and science education.

At the beginning of the project, the MOE/TSC recruited 8 national trainers on merit, 2 each from Mathematics, Physics, Chemistry and Biology departments who were trained in Japan and subsequently deployed as full-time staff in the project. As colleagues the 8 Kenyans worked with the Japanese personnel to develop materials, management procedure/system and activities for the INSET. Currently, the national office at the

Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) is manned by 61 Kenyans and 4 Japanese.

The JICA training of Kenyan personnel in Japan and elsewhere has continued since 1999 for effective implementation of SMASSE INSET and general capacity building in education. From 2002, JICA has facilitated training of SMASSE Project officials and critical stakeholders in various universities in Japan, the Philippines and Malaysia as summarized in Table 4. More opportunities for capacity development of teacher trainers, education managers and teachers have been made available at the CEMASTE (national) and 106 district training centres through the two-tier cascade system as at September, 2006.

JICA also sends short-term and long-term experts to the project to provide technical assistance on quality INSET. Capacity development of Kenyans through technical cooperation has also been effected through long-term training, short-term exchange visits, study tours, seminars, workshops, and mentoring by short-term and long term Japanese experts.

The opportunities for capacity development of project staff and provision of equipments minimize assignment of foreign experts in the project. This ultimately ensures that professional development of teachers is institutionalized, continuous and sustainable. For instance, the Japanese contribution has been declining while Kenyan contribution has been increasing, (JICA, 2006; 2007). That is, as long as the local policies on funding remain, SMASSE INSET in Kenya will be sustainable. These policies have been nurtured and maintained through regular stakeholders' workshops as outlined in the next section.

4.2.4.2 Stakeholders' Workshop/ Sensitization.

These are annual stakeholders' workshops to review progress and achievements of SMASSE INSET, challenges encountered and way forward. They also provide opportunities for capacity building for SMASSE-INSET, general education and school management. The objective of the stakeholders' workshop is primarily to sensitize, deliberate and make recommendations to guide the project activities.

i) Principals' Workshops

Principals are responsible for ensuring effective and efficient implementation of curriculum at school level. The theme of Principals' Workshop has been '*Resource Mobilization, Prioritisation and Utilisation for Effective Teaching and Learning of Mathematics and Science*'.

The objectives of the workshop are to sensitize principals on:

- a) Baseline conditions that necessitated SMASSE as well as the intervention strategies adopted by the Project.
- b) The SMASSE INSET System Construction, Quality System Construction, Financial System Construction and Impact of Project activities.
- c) Resource mobilization, prioritization and utilisation for quality teaching and learning of mathematics and sciences.
- d) Role of principals as custodian and promoters of quality mathematics and science education.

ii) Quality Assurance and Standards Officers' Workshops

Being in-charge of quality assurance in education, QASOs undergo SMASSE training in order to be conversant with the principles and practices of SMASSE INSET- the ASEI- PDSI Approach. This also reduces conflict between them and the SMASSE in-serviced teachers. In addition, the officers are in charge of organisation and management of SMASSE INSET at district level. The Project therefore organises annually a five-day sensitisation workshop whose objectives include, to: reiterate GOK policies on INSET and the roles of QASOs in the implementation of SMASSE activities in the districts, reflect on the current status of mathematics and science education at secondary school level, introduce ASEI-PDSI as classroom intervention and the use of SMASSE's Internal Monitoring and Evaluation (M&E) tools for classroom observation.

iii) District Education Officers' Workshops

The DEOs have to oversee the management of education activities within a district. More significantly, as the chairperson of SMASSE DPC, the DEO influences effective implementation of SMASSE District INSET activities. During the workshop the role of the DEO in the implementation of the SMASSE INSET are emphasised as he/she is responsible for:

- a) Sensitisation of stakeholders within the district on the need for INSET for mathematics and science teachers.
- b) Ensuring efficient collection and remittance of SMASSE Funds by principals and their management.

Table 4 Summary of Overseas training of SMASSE staff and stakeholders

National Trainers: (Short Courses on INSET)-Overseas.	59	District Trainers (4 per subject) - in Kenya.	1381
National Trainers: M. Ed Science	07	Mathematics and Science Teachers	14,597
Education Administrators /INSET Managers	58	Kenyan school principals –to date	686*
District Trainers	145	District Education Officers (DEOs)	72
		Quality Assurance & Standards Officers (QASO)	72
		Diploma Science TTC Tutors	150
		TIVET Tutors	177
		PTTC Tutors	218
		Third Country Counterpart Training (SMASSE-WECSA)	775 [#]
Total	269	Total	17,194

* In total over 4,000 principals are targeted

From other African countries.

4.2.5 SMASSE INSET Curriculum

The current SMASSE INSET is based on a curriculum, Appendix I, developed from the results of a Baseline Survey carried out in 1998 and findings of SMASSE Curriculum Review Committee (SCRC) which was commissioned by the Chief Inspector of Schools in September 2001 (SMASSE, 2002). The curriculum consists of:

- a) General topical issues in secondary school mathematics and science education
- b) Topic areas that are of concern to both teachers and students in the four subjects: Biology, Chemistry, Mathematics and Physics.

For example, in order to address the problem of curricula transition (see (g) in

Table 3), there are sessions on Form One Induction and Syllabus/ Textbook analysis. The subject sessions are organized to include identification of relevant resources and provide opportunities for peer-teaching by participants.

The guiding principle of SMASSE INSET is the ASEI/PDSI pedagogical paradigm. ASEI principle involves providing meaningful teaching **Activities** focused on **Student** learning mainly **Experimental**/practical work and **Improvising** resources where necessary. PDSI approach embraces orderly steps of executing learning activity by first **Planning** for the activity, then **Doing** it while **Seeing**, observing with intent to evaluate and then finally **Improving** on the process (ADEA, 2005; Republic of Kenya, 1988; World Bank, 1995; 2007; UNESCO, 1996).

SMASSE INSET is delivered through a two-tier cascade system in which training is conducted at national and district levels. At national level, the national trainers facilitate INSET for district trainers, who in turn train all the other mathematics and science teachers in their respective districts throughout the country.

The curriculum for the INSET is designed and divided into 4 cycles of 10 days each per year (Table 9). This is to allow trainers and teachers to be free for 2 weeks during the school holidays and to ensure that lessons learnt are applied as soon as possible to benefit learners. Each of the 4 cycles has specific emphasis but cover a wide range of relevant aspects in teaching and learning of mathematics and sciences in the classrooms.

- a) Cycle 1 of SMASSE INSET emphasises positive *attitude change* towards mathematics and science education among teachers. Positive attitude is seen as prerequisite for teachers to embrace the ideals of SMASSE INSET.
- b) Cycle 2 of INSET is hands-on activity/practical work oriented. It provides participants with the opportunity to experience an assorted *hands-on activities/practical* work in order to enhance their skills in designing relevant teaching and learning activities that promote student interest and understanding.
- c) Cycle 3 of INSET focuses on actual classroom implementation of the principles of ASEI/PDSI, that is, *Actualization of ASEI/PDSI*. INSET participants plan for, implement and discuss ASEI lessons during peer-teaching sessions and then proceed to schools for actual classroom implementation. To augment effective classroom implementation of the lessons, this cycle of INSET includes sessions on monitoring and evaluation with bias towards classroom observation.
- d) Cycle 4 of INSET: The main objective is to consolidate, enhance and *sustain effective classroom practices* from the three basic cycles before participants plan, organize and implement District INSET on their own. It is a capacity building session to ensure efficient, effective and self-reliant District INSET Systems.

4.2.6 Improving and Sustaining INSET Quality

To ensure efficient and effective implementation of SMASSE project, the internal monitoring and evaluation unit developed tools for monitoring the implementation and impact of the project. Quality of the INSET is monitored and evaluated through the application of a number of instruments including: Pre- and Post-INSET evaluation instruments which focus on; instrument for evaluating ability of trainers to plan, implement and evaluate INSET; session evaluation instrument to gather information on session organization and quality of facilitation, and classroom observation checklists.

In each cycle of national training, a pre-INSET and post-INSET evaluation questionnaires are administered to infer participants' attitude. In addition, cumulative impact of INSET is anticipated to shift classroom instruction from teacher-centred to student-centred and the role of resources in the learning of mathematical and scientific concepts (Table 5).

Table 5 Measurable results anticipated at the end of the 4-cycles of SMASSE INSET.

Pre-ASEI/PDSI	SMASSE Training ASEI/PDSI	After Training on ASEI/PDSI
<ul style="list-style-type: none"> ✓ Knowledge based, ✓ Teacher-centeredness, Chalk and talk ✓ Full scale experiments 	<ul style="list-style-type: none"> ✓ Attitude Change ✓ PDSI, ✓ Methods ✓ Material production ✓ Capacity Building ✓ INSET institutionalization 	<ul style="list-style-type: none"> ✓ Student-centeredness ✓ Activity-based teaching ✓ Experiment and research
Resource mostly used towards non-academic activities	Mobilization and rationalization of resources use towards academic activities	

Inadequate inspection	Prudent, frequent and regular inspection (QASO/SMASSE M/E personnel)	
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4. 3.0 Characteristics of SMASSE INSET for Teachers

The SMASSE project has characteristics which are appropriate for improving the quality of education in developing countries. These include:

- i) Demand-driven and based on needs assessment,
- ii) National trainers selected from competently acknowledged classroom teachers,
- iii) National trainers working on full-time basis so as to give full attention to training and monitoring of implementation and impact of INSET,
- iv) Two-level cascade model and organizational capability to handle all mathematics and science teachers in schools served by a District Training Centres, (reduces information fall-out).
- v) District (cluster) trainers are regular classroom teachers who are familiar with classroom situations and continuously apply ASEI/PDSI while acknowledging teaching and learning complexities in schools. It also facilitates assessment and feedback into both training activities and material development.
- vi) District trainers are paid facilitation fees as incentives and to compensate them for preparing training materials alongside normal teaching duties,
- vii) Selection and use of well-equipped schools as training and resource centres during the school vacation- Use of school facilities/equipment and personnel reduce the INSET cost thereby having SMASSE funds used for delivery of INSET curriculum.
- viii) Supported by:
 - GOK/MOE policy on INSET institutionalization and regularization as MOE programme,
 - District Education Board (DEB) and school principals individually and by their association,
- ix) District INSET is conducted during the school holidays, thus without interfering with regular teaching and violating Teachers' Service Commission (TSC) Code of Regulations which provides when annual leave should be taken. This in effect means that teachers attending INSET are on duty and hence no allowance, and
- x) Capacity building for DEO and Principals on INSET management and resource mobilization, prioritization and utilization; Training QASO on monitoring of ASEI/PDSI in the classroom.

The other important aspect of SMASSE INSET System is that it can be used for up-grading teachers' subject content/mastery and pedagogy from one grade to the next particularly in countries experiencing shortage of qualified teachers and/or having many untrained or under-qualified teachers. INSET system for social science teachers in Kenyan secondary schools based on SMASSE model is under consideration due to demand by the principals and teachers (Ministry of Education, 2007).

4.4.0 Extension to Other Countries

4.4.1 Rationale and Objectives

At the onset of the SMASSE Project, the staff made technical exchange visits to other African countries which revealed that other African countries experience similar problems and challenges in mathematics and science education. Similar findings on poor performance of mathematics and sciences and low participation in science related course at post secondary institutions- (like in Kenya) had been established by the FEMSA study (FAWE Series). These brought to the fore the need for a forum in which these countries could share experiences and come up with intervention measures.

In February 2001, JICA supported regional conference for countries in Western, Eastern, Central and Southern Africa (WECS) in which 11 countries participated. The conference recognized challenges in the teaching and learning of mathematics and sciences in primary and secondary level of education in the region. It also appreciated the role of ASEI/PDSI principles of SMASSE in improving quality of teaching and learning. Subsequently SMASSE-WECSA association for mathematics and science educators was formed in June 2002

and the membership has since grown from 11 to 32. The mission of the Association is to strengthen science and mathematics education through pre-service and in-service education and training, research, exchange of information, seminars, conferences and collaborative activities.

At the same time, through Tokyo International Conference for African Development (TICAD) process and in regard to mathematics and sciences, Japan declared that “capabilities in science and technology will be raised at the national and regional levels in Africa”. Japan’s/ JICA’s support for education in Africa was thereafter expressed in its Basic Education for Growth Initiative (BEGIN). Moreover, at the World Summit for Sustainable Development (WSSD) in 2002 in Johannesburg, Japan pledged to continue its support to strengthen mathematics and science education in Africa through SMASSE Project in Kenya.

In collaboration with MOE Kenya, JICA has expanded and extended nationally and regionally, the successfully implemented SMASSE Project to several African countries since 2004, while GOK established CEMASTEAM to facilitate the strengthening of networking among SMASE-WECSA countries. In order to accelerate this movement more effectively and efficiently at policy level, ADEA, GOK and JICA jointly established ADEA Working Group on Mathematics and Science Education (WGMSE). The working group’s main activities are i) capacity building through training, ii) networking through WECSA Association, iii) analytical work through monitoring and evaluation, iv) information dissemination and v) advocacy through conferences, seminars and workshops, etc.

4.4. 2 SMASE-WECSA Association

4.4.2.1 Objectives of Association

The Association was established with the following objectives and currently plays a role of promoting capacity development in mathematics and science education in member countries; that is:

- a) To enhance professional interaction among mathematics and science educators,
- b) To enhance classroom activities for quality teaching and learning of mathematics and science,
- c) To develop teaching and learning materials for mathematics and science, publish journals and newsletters and exchange such materials amongst its members and within the region ,
- d) To liaise with relevant government departments and other organizations for achievement of association’s objectives,
- e) To solicit for assistance for furtherance of the development of mathematics and science education and achievement of association’s objectives.

The Association now plays an important role as a basis for strengthening a network for WGMSE.

4.4. 2.2 Thematic and Program Areas

To achieve its goals, the Association focuses on two thematic areas:

- i) INSET implementation, institutionalization and regularization
- ii) Enhancing classroom practices through ASEI movement and PDSI approach

The Association mainly undertakes the above SMASE activities namely, needs assessment, project formulations, monitoring and evaluation of the impact of various activities, capacity development in mathematics, sciences and technology education; action research on effective curriculum implementation; exchange of information and lessons learnt, and technical assistance to various African countries who are interested in ASEI-PDSI approach and networking. Reports on these activities form a major agenda for the Association’s annual regional conferences.

4.4.2.3 SMASE-WECSA Association Partners

- Japan International Cooperation Agency (JICA)
- Ministry of Education (MOE), Kenya
- Centre for Mathematics, Science and Technology Education in Africa (CEMASTEAM), the association’s secretariat and headquarters
- New Partnership for Africa Development (NEPAD)
- Association for Development of Education in Africa (ADEA)
- UP-NISMED, the Philippines

- RECSAM-SEAMEO in Malaysia

4.4.3 Strategies for Implementing Regional Activities

4.4.3.1 Implementation strategies

The following strategies are employed in the implementation of the association's activities:

i). Sensitization and training of personnel

SMASE-WECSA organizes sensitization workshops on capacity building for its member countries and other interested parties through joint workshops, technical exchange visits and INSET. These provide fora for information exchange on education and networking. The country education authority in collaboration with JICA Country Office selects educators who receive training on ASEI-PDSI in Kenya at CEMASTEAM under JICA Third Country Training Programme (TCTP).

ii). Project Formulation in SMASE-WECSA countries.

The target countries are those that plan to start INSET activities based on the SMASE model. These countries exchange views on ways of developing capacity for project designs, implementation and evaluation of INSET activities. At the invitation of a member country, Third Country Experts (TCE) (Kenyans) and Japanese experts are sent through sponsorship of JICA from the SMASE-WECSA secretariat to the target countries to assist in:

- Needs assessment surveys, Project (INSET) formulation and general sensitization of the education authorities and stakeholders.
- Capacity development for project management in planning, implementation and evaluation of INSET.
- Development of training programmes,
- Conduct training together with country counterparts; conduct training for core trainers, and monitor and evaluate INSET.

4.4.3.2 Collaboration with other Organizations

In its effort to spread the ASEI/PDSI principles and lessons learnt, SMASE-WECSA Association collaborates and networks with other organizations in the provision of quality education, capacity development and INSET in mathematics and science. In March 2004 Association for Development of Education in Africa (ADEA) in collaboration with SMASE-WECSA launched a working group for science and mathematics education (WGMSE) in Sub-Saharan Africa (SSA).

New Partnership for Africa Development (NEPAD) has shown interest in SMASE-WECSA activities to function as its flagship in the enhancement and promotion of mathematics and science in Africa (2006- 2015). The African Union (AU) has also shown interest in collaborating with SMASE-WECSA in the implementation of Second Decade of Education in Africa. And, the Southern African Consortium for Monitoring Education Quality (SACMEQ) and SMASE-WECSA has a formal relationship in monitoring of the quality education in science and mathematics, particularly at the secondary school level.

5.0 SMASSE ACHIEVEMENTS

Achievements of SMASSE are externally and internally evaluated. External evaluation is conducted by evaluation consultants/agents identified by JICA and MOE. Internal monitoring and evaluation is carried out by national staff who also evaluates SMASSE-type projects in SMASE-WECSA member countries. As one of the KESSP investment programmes, SMASSE Project is evaluated along with other development partners programmes during annual donors-MOE Joint Review of Education Sector.

5.1 Establishment of INSET Structures

The achievements in this respect include:

- a. *Establishment of a system of training for District Trainers in mathematics and sciences at National level*
The activities at the national level are currently carried out at CEMASTE. Due to high demand, the benefits of SMASSE INSET have been extended to the PTTCs. SMASSE Project also intends to extend its activities to cover TIVET institutions.
- b. *Establishment of a system of INSET in mathematics and sciences in all districts in Kenya*
There are currently a total of 106 INSET centres nationally established in selected secondary schools to cater for all mathematics and science teachers. A total of 21 INSET centres in PTTCs have been established.
- c. *Strengthening the role of National INSET Centre and District INSET Centres as resource centres*
by providing equipment, material etc, and training stakeholders and staff on effective management and implementation of quality INSET,
- d. *Approximately 20,000 mathematics and science teachers with about 1 million students are primary beneficiaries in secondary education. Other beneficiaries include 110 DEOs, approximately 800 QASOs and 4,000 principals are secondary beneficiaries. When 250 PTTC and 500 TIVET lecturers will be incorporated fully into SMASSE, number of beneficiaries will be increased by approximately 22,620 and 34000 tutors, respectively.*
- e. *Other African countries (Uganda, Malawi, Nigeria, Zambia, Senegal, Niger, Rwanda, etc) have started following a similar way with assistance from Kenya.*

5.2 Attitude change

SMASSE determines the impact of INSET activities on participant's attitude towards various issues on the teaching and learning through the administration of pre-INSET questionnaire just before INSET begins and post-INSET questionnaire at the end of the training. A comparison of the items of the questionnaires for mathematics is given in the Appendix II. The categories in the original questionnaires are blind (A-G) but the intended indicators have been included for this paper. The questionnaires for the other subjects are similarly constructed with minor adjustments.

Interpretation of mean scores (M) in the Pre and Post-INSET evaluation ranges from “definite change of attitude required” ($0.0 \leq M < 2.0$), “positive but needs confirmation” ($2.0 \leq M < 3.5$) and “can be sustained” ($3.5 \leq M \leq 4.0$) (SMASSE Project, 2003). The results for 2001 and 2002 represent pilot phase of the project, while 2004-2007 represent each cycle of INSET for the national phase. The results indicate a tendency towards positive attitude change may be sustained. In all instances participants had more positive attitude by the end of INSET than before, indicating that INSET activities indeed influenced them for the better, as shown in Table 6.

Table 6 Summary of overall Mean Scores on teachers pre- and post INSET attitude

Subject	2001		2002		2004		2005		2006		2007		Overall Mean	
	Pre	post	Pre	post	Pre	post	Pre	Post	Pre	Post	pre	Post	pre	post
Biology	3.1	3.5	3.2	3.6	2.7	3.4	2.8	3.3	3.0	3.4	3.1	3.5	2.99	3.45
Chemistry	2.9	3.3	3.0	3.3	2.7	3.5	2.9	3.3	3.0	3.5	3.2	3.5	2.95	3.4
Mathematics	2.9	3.5	3.1	3.5	2.8	3.5	2.9	3.2	3.0	3.5	3.1	3.5	2.97	3.45
Physics	2.8	3.4	3.1	3.6	2.8	3.4	2.9	3.4	3.0	3.5	3.2	3.5	2.97	3.47
Overall	2.9	3.4	3.1	3.5	2.7	3.4	2.9	3.3	3.0	3.5	3.2	3.5	2.97	3.43

5.3 Classroom Practices

The impact of INSET activities is felt to the extent that they influence teachers' classroom practices. Classroom observations have indicated that teachers' classroom practices in terms of quality of teaching and the extent of student participation are better after undergoing SMASSE INSET. Observations based on M&E instruments: ASEI/PDSI checklist and Lesson Observation Instrument Appendix III indicate that lessons implemented by teachers who have participated in SMASSE INSET are of higher quality than those

implemented by teachers who had not participated in SMASSE INSET. Further, on the scale of 0 to 4 the extent of attainment as measured by *Lesson Innovation Index* overshoot the targeted mean ratings of 3 and 2.5 at national and district level respectively as shown in

Figure 1:. The figure shows results by the same teacher observed in 2003/04 and 2007.

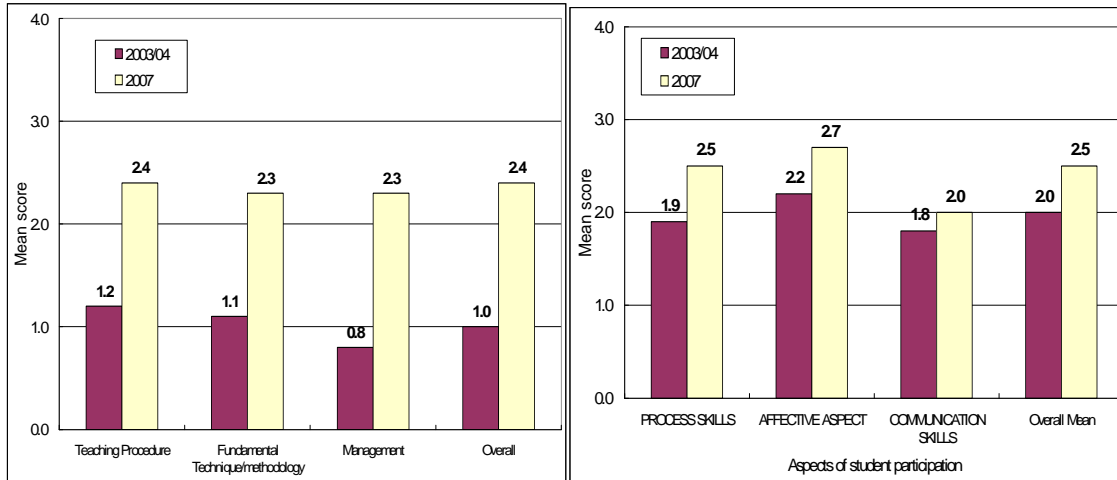


Figure 1: Impact of INSET on Classroom Practices

5. 4.0 Students' Achievement

5.4.1 Achievement in SMASSE and Non-SMASSE Districts

Students' achievement, which is an important reflection of the quality of teaching and learning, is monitored through the SPIAS. The correlation between students' performance in the Kenya Certificate of Secondary Education (KCSE) examination and the achievement tests for each subject is very high, with values tending to 1, Figure 2. From a survey carried out in 2002, the achievement scores of students taught by SMASSE trained teachers were higher than those of students whose teachers had not undergone SMASSE training, Table 7. And on the basis of national examinations differences in favour of students taught by SMASSE trained teachers ranged from 0.64 to 1.66 units on a 12-point scale.

Table 7 KCSE score of samples schools used as an indication for the school educational standard in SMASSE and non-SMASSE (total score being 12).

Subject	SMASSE	Non-SMASSE
Biology	7.61	5.67
Chemistry	4.63	3.92
Mathematics	3.84	3.32
Physics	5.29	4.69
Overall	5.34	4.40

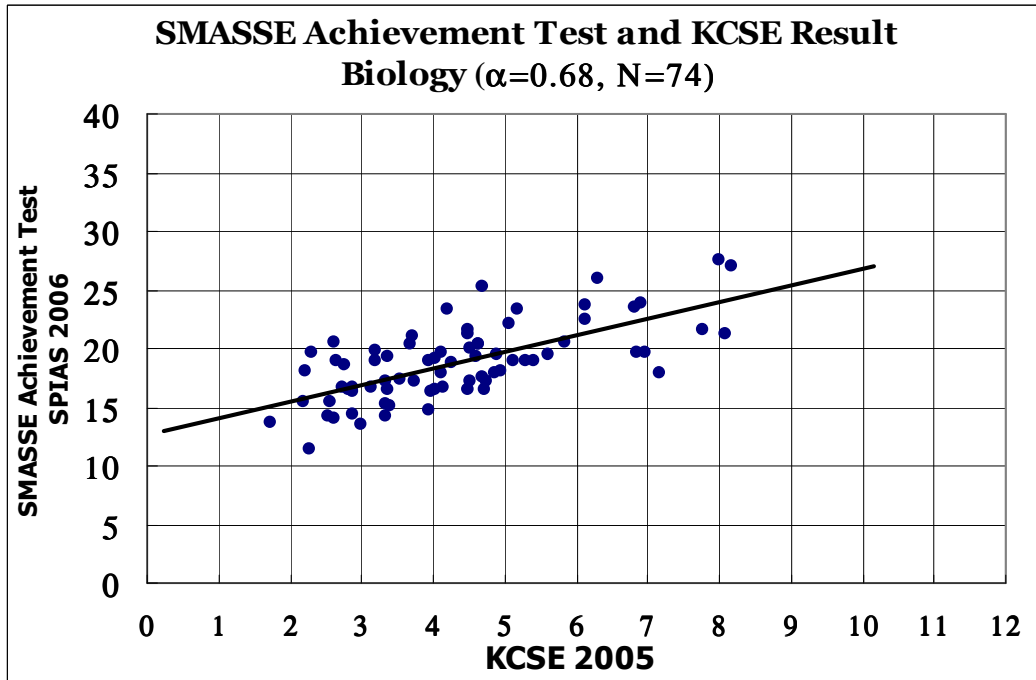


Figure 2: Correlation between SPIAS and KCSE examination results

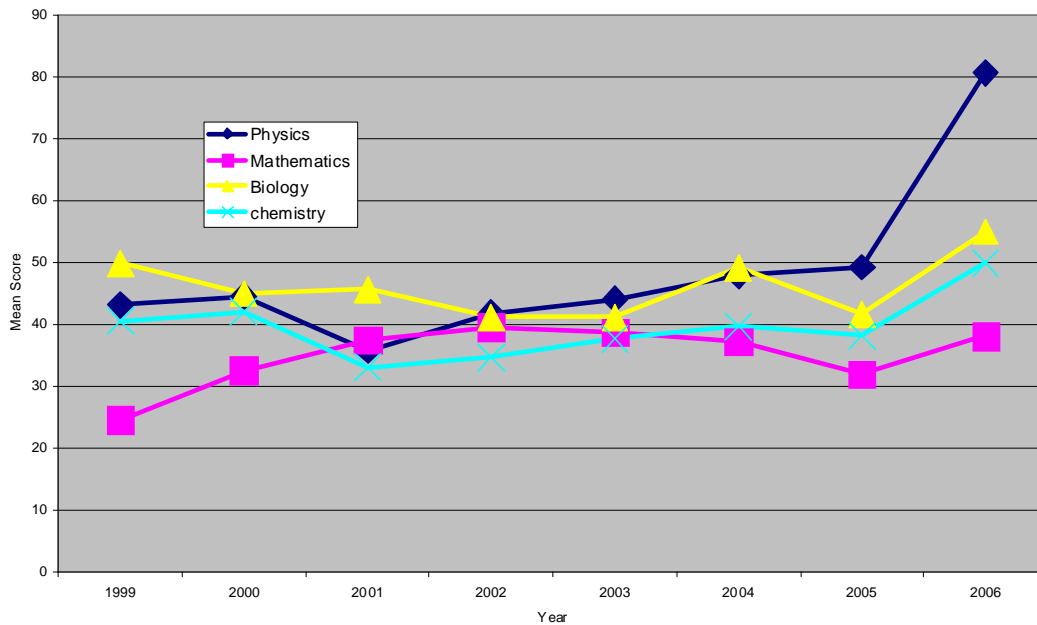


Figure 3: Trends in KCSE Mean Scores in Mathematics and Sciences

To assess the overall impact of the programme towards the achievement of the overall goal, SMASSE Project Impact Assessment Survey (SPIAS) is used. In Kenya, the SMASSE Project’s impact assessment has already been done for Phase I (pilot) at mid-term and final evaluation and phase II (national and regional).

5.4.2 SMASSE Impact on National Examinations

There has been general improvement of KCSE grades as indicated in Figures 3 and 4, and Table 8

Table 8 Impact of INSET on KCSE Examination Scores in Mathematics and Sciences

Subject	Yr	Entry	No. scoring A-B	% scoring	Mean score	KCSE Entry	% doing Subject	% improvement
Physics	1999	36049	6342	17.59	43.04	173,792	20.74	9.21
	2006	72890	19,932	23.23	80.64	243,317	29.96	
Maths	1999	173,792	6527	3.76	24.46	173,792	100%	
	2006	243,317	21,702	8.92	38.02	243,317	100%	
Bio	1999	93,871	21,045	22.42	49.81	173,792	54.01	35.97
	2006	219090	35,681	16.29	54.93	243,317	90.04	
Chem	1999	98,813	12,812	12.97	40.49	173,792	56.86	40.99
	2006	238,102	28,638	12.03	49.86	243,317	97.86	
Mean score (%) fluctuations recorded 1999-2006						Comment: Although examination moderation for each year's marking is different from that of the previous year, this data from the KNEC shows improvement of examination performance in the 4 subjects at KCSE since 1999.		
Subject	Lowest & year	Highest & year						
1. Physics	35.71(2001)	49.18(2005)						
2. Maths	24.48(1999)	39.45(2002)						
3. Biology	41.08(2002&2003)	54.93(2006)						
4. Chemistry	32.99(2001)	49.86(200)						

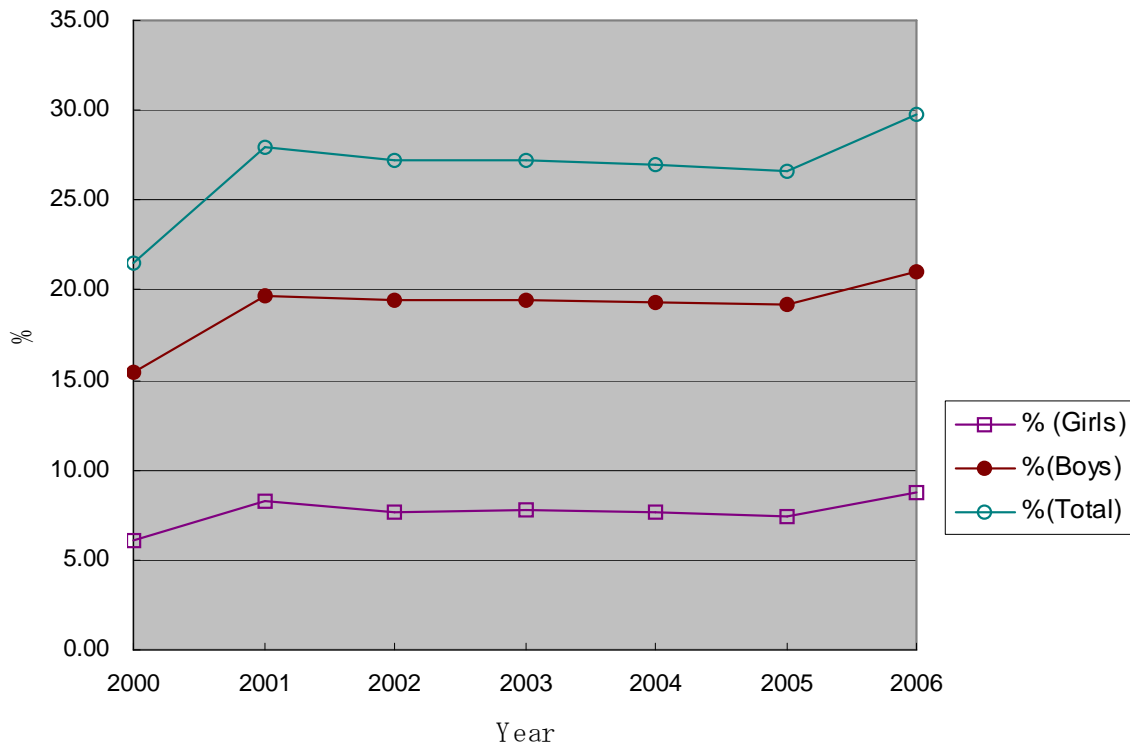


Figure 4: Trend of students' Enrolment in Physics

5.5 SMASSE Project Impact Assessment Survey (SPIAS)

In order to assess the impact of the project, SPIAS (SMASSE Project Impact Assessment Survey) has been conducted every year since 2004. SPIAS questionnaire is administered to students, teachers and principals. In addition, the socio-economic regional data has been collected. Statistical analysis of this data has been done and recommendations made for future operation of the project (SMASSE Project, 2008).

According to the report although it is still draft stage, hypothesis in which INSET will enhance students' performance through teachers' attitude change followed by students' attitude change in classroom has been

fairly well proved as promising. However, it suggests that INSET will have to be continued and regularised to achieve the ultimate goal of improvement of student performance. The results of the report are summarised as listed below. Final version of the report will be published soon.

The first major finding in this study is: the “capability” of students, measured by SPIAS tests score, has been improved by implementation of SMASSE/INSET. Especially, remarkable improvement has been detected in mathematics and biology.

The second major finding is that students’ capacity, measured by test scores, would be improved by “students’ attitude to the subject”, rather than by the direct effort to mastering the subject contents.

The third major finding is Principal’ s encouragement would affect the improvement of teachers’ teaching process. Other background factors consist of those that would affect and the others that would not affect.

Fourth, it is observed that quality of INSET has given the impact for learning, and then, the impact has gradually come true through the quantity of INSET. It would be safe to indicate both quantity and quality should be well considered in training plan and implementation.

Fifth, although the overall impact has been observed, district schools had more impact than provincial schools. It might indicate that there is more room for improvement at district schools by teacher training. Also respective training suitable to respective subgroups (district schools and provincial schools) should be considered to raise more impact.

The final comment is that it should be admitted that this study using Structural Equation Modelling (SEM) has large room for improvement partly due to the limitation of data availability, especially socio-economic background data. Thus, the successive study is recommended to be conducted because the more detailed study is possible.

5.6 Final Joint Evaluation of Phase II

The project is contributing to the strengthening of the quality of mathematics and science education as is evidenced by the studies conducted in 2003, comparing the classroom practices of teachers who had undergone SMASSE INSET and those in the districts the project had not covered before the national phase. The Phase II Mid-term evaluation reveals that the project’s overall goal, purpose and results are highly consistent with the policies of the Government of Kenya. The **relevance** of the project is therefore very high and so are its **effectiveness and efficiency**. **Impact** with respect to the national component is high because impact is felt in all public secondary schools in Kenya as reported in the SMASSE Project Impact Assessment Survey (SPIAS). This positive result is attributed to the establishment of district INSET centres; support from DEB in financing district INSETs and the quality of both district and national trainings (JICA, 2007).

The **sustainability** for the national component is high. The project activities are within GOK policy framework. GOK is already covering 70% of the total operation costs of the INSET. Sustainability in political, organizational and financial aspects is high.

6. CHALLENGES AND LESSONS LEARNT

6.1 Challenges

Despite the successes registered, the project has faced several challenges which include:

- i) some teachers have not appreciated the role of INSET in their individual continuous professional development,
- ii) Few field officers and principals have not been supportive enough
- iii) Lack of effective incentives beyond getting students to do well in their studies
- v) Conflict of interests. SMASSE being only for mathematics and science teachers and being conducted during the holiday when other teachers are free to attend their personal interests.

- vi) Coordination of INSET and other programmes that have future financial or promotional gains- e.g. post-graduate programmes and KCSE examiners' training conducted during the school holidays.
- vii) Non-collection and/or non-remittance of SMASSE funds to DPC due to poverty level that diminishes DEB capability in raising and remitting funds to DPC for effective conducting and managing INSET.
- viii) Strengthening INSET management capacity at the district level besides coordination of educational activities for enhance attendance of INSET
- ix) High staff turnover and transfer of trainers to non-curriculum implementing posts.
- x) Interferences in recruitment process of INSET trainers- failure to use specified criteria.
- xi) Language barrier
- xii) Different educational levels among participants
- xiii) Limited opportunities for further training for trainers.
- xiv) Harmonisation and collaboration of QASO and SMASSE M&E activities/duties.

6.2 Lessons Learnt

- i) The government and ministry of education should have policy on institutionalized and regularized INSET. The policy should be supported at the highest level in the ministry.
- ii) INSET programme should be a priority and crucial programme for quality delivery of curriculum and improvement of education quality.
- iii) There should be sustainable funding mechanism preferably on per capita basis.
- iv) It is critical to support teachers in their efforts to upgrade their lesson practices and that the support should be comprehensive with broad outlook of the whole environment
- v) School Principals, school committees, regional and district officers should be sensitized regularly on the need to give continuous support to both teachers and INSET programmes
- vi) Continuous monitoring and evaluation of both the programme and classroom activities and giving immediate feedback is of critical importance to the teachers and INSET management/administration. There should be understanding and close collaboration between those involved in INSET M&E and education/school inspectors
- vii) Sustained capacity development of the INSET managers and stakeholders at different levels is paramount for timely and effective support.
- viii) Core INSET trainers at national, and where possible, regional/district trainers should be deployed on full time basis.
- ix) As far as possible district INSET should be held during the school holidays.
- x) Full time classroom teachers who train others should be considered and given incentives (facilitation fees).
- xi) Pre-service programme should collaborate with INSET programme.
- xii) Trainers in the pre-service and INSET programmes should intermittently be teaching students for the level they train to have up-to-date exposure of the classroom experience.

7. WAY FORWARD/RECOMMENDATIONS

WGMSE intends to pursue the following strategies:

- i) Establish collaboration links with organizations that have an interest in capacity development and INSET
- ii) Continue assisting other African countries to adapt similar capacity development and INSET projects
- iii) Continue carrying out INSET for improved pedagogical skills and mastery of subject matter for mathematics and science trainers
- iv) Strengthen the quality of mathematics and science education in African countries through ADEA WGMSE
- v) Establish viable and functional department of research and development
- vi) Ensure retention of highly competent and motivated staff for optimum productivity
- vii) Develop an Information Communication and Technology (ICT) policy and infrastructure
- viii) Continue monitoring and evaluating INSET activities

WGMSE strongly believes that if INSET for mathematics and science teachers would be institutionalized and regularized in African countries, strengthening of mathematics and science education in Africa can be achieved in future. And improvement in these subjects will contribute, in long run, to the development of science and technology in the African society.

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APPENDIX I

INSET Curriculum

Table 9 INSET Sessions per Cycle

SESSION	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4
GENERAL	<ul style="list-style-type: none"> • Rationale for INSET • Communication skills • Adolescent psychology • Work planning and PDSI approach • Gender issues in mathematics and sciences • Teaching Approaches and methods • Trends in teaching learning of sciences • Attitude towards mathematics and sciences • Discussion of INSET Curriculum 	<ul style="list-style-type: none"> • Project design matrix • Instrumental design (PDSI) • Rationale for practical work • Laboratory Management (Science) • Team building • Monitoring learning achievement in mathematics and science 	<ul style="list-style-type: none"> • Actualization of ASEI I • Assessment and evaluation • INSET system construction • Monitoring and evaluation I 	<ul style="list-style-type: none"> • Actualization of ASEI II • Monitoring and Evaluation II • Effective classroom practices—ASEI Lesson demonstrations • Impact of INSET at classroom level • Leadership skills • Monitoring learning achievement in mathematics and sciences • Discussion on INSET Write-ups
BIOLOGY	<ul style="list-style-type: none"> ○ Resources and facilities for teaching and learning ○ Classification ○ Ecology ○ Cell structure and physiology 	<ul style="list-style-type: none"> ○ Excretion and homeostasis ○ Stimulus and response ○ Reproduction ○ Respiration ○ Preparation of common laboratory reagents ○ Resources and facilities for teaching II 	<ul style="list-style-type: none"> ○ Genetics ○ Support and movement ○ Evolution ○ Examination and assessment in Biology ○ Resources and facilities for teaching III ○ Actualization of ASEI and PDSI I 	<ul style="list-style-type: none"> ○ Growth and development ○ Transport in plants and animals ○ Nutrition in plants and animals ○ Actualization of ASEI and PDSI II ○ District innovations
CHEM	<ul style="list-style-type: none"> ➤ Recent developments in chemical education ➤ The ASEI movement ➤ Class management ➤ Planning for chemistry lessons ➤ The chemistry syllabus/ history of chemistry in Kenya ➤ Topics of concern (Mole concept; electrochemistry; thermal chemistry; radiochemistry; organic chemistry; metals; structure and bonding) 	<ul style="list-style-type: none"> ➤ Experiments in chemistry ➤ Topics of concern ➤ Chemistry INSET curriculum evaluation ➤ Laboratory management and safety techniques 	<ul style="list-style-type: none"> ➤ Assessment in chemistry ➤ Development of teaching materials in chemistry ➤ Topics of concern ➤ Chemistry textbook evaluation ➤ Chemistry INSET curriculum evaluation ➤ Actual classroom 	<ul style="list-style-type: none"> ➤ Reports and discussions on district innovations ➤ Thermo chemistry ➤ Organic chemistry ➤ Effective use of teaching/learning resources ➤ Preparation and practice of chemistry ASEI lessons ➤ Actual classroom implementation

	➤ Chemistry classroom activities		implementation of ASEI lessons	of chemistry ASEI lessons
	➤ Chemistry INSET curriculum			
PHYSICS	<ul style="list-style-type: none"> ✓ Pressure ✓ Circular motion ✓ Fluid flow ✓ Waves I & II ✓ Sound I & II 	<ul style="list-style-type: none"> ✓ Current ✓ Electricity I & II ✓ Electrostatics I & II ✓ Improvisation ✓ Magnetic effect of an electric current ✓ Electromagnetic induction ✓ Heating effect of an electric current ✓ Thin lenses 	<ul style="list-style-type: none"> ✓ Innovative lesson activities ✓ Textbook evaluation ✓ The atom ✓ Actualization I ✓ Electromagnetic spectrum ✓ Radioactivity ✓ Choice of teaching learning materials ✓ Photo-electric effect ✓ x-rays ✓ project work and preparing students for science congress ✓ electronics I 	<ul style="list-style-type: none"> ✓ District innovative activities ✓ Linear motion ✓ Properties of waves ✓ Quantity of heat ✓ Actualization of ASEI II ✓ Electronics II
MATHS	<ul style="list-style-type: none"> ◇ Trends in teaching and learning of mathematics ◇ Status of mathematics classrooms, subject objectives ◇ Error analysis ◇ KCSE results analysis ◇ Key concepts in mathematics ◇ Syllabus analysis ◇ Textbooks analysis ◇ Difficulties in mathematics classrooms ◇ Form one induction ◇ Problem posing and problem solving in mathematics ◇ Open approach ◇ Socio-cultural aspects of mathematics education ◇ Teaching/learning Resources in mathematics ◇ ASEI lessons on Probability and statistics; Integers; sequences and series 	<ul style="list-style-type: none"> ◇ Error analysis ◇ Open approach ◇ Content pedagogy ◇ ASEI lesson planning ◇ (Ratio and proportion; Loci; Vectors II; Transformation geometry II; Trigonometry; Compound proportions, mixtures ◇ Problem solving/problem posing ◇ Reflections and applications of Probability and statistics ◇ Navigation ◇ Integers ◇ Graphical methods 	<ul style="list-style-type: none"> ◇ Three dimensional geometry ◇ Classroom management ◇ Practical work in mathematics ◇ Assessment in mathematics ◇ Issues in mathematics education ◇ Actualization of ASEI lessons ◇ Compound proportions, rates and mixtures ◇ Vectors ◇ Loci ◇ Linear programming ◇ Inter INSET activities and development of write-ups 	<ul style="list-style-type: none"> ◇ District innovations ◇ -Development of INSET Write-Ups ◇ -Analysis of Content Pedagogy ◇ -Assessment and Evaluation ◇ -Linear Programming ◇ -Latitude and longitude ◇ -Loci ◇ -ASEI Actualization

Appendix II. Pre-INSET and Post-INSET Questionnaire Items

The purpose of this questionnaire is to evaluate the SMASSE mathematics trainers' opinions on their roles during normal school teaching sessions in their respective schools/ districts.

Please consider each of the following statements and indicate the response that reflects your opinion about your situation by putting a line in the appropriate column on a separate worksheet

Key: 0-Strongly Disagree, 1- Disagree, 2- Not Sure, 3- Agree, 4- Strongly Agree

	PRE-INSET	POST INSET
	<i>Statements regarding your teaching/ learning or INSET activities</i>	<i>The INSET Workshops have prepared and made me aware of:</i>
A	PERCEPTION OF TEACHERS	
1	Mathematics students are encouraged to think logically during teaching/ learning sessions	How to encourage students to think logically during teaching/learning sessions
2	Students are helped to understand procedures and practical work in mathematics practical	The importance of helping students to understand procedures in mathematics practical work
3	Mathematics students are encouraged to think creatively during teaching/learning sessions	How to encourage mathematics students to think creatively during teaching / learning sessions
4	Students are assisted to view the relevance of mathematics learned class in relation to what they come across in real life situations	How to assist students to view the relevance of mathematics learned in class in relation to what they come across in real life situations
5	Students are encouraged to design investigations aimed at solving problems on mathematics issues	How to encourage students to design investigations aimed at solving problems on mathematics issues
6	Mathematics is a primarily theoretical and abstract subject	How to view mathematics as a primarily practical and concrete subject
7	Students voluntarily opt to do mathematics work above and beyond the minimal expectations	How to make students voluntarily opt to do mathematics work above and beyond the minimal expectations
8	Mathematics is usually taught to enable students master the subject content and not necessarily to excel in the final examinations	The importance of teaching mathematics tenable students master the subject content and not necessarily to excel in the final examinations
B	STUDENTS' PARTICIPATION	
9	Mathematics students are helped to make precise/ and accurate solutions during the problem-solving sessions	How to enable mathematics students to make precise/ and accurate solutions during the problem-solving sessions
10	Class discussions are encouraged during mathematics teaching/ learning sessions	How to encourage class discussions during mathematics teaching/ learning sessions
11	Mathematics students are encouraged to show methods used to their solutions during problem solving work they do in class	The importance of encouraging mathematics students to show methods of their solutions during problem solving work they do in class
12	During mathematics problem solving work sessions, students are encouraged to make their own predictions/ extensions	The importance of encouraging students to make their own predictions/ extensions mathematics during problem solving work sessions
13	Students are encouraged to verify their predictions or extensions through evidence / facts in mathematics textbooks / journal in class	The importance of encouraging mathematics students to verify their predictions or extensions through evidence / facts in mathematics textbooks / journal in class
14	Students are encouraged to verify their predictions or extensions by solving problems that are based on a mathematical idea	The importance of encouraging students to verify their predictions or extensions by solving problems that are based on a mathematical idea
15	Students write down blackboard examples as mathematics lessons progress	The importance of students writing down blackboard examples as mathematics lessons progress
16	Individual attention is paid to students in a mathematics class	How to pay individual attention to students in a mathematics class
17	Group work is encouraged during mathematics teaching sessions	The importance of encouraging group work during mathematics teaching sessions
18	Mathematics teachers are able to guide students with poor study habits	How mathematics teachers can guide students with poor study habits

- | | | |
|----|--|--|
| 19 | Mathematics is taught/ learned as sets of rules and algorithms | The importance of not teaching mathematics as sets of rules and algorithms |
| 20 | Mathematics students with difficulties are given more exercises and practice based on observations/ practical work | How to give mathematics students with difficulties more exercises and practice based on observations/ practical work |
| 21 | Teachers of mathematics can use appropriate question/ answer techniques with reinforcement of students' responses accordingly | How mathematics teachers can use appropriate question/ answer techniques with reinforcement of students' responses accordingly |
| 22 | Mathematics teachers provide their students with comprehensive instruction that includes what to do, how to do it and when and why to do it | How mathematics teachers can provide their students with comprehensive instruction that includes what to do, how to do it and when and why to do it |
| 23 | Mathematics teachers promote retention of content taught by occasional review activities and with opportunities for students to practice what they have learnt | How mathematics teachers may promote retention of content taught by occasional review activities and with opportunities for students to practice what they have learnt |

C ATTITUDE TOWARDS WORK-PLANNING

- | | | |
|----|---|--|
| 24 | School duties, other than teaching, do hinder effective teaching learning sessions in mathematics | How school duties, other than teaching, may not hinder effective teaching learning sessions in mathematics |
| 25 | High student/teacher ratio does hinder effective teaching during mathematics sessions | How high student/teacher ratio may not hinder effective teaching during mathematics sessions learning activities where class practical activities are not possible |
| 26 | Teachers incorporate students' practical experiences (or ideas) when planning for teaching/ learning sessions | How mathematics teachers can incorporate students practical experiences (or ideas) when planning for teaching/ learning sessions |
| 27 | Where class practical activities are not possible, mathematics teachers plan for other meaningful learning activities for their students to do | The importance of mathematics teachers planning for their students to do other meaningful |
| 28 | Mathematics teachers try-out the experiments or any other practical work and obtain sample results before going to class to teach | The importance of mathematics teachers trying out the experiments or any other practical work and obtaining sample results before going to class to teach |
| 29 | Mathematics teachers prepare worked out examples related to subject content they are going to teach | Importance of mathematics teachers preparing worked out examples related to subject content they are going to teach |
| 30 | Mathematics teachers prepare teacher friendly but student-centred work plans for their daily lessons | How mathematics teachers can prepare teacher friendly but student-centred work plans for their daily lessons |
| 31 | Mathematics lessons are based on aims and objectives of learning the topic | The importance of mathematics lessons being based on aims and objectives of learning the topic |
| 32 | Mathematics lessons are designed such that the hierarchical nature of mathematical ideas or events makes sense and the relationship among them are clear to the student | How mathematics lessons can be designed such that the hierarchical nature of mathematical ideas or events makes sense and the relationship among them are clear to the student |

D ATTITUDE TOWARDS IMPROVISATION AND TEAM-TEACHING

- | | | |
|----|---|---|
| 33 | Mathematics teachers conduct teacher demonstration sessions where facilities are limited in school | How mathematics teachers can conduct teacher demonstration sessions where facilities are limited in school |
| 34 | Mathematics teachers are able to conduct class practical sessions with the facilities available in school | How mathematics teachers can conduct class practical sessions with the facilities available in school |
| 35 | Mathematics teachers are able to conduct teaching sessions even where there is shortage of conventional teaching media and aids in school | How mathematics teachers can conduct teaching sessions even where there is shortage of conventional teaching media and aids in school |
| 36 | Mathematics sessions are hindered by low morale among fellow teachers in school | How mathematics sessions may not be hindered by low morale among fellow teachers in school |
| 37 | Mathematics teachers are able to deal with | How mathematics teachers can deal with students with |

	students with different socio-economic backgrounds in class	different socio-economic backgrounds in class
38	Low morale among students does hinder teaching of mathematics in school	How low morale among students may not hinder teaching of mathematics in school
39	Team teaching enhances teaching/ learning of mathematics	How team teaching enhances teaching/ learning of mathematics in school
40	Teachers usually practice improvisation to supplement shortage of equipment and materials	How teachers can practice improvisation to supplement shortage of equipment and materials
41	Teachers usually practice improvisation to raise the interest and curiosity of the student	How teachers can practice improvisation to raise the interest and curiosity of the student
E	ATTITUDE TOWARDS EXPERIMENTS	
42	Mathematics students are usually made to perform practicals to aid learning of mathematical concepts	The importance of making mathematics students perform experiments to aid learning of mathematical concepts
43	Mathematics students are usually made to perform experiments/practical necessarily to understand the mathematics involved	The importance of making mathematics students perform experiments/practical not necessarily to understand the mathematics involved
44	Mathematics students are usually made to perform experiments/ practical for them to develop various mathematical skills	The importance of making mathematics students perform experiments/ practical work so that they develop various mathematical skills
45	Teachers are able conduct practical sessions that require extensive safety precautions	How mathematics teachers can conduct practical sessions that require elaborate safety precautions
46	Where necessary, mathematics teachers simplify or modify mathematical problems through experiments/practical work	How mathematics teachers can simplify or modify mathematical problems through experiments/practical work, where necessary
47	Mathematics teachers usually conduct small-scale practicals	How mathematics teachers can conduct small-scale practical work
48	Mathematics teachers guide their students on project work	How mathematics teachers can guide their students on project work
F	ASSESSMENT OF STUDENTS' GROWTH	
49	Mathematics teachers plan for assessment as a basic part of the teaching/ learning process	The importance of mathematics teachers planning for assessment as a basic part of the teaching/ learning process
50	Mathematics students' achievement during the teaching/learning process is continuously monitored by a series of tests and quizzes	The importance of continuously monitoring students' achievement during the teaching/learning process by series of tests and quizzes
51	Continuous assessment is necessarily used to prepare mathematics students for the national examinations	The shortcomings of using continuous assessment to prepare mathematics students for the national examinations
52	Continuous assessment is used to promote mastery of mathematics content	How continuous assessment can promote mastery of mathematics content
53	Continuous assessment contributes more to effective teaching/learning of mathematics than just covering the whole syllabus in time	How continuous assessment contributes more to effective teaching/learning of mathematics than just covering the whole syllabus in time
54	Mathematics teachers use results of classroom assessment to gauge their own effectiveness of teaching the subject	The importance of mathematics teachers using results of classroom assessment to gauge their own effectiveness of teaching the subject
55	The learner's mental state of readiness is usually considered when designing mathematics assessment	The importance of considering the learner's mental state of readiness when designing mathematics assessment
56	In designing mathematics assessments, provision is made for the learners to experience moments of success	The importance of making provision for learners to experience moments of success when designing mathematics assessment
57	Suitable assessment procedures are used to determine the level of readiness of the learner	How to use suitable assessment procedures to determine the level of readiness of the learner
58	Effort is usually made, through suitable assessment procedures to identify the root cause of students' persistent learning difficulties in mathematics	The importance of making effort, through suitable assessment procedures, to identify the root cause of students' persistent learning difficulties in mathematics

59	Students' level of achievement in mathematics practical work is assessed through the performance of the actual tasks	The importance of assessing students' level of achievement in practical work in mathematics through the performance of the actual tasks
60	Effort is made to check textbook questions for their suitability before assigning them to students	The importance of making effort to check textbook questions for their suitability before assigning them to students
61	Effort is usually made to give learners a variety of questions that promote their interest and understanding	The importance of giving students a variety of questions that promote their interest and understanding
62	Mathematics teachers, when assessing, set positive and realistic goals for their classes and for individual students	The importance of mathematics teachers setting positive and realistic goals for their classes and for individual students when assessing
63	Question-answer technique is used in teaching learning of mathematics as an important assessment tool	The importance of using question answer technique in teaching learning of mathematics as an important assessment tool
64	Results of mathematics classroom assessment are used to improve on the process of teaching /learning the subject	How results of mathematics classroom assessment can be used to improve on the process of teaching/learning the subject
65	Students are given an opportunity to give the teacher feedback on the lesson presentation	The importance of giving students the opportunity to provide the teacher with feedback on the lesson presentation
66	From time-to-time, fellow teachers are asked to sit through a lesson presentation to evaluate it and give feedback	The importance of asking fellow teachers, from time to time, to sit through a mathematics lesson presentation, evaluate it and give feedback
67	Assessment results are used to guide students to choose careers or areas for further studies	The importance of using assessment results to guide students in their choice of careers or areas for further studies
G	PREPARATION FOR THE DISTRICT TRAINING	
68	District Trainers usually prepare work plans in time	The importance of district Trainers preparing work plans in time
69	District Trainers usually make effective use of INSET work plans	The importance of District Trainers making use of INSET work plans during INSET
70	Time is effectively managed during the District INSET	The importance of District Trainers managing time effectively during INSET
71	Updated inventory of Project's equipment, apparatus and other training materials is maintained at the district centres	The importance of maintaining updated inventory of Project's equipment, apparatus and other training materials at the district centres
72	District Trainers usually make and submit requisitions for INSET materials in time	The importance of District Trainers making and submitting requisitions for INSET materials in time
73	Effort is made by the District Trainers to develop and use improvised INSET training [materials] based on available resources	The importance of District Trainers making effort to develop improvised INSET training materials based on available resources
74	District Trainers are capable of developing training manuals	How District Trainers can develop training manuals
75	District training manuals are usually submitted for quality assurance as recommended	The importance of submitting district training manuals in time for quality assurance
76	District training manuals are usually produced in time for INSET	The importance of producing district training manuals in time for INSET
77	Participatory approach is used during district INSET sessions	The importance of using participatory approach during district INSET sessions
78	Good interpersonal relationships are usually maintained among district trainers, participants and support staff	The importance of maintaining good interpersonal relationships among district Trainers, participants and support staff
79	District Trainers provide good leadership /guidance during the preparation for and conduct of INSET	The importance of District Trainers providing good leadership/guidance during the preparation for and conduct of INSET
80	There is equitable sharing of workload among district Trainers	The importance of equitable sharing of workload among district Trainers
81	District INSET attendance registers are usually kept	The importance of keeping record of district INSET attendance registers

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|----|---|---|
| 82 | Post-INSET seminar/workshop/meetings are usually conducted at the districts | The importance of conducting distinct post-INSET seminar/workshop/meetings |
| 83 | Feedback on various aspects of district INSET are usually gathered, analyzed and interpreted | Feedback gathered on various aspects of district INSET can be analyzed and interpreted |
| 84 | Effort is usually made to improve subsequent district INSET based on the report of analysis and interpretation of feedback obtained form the previous INSET | The importance of making effort to improve subsequent district INSETs based on the report of analysis and interpretation of feedback obtained form the previous INSET |

Appendix III. Lesson Observation Instrument

Name..... School.....
District.....Date.....Subject.....
Topic/ Subtopic.....
Class..... Number of students.....Observer.....

Please indicate your assessment of the following aspects of the lesson by placing a tick in the appropriate box on the rating scale

(Rating scale: 0-poor; 1-fair; 2-satisfactory; 3-good; 4-very good)

<i>1. Teaching procedure</i>	<i>Rating scale</i>				
	0	1	2	3	4
<i>Clarity/feasibility of lesson objectives</i> <ul style="list-style-type: none"> ○ Stated in simple and clear language ○ Stated in terms of what learners are expected to achieve ○ Achievable within stipulated time 					
<i>2. Appropriateness of lesson in terms of:</i>					
i) Introduction <ul style="list-style-type: none"> ○ Helps learners to focus on content of lesson ○ Stimulating ○ Makes reference to previous lessons, everyday experience 					
ii) Content <ul style="list-style-type: none"> ○ Related to learners' previous experience ○ Geared to level of learners ○ Stimulus variation (use of a variety of techniques) apparent in handling of content ○ Teacher well versed in content 					
iii) Gender <ul style="list-style-type: none"> ○ Examples free of gender bias ○ Questions distributed evenly ○ Motivational cues free of gender bias 					
iv) Language <ul style="list-style-type: none"> ○ Voice well projected ○ Language appropriate to the level of learners ○ Teacher defines and explains difficult terms ○ Friendly in terms of communication with learners ○ Instructions given clearly and unambiguously 					
<i>3. Emphasis on main concept</i> <ul style="list-style-type: none"> ○ Explanation and elaboration on main concept ○ Use of appropriate and familiar examples to illustrate main concept 					
<i>4. Lesson consolidation/summary</i> <ul style="list-style-type: none"> ○ Recapitulation of main points ○ Reference to main concept, ○ Sufficient time for learners to ask questions seek clarification 					
<i>5. Achievement of set objectives</i> <i>Is apparent in:</i> <ul style="list-style-type: none"> ○ Activities ○ Teachers questions ○ Students' questions ○ Students' answers ○ Level of enthusiasm 					

II. Fundamental Technique/ methodology	Rating scale				
	0	1	2	3	4
1. Student involvement through questioning and discussion <ul style="list-style-type: none"> ○ Did the teacher ask questions? ○ Did students ask questions? ○ Were the learners involved in discussions? 					
2. Student involvement in hands-on/minds-on activities <ul style="list-style-type: none"> ○ Were learners meaningfully engaged in learning activities? ○ Were the activities planned to arouse and sustain interest? 					
3. Appropriateness of demonstrations, teaching aids and improvised materials <ul style="list-style-type: none"> ○ Materials, demonstrations appropriate for the purpose ○ Evidence of improvisation and economy in use of materials 					
4. Appropriateness of teacher's attitude and expression <ul style="list-style-type: none"> ○ Did the teacher appear to be enjoying the teaching? ○ Was the teacher sympathetic to the needs and problems of the learners? ○ Did the teacher exercise patience with the learners? 					
III. Management					
1. Distribution of time Was the time appropriately distributed <ul style="list-style-type: none"> ○ In the work plan? ○ In the execution of the lesson? 					
2. Class control <ul style="list-style-type: none"> ○ Did the teacher ensure that all students were engaged in relevant learning activities? ○ Did the teacher handle disruptive behaviour appropriately? 					
1. Use of students' opinions/ideas <ul style="list-style-type: none"> ○ Did the teacher actively solicit students' ideas on content being taught? ○ Did the teacher relate students' ideas to the content being taught? ○ Did the teacher discuss and correct students' misconceptions? 					
1. Evaluation of the lesson by the teacher <ul style="list-style-type: none"> ○ Was evaluation incorporated in the plan? ○ Did the teacher actually evaluate the lesson? ○ Did the teacher indicate measures to be taken to improve future planning/execution? 					

Additional comments.....

KCSE result - Year 2002/2003

Subject.....Mean Score.....Number of Candidate.....

AUTHORS

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Samuel is a Kenyan, holds B. Sc. (1969) and PGDE (1970) University of East Africa. He has had education management and development training at Kenya Institute of Administration 1978, University of Pittsburgh (USA) 1979, Birmingham (UK).1982

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Samuel served as National Secretary of Kenya Secondary Schools Heads' Association (1977-1996). He has contributed to various educational seminars as a resource person, and participated in many international education conferences by UNESCO, Commonwealth Secretariat and also SEIA workshops.

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