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The effect of in-service education and training (INSET) programmes in mathematics and science on classroom interaction: a case study of primary and secondary schools in Kenya

Daniel N. Sifuna, James G. Kaime

Department of Educational Foundations,
Kenyatta University

Sawamura, Centre for the Study of International
Cooperation in Education, Hiroshima University
dnsifuna@wananchi.com & Nobuhide

Abstract

The purpose of this study was to assess the effectiveness of the Strengthening of Mathematics and Science in Secondary Education (SMASSE) and the School-based Teacher Development (SbTD) programmes on classroom interaction in secondary and primary schools in Kenya. It was a case study which focused on four districts, and included holding interviews with 185 teachers, observing lessons and holding focus group discussions with pupils and students. It was established that, while teachers evaluated the two INSET programmes as having been effective in exposing them to a student-centred approach, this was not reflected in their classroom practices which were largely teacher dominated. This is partly attributed to large classes, the use of English as a second language and pressure to cover the syllabuses in preparation of the national examinations. It is however, recommended that the Ministry of Education mainstream INSET programmes in its policy for teacher development in the country.

Introduction and background to the study

Just over 40 years ago Clarence Beeby pointed out that, in the context of planning education for development, attempts to change the quality of learning in schools had to be linked to improvements in the education of teachers if they were to be effective (Beeby, 1966). Yet this area has received relatively little attention from policy-makers, donors and researchers since then. Though development agencies have supported a range of teacher education projects, few have contained support for research on learning processes and practices. As a result, the evidence base is weak, and much policy on teacher education has not been grounded in the realities that shape teacher education systems and their clients.

Perhaps most surprisingly, the World Declaration on Education for All (EFA), which emerged from the conference at Jomtien in 1990, devoted scant attention to the problems of teachers and teacher education, despite their centrality to the achievement of better learning outcomes. It was not until ten years later, at the Global Forum on EFA in Dakar, Senegal during which it became clear that in many of the countries which had fallen well short of the goals set at Jomtien, teacher supply and teacher quality were amongst the most important constraints. In the Dakar Forum, therefore, teacher education moved up the agenda of the EFA forum to the extent that the Sub-Saharan Regional Action Plan included it as one of its ten targets: "... ensuring that by the year 2015, all teachers have received initial training, and that in-service training programmes are operational. Training should emphasize child-centered approaches and rights and gender-based teaching" (UNESCO, 2002).

But the extensive implications that this target had for teacher training systems were not elaborated; nor was the evidence base for the advocacy revealed. This has been reflected in some of the ongoing developments. For example, the Association for the Development of Education in Africa (ADEA) has ten thematic international Working Groups, one of which is focused on the teaching profession. However, the objectives of this group are primarily concerned with improvements in management, employment benefits and professional support for teachers. Initial and in-service training do not feature as primary concerns, neither does research on practice. There is very little information and development activities that could guide policy and practice in low-income countries, especially in Sub-Saharan Africa (Stuart and Lewin, 2002).

And yet in many of the less industrialised countries, especially in Africa, teacher education is in a crisis. Inherited systems of teacher education have proved increasingly unable to satisfy the dual demands for higher quality training and substantially increased output called for by commitments to universalise primary schooling (Ncube, 1982; UNESCO, 1997). Many education systems still contain high proportions of untrained teachers; at the primary level most who enter teacher training will only have completed secondary school. The quality of primary schools is such that many are unable to provide a supportive professional environment for trainees of the kind possible where staff are fully trained and often graduates. Donor enthusiasm for new pedagogy, which frequently advocates learner-centred approaches, group work, attention to special needs, and a panoply of methods of training associated with best practice in rich countries, remains an ideal. Much of the rhetoric of reform has been difficult to translate into real changes in practice (Kunje, 2002).

As a way of improving the teaching skills of teachers, especially at the primary and secondary school levels, a number of countries have, with donor support, mounted school-focused INSET programmes to meet the specific needs of schools, especially as a means of halting the declining quality of education. Such INSET programmes have focused on two main areas, namely the problem of reducing significant numbers of unqualified and underqualified teachers and improving the teaching of particular areas

of the curriculum (Bude and Greenland, 1983). The implementation and effectiveness of these programmes have, however, not been adequately evaluated, although there are some notable exceptions which suggest their potential usefulness. Rogan and MacDonald (1985), for example, highlight the success of an INSET programme for science teachers in South Africa, the *Science Education Programme (SEP)*. It used a model involving cycles of workshops for teachers and follow-up support in the classroom. This model was successful in improving teacher performance in the classroom.

Several writers have argued that, if it is to be effective, INSET should be related to particular innovations and to functional groups in the schools, that each school should devise its own staff development policy and that the local authorities should provide external support for this process. Staff development should also try to meet the needs of both individuals and the organisation as a whole; effective staff development policies should be directly related to the overall policy of the institution; and new methods, like job rotation and sabbaticals, should be encouraged in these staff development policies (Bolam, 1983). This thinking has led to the notion of school-focused INSET targeting the needs of particular schools and individual teachers.

The available literature seems to endorse most of the strategies for school-focused INSET programmes, but presents little evidence to support their use. For example, a needs assessment is widely supported in the literature. However, there are few examples of programmes in which INSET providers assessed teachers' training needs. One of the reasons for this could be the lack of empirical research and knowledge about the actual process of needs assessment (O'Sullivan, 2002). There is also a dearth of knowledge concerning the determination of content, effective training processes and follow-up strategies. The available literature on content for INSET is mainly concerned with whether the content should be more or less theoretical, rather than pedagogical (Greenland, 1983; Hawes and Stephens, 1990; Heneveld and Craig, 1996).

The literature on evaluation has also been found to provide inadequate guidance for practice. Avalos (1985) lamented the failure of many INSET programmes to adequately evaluate their effectiveness. Fuller's (1987) review reports the evaluation of only six studies. Greenland's notable study of INSET in Africa pointed out that of the 60 separate INSET activities researched, approximately half included a formally conducted evaluation, but in "only six cases was there actual follow-up at the school level to judge effectiveness" (Greenland, 1983:107).

The literature explains an apparent gap in the research. Greenland (1983) asks what counts as evaluation evidence: Is it pupil achievement, teacher performance, teacher opinion or all three? Evaluation of effective INSET presents extremely difficult methodological problems. Consequently, researchers and INSET trainers have shied away from addressing these difficulties. Little (1994) points out that evaluation mainly gathers quantitative data, concentrating on numbers of seminars and workshops conducted, teachers trained, materials delivered, and so on. Such data fails to indicate the effectiveness of a programme, if implementation in the classroom is taken as the

indicator of effectiveness. Some key studies, therefore, suggest a useful method of or approach to evaluation: the collection of baseline classroom data at the beginning of a programme and its comparison with evaluation data collected upon completion of the programme.

An attempt made to present the realities of life in the classrooms for both teachers and pupils in some selected studies based in industrialised countries are, however, not different in many of the Third World countries in general, and Africa in particular. The basic assumption is that such presentations are a reflection of the teacher-pupil interactions in the classroom through which schooling actually takes place. It is as a result of the paucity of information on the effect of in-service projects that this study attempted to assess two donor community supported projects in Kenya.

INSET programmes in primary and secondary schools in Kenya

The two recent INSET projects that are intended to improve teacher-pupil interactions, among other things, are the Strengthening of Mathematics and Science in Secondary Education (SMASSE) programme and the School-based Teacher Development (SbTD) programme, the latter which was part of Strengthening Primary Education (SPRED 3). The two projects were first launched on a pilot basis and later transformed into nationwide projects involving many primary and secondary school teachers.

The SMASSE project: SMASSE is a joint project between the Ministry of Education (MoE) and Japan International Agency (JICA). It was started in July 1998 as a pilot project and expanded to the entire country in July 2003. Its overall goal is to upgrade the capability of Kenyan teachers in the teaching of Mathematics and Science (Physics, Biology and Chemistry).

The project was launched following a general demand for INSET among teachers and secondary school heads following poor student performance in these subjects in the Kenya Certificate of Secondary Education (KCSE). Since 1994, the Kenya Secondary School Heads Association (KSSHA) had been advocating for INSET and had attempted to organise INSET for cluster schools in the Coast, Nairobi and Central provinces.

Before launching the SMASSE project, a baseline survey was carried out in 1998 to establish the status of secondary school mathematics and science. The baseline survey identified some major areas that were said to lead to negative attitudes and poor performance in these subjects. These, among others, included poor mastery of content and teaching methods, attitudinal factors and lack of teaching/learning materials. On the basis of the baseline survey, the project recognised the need to enhance the quality of teaching in terms of these issues through an INSET project. Its main purpose is to strengthen mathematics and science education at the secondary school level through an INSET programme for serving teachers in the country.

The Kenya Science Teachers' College was identified as the institutional partner for

the project. In the mid-1990s, the Kenya government had made a request to the Japanese government to upgrade the college's laboratories, which were now considered ideal for the SMASSE INSET project. The Government of Kenya provided full-time personnel for the National INSET Centre while JICA provided Japanese experts to assist in the planning and implementation of the INSET activities. The team of experts developed training materials that were used in the national and district INSET programmes.

The project adopted a cascade mode of INSET training. There are two levels of training: one at the national level and another at the district level. At the national level, national trainers train key district trainers, while at the district level, district trainers train teachers in their respective districts.

To ensure the quality of mathematics and science teaching and their steady improvement, the project promotes an ASEI (**Activities, Students, Experiments and Improvisation**) movement, which is key in the project for lesson innovation. **Activities** for the students such as practical work, discussion, presentation and others, should be carried/practised more in the lesson to promote students' active participation. **Students**, not the teacher, should be placed at the centre of lesson presentation. How the students learn should be given priority over how teachers teach. Students should also be given opportunities to perform **experiments**, which enhance an understanding of concepts and principles in mathematics and science. When conventional apparatus are not available, teachers should make efforts to perform experiments by **improvisation** using locally available resources. Improvisation should also be applied to create interest in the learners.

The ASEI movement is made possible by **Planning, Doing, Seeing and Improving** (PDSI) practice, which involves the following: **Plan:** Do careful preparation based on the learners' needs and problems; **Do:** Teach the lesson, using well-chosen and planned activities; **See:** Evaluate the lesson at all the stages of its development. **Improve:** Use feedback on the evaluation results to improve lesson instruction and future planning and implementation (SMASSE National INSET Centre, 2003).

The SbTD project: The SbTD was part of the launching of the Strengthening of Primary Education programme (SPRED) as a result of the perceived decline in the quality of primary education in the country. Kenya's educational provision had grown rapidly since the attainment of independence in 1963. This growth had culminated in the rise of the Gross Enrolment Ratio (GER) to 95% in 1990. Despite such growth, enrolment and quality had been declining over the years, falling to 88,8% in 1999. The negative trend was attributed mainly to the high cost of education and the lack of teaching and learning materials. The Ministry of Education's National Baseline Survey of 1998 showed a limited range of pedagogic practices in public schools, which provided little opportunity for pupil interaction or practical activity.

To arrest the decline in enrolments and improve the quality of primary education, the British Government through the Department of International Development (DFID) supported a joint intervention, the Strengthening of Primary Education (SPRED) Project. The first phase ran from 1993 to 1996 and, although it was considered successful in

achieving many of its aims, it was found to have a limited impact at classroom level. This was ascribed to the lack of involvement of some of the key stakeholders and the utilisation of a cascade model of training. Another perceived weakness was the opportunity cost for the pupils as the in-service training took the teachers away from the classroom.

SPRED 3, a three-year project whose implementation commenced in July 2000, sought to address these weaknesses. The primary purpose of the project was to improve the access of poor children to better quality primary education. The project had two components: the text book programme; and the School-based Teacher Development project (SbTD) which advocated a school-based model of teacher development, supported by self-study distance education materials. This approach was said to be supported by research findings that showed that distance education was one of the most successful means for upgrading primary school teachers (Lockhead, 1991). Distance education had also been found to be more cost effective than a face-to-face model in the training of large numbers of teachers. Similarly, opportunity cost for the pupils was low, as the teachers continued to study whilst teaching.

With regard to the SbTD in particular, its main aim was to develop teachers who reflected on their teaching and could respond to their children's needs and support their learning. The project's specific objectives, among others, were as follows:

- To develop teachers' ability to reflect on all aspects of teaching and learning;
- To guide teachers to understand and believe in the importance of children being actively involved in their own learning;
- To improve teachers' classroom management and assessment skills;
- To help teachers to identify and give attention to children with special educational needs.

The programme was also designed to ensure that training at the teacher level was of consistent quality through distance learning materials (modules) and that teachers could get professional support at all levels, i.e. school, zone, district, division, province and Ministry of Education, Science and Technology (MoEST) (INSET). To support this principle, the design and implementation of the project was geared towards capacity building, developing and strengthening mainstream systems, involving key stakeholders, gender equality and quality assurance.

At the primary school level, the course was expected to target motivated and committed teachers who were willing to improve their own teaching and the quality of learning in the schools. Three teachers from every school were selected by the subject panels and endorsed by the whole staff. Each of the three teachers referred to as **Key Resource Teachers** (KRTs) would specialise in Mathematics, Science or English. Such teachers were selected according to set criteria, which included gender, motivation, commitment and professionalism, among others. Their key function was to work through the distance education learning materials.

In February 1999 a Ministry of Education, Science and Technology (MoEST) Unit was established within the Inspectorate Section of the ministry to manage and sustain the project. It developed modules and handbooks for KRTs and ensured adequate training for the different cadres involved in the project.

Purpose of the study

The purpose of the study was to assess the effectiveness of the SMASSE and SbTD INSET projects on classroom interaction. More specifically, the study was guided by the following objectives:

- To assess teachers' perceptions about the implementation and effectiveness of the SMASSE and SbTD in-service programmes and the challenges experienced by schools in the teaching of mathematics and sciences and sustaining these projects;
- To assess pupils'/students' perceptions about their teachers' classroom behaviour with particular focus on their taking greater responsibility for their own learning processes and the general classroom atmosphere; and
- To assess the effects of the two in-service programmes on teachers' teaching approaches, especially embracing changes in teaching skills, classroom management and teacher-pupil/student interactions.

Data collection

This section focused on the design, sampling procedures and research instruments. The study design and approach were discussed and approved in two workshops held at the JICA centre in Hiroshima in March 2004 and the University of the Philippines in February, 2005.

Study sample: On the basis of resources available for the study, the researchers adopted the case study approach in selected primary and secondary schools located in four districts of Kenya. These were Nairobi, the country's capital city; Kiambu, a peri-urban rural district situated next to Nairobi; Kajiado and Garissa districts, which are predominantly rural-pastoral districts in the arid and semiarid regions of the country. Since the main focus of the study was to assess the effect of the two INSET projects on classroom interaction, this called for a purposive sampling of a relatively small number of schools in each district based on the recommendations of the education officers for quality assurance and standards in the districts, but also taking into consideration their geographical and administrative locations. Consequently, 6 public secondary and 4 primary schools were sampled in each of the districts of Nairobi, Kiambu and Kajiado, while 4 secondary and 2 primary schools were sampled in Garissa due to the expansive distances between the schools. In each of the secondary schools, 1 teacher each for mathematics, physics, chemistry and biology who had participated in the SMASSE programme were targeted, while non-SMASSE teachers in the same subjects were randomly selected. With regard to the SbTD project, 2 mathematics and 2 science teachers (KRTs), who had participated, and 1 non-SbTD teacher in each of the subjects

were randomly selected. Therefore, teachers trained in SbTD and SMASSE projects at the primary and secondary school levels respectively were involved, as well as a control group of teachers who had not been trained in the two programmes. The actual sample is shown in Table 1.

Table 1: The study sample

Instrument	Project	Kiambu	Kajiado	Nairobi	Garissa	Total
Interviews	SMASSE	28	23	17	11	79
	Non-SMASSE	10	7	9	4	30
	SbTD	17	13	16	10	56
	Non-SbTD	6	6	7	5	24
Lesson observations	SMASSE	12	10	13	10	45
	Non-SMASSE	7	6	5	5	23
	SbTD	8	9	11	5	33
	Non-SbTD	3	4	4	5	16
Focus Group Discussions (FGDs)	Primary Schools	5	4	6	5	20
	Secondary Schools	9	5	10	5	29

Research Instruments: To capture the various aspects of the SbTD and SMASSE projects, a number of data collection instruments were designed for the key participants involved in the research. These included the following:

- Interview schedule for the SMASSE teachers in Mathematics, Physics, Chemistry and Biology and SbTD teachers in Mathematics and Science. The interviews focused on their perceptions about the implementation and effectiveness of the SMASSE and SbTD in-service projects and the challenges experienced by schools in the teaching of mathematics and sciences and sustaining of these programmes. Non-SMASSE and non-SbTD teachers were interviewed about the general problems they experienced in the teaching of these subjects in secondary and primary schools. The interview schedule was validated by leading researchers in the Department of Educational Foundations at Kenyatta University.
- Focus group discussion guides for senior primary school pupils and students from the four grades of secondary school which focused on pupils'/students' perceptions about their teachers' classroom behaviour with particular focus on their taking greater responsibility for their own learning processes and the general classroom atmosphere.
- Classroom observation guides for SMASSE and Non-SMASSE teachers in Mathematics, Physics, Chemistry and Biology and SbTD and Non-SbTD teachers in Mathematics and Science subjects. This required the construction of an observation instrument which could be used to reliably record actions engaged in by teachers

over sampled class periods. The behavioural scales were developed to measure discrete behaviours of the individual teacher and dominant pupil/student behaviours in which the entire class was engaged. The observation instrument focused on three main areas, namely (a) how the teacher utilised class time, (b) the frequency with which instructional materials were employed, and (c) the amount and form of interaction observed between the teacher and pupils/students. The observation instrument contained two parts. The first part included a continuous assessment that required the observer to estimate the proportion of time the teacher behaved in specified ways. For instance, each observer estimated the share of total class time the teacher lectured/presented information, led a recitation and other logistical tasks. These estimates applied to the entire 40-minute period. The second part consisted of an estimation of pupil/student behaviours engaged in by the entire class during the same period. Observers, for example, checked if pupils/students were reading a textbook, i.e. if a majority of pupils/students were engaged in this particular activity. The instrument, therefore, included basic descriptions of the classroom behaviours, subjects taught and instructional materials in use on the basis of both the teacher actions and pupils'/students' behaviour with regard to the use of time, all of which constituted pupils'/students' interaction. The observation instrument was validated by members of the Teaching Practice Unit of Kenyatta University.

The three approaches were considered necessary to generate a wide range of data for the classroom impact study of the two projects. For the SbTD and SMASSE Mathematics and Science teachers, it was appropriate to hold face-to-face, in-depth discussions to obtain more insights into the operations of the projects, since the teachers were key in their implementation. Pupils and students, on the other hand, were perhaps the most crucial stakeholders in the SbTD and SMASSE projects, since they were the end beneficiaries of an improved teaching and learning process. As such, their views on what went on in the classroom were essential in gauging the success of the implementation and the direction the projects had taken. It was in this regard that their views were sought through FGDs.

In the light of the research design adopted, it was important to undertake largely qualitative and some quantitative analyses of data collected for a more in-depth and systematic evaluation of the projects' implementation and impact on the classroom teaching and learning processes.

An important factor that needs to be taken into consideration with regard to the results of the study is that, since both the SMASSE and SbTD are now national programmes, a purposive sample of four districts (although selected on the basis of some geographical settings and particular features regarding the programmes' implementation) tends to limit the generalisation of the findings.

The school settings

Before focusing on teachers' and students' perceptions and classroom interaction practices, it is useful to briefly discuss the general classroom settings in both secondary and primary schools in the country.

Secondary schools: Classrooms in the secondary schools are generally large, bright rectangular rooms with windows running full length of both sides of the classroom. Some have wall displays that are not well used apart from timetables and class rotas. In some of the older schools, many classrooms contain old and often damaged desks and chairs, and it is not uncommon to see children sharing chairs throughout a lesson. The classrooms vary in tidiness. Each classroom has a cleaning rota of students, but the care and energy that they put into this very dusty activity depends on the enthusiasm of the class teacher or duty master in maintaining a clean school.

The practical subjects are normally accommodated in specialised units, in the form of workshops for technical subjects and home science, and laboratories for sciences. The latter are furnished with bench-tables and stools. For most established secondary schools, utilities and services such as gas, water and electricity are provided.

Instructional time is normally forty minutes, but frequently two forty-minute lesson periods are blocked together for the practical subjects, especially in the sciences.

Primary schools: These vary so enormously that it is not quite easy to generalise about them. In some places, classes are taken in the open air and the quality of the physical facilities and the teaching/learning materials are dependent on the capacity of the surrounding communities to mobilise the necessary support resources. On the whole, urban primary schools have superior learning facilities. The poor teaching and learning throughout the country has, however, been exacerbated the government's decision to provide free primary education from January 2003. It is now very common to find classrooms which were constructed to house 40 pupils crowded with 90 pupils or more.

Analysis of results

In the following sections we present the results of the study.

Teachers' assessment of the in-service training projects

Teachers' assessment of the effect of INSET projects on classroom practice: Teachers were asked what they perceived to be the effect of the INSET projects on their classroom behaviour. Their perceptions are presented in Table 2.

Table 2: The effect of INSET programmes on classroom practice

Item	SMASSE				SbTD			
	Total number of teachers = 79				Total number of teachers = 56			
	No.	%	No.	%	No.	%	No.	%
Prepares schemes of work and lesson plans	73	94,0	6	6,0	50	90,3	6	8,7
Combination of student-centred methods, questioning and lecturing	51	63,2	28	35,8	32	57,9	24	42,1
Improvised materials, laboratories and equipment, and textbooks	59	75,4	20	24,6	30	54,4	26	44,6
Group work, experiments, field work, writing notes, asking questions, and lecturing	52	65,8	27	34,2	36	64,7	20	34,3
Homework - regular assessments and assignments	76	96,0	3	4,0	45	81,3	11	9,7

Overall, teachers were of the view that the projects had considerably improved their classroom performance. With regard to the preparation of schemes of work and lesson plans, 94,0% (79) of the SMASSE respondents and 91,0% (56) of the SbTD respondents were of the view that they very frequently prepared those documents, although there was no reflection of that in the observed lessons. Furthermore, as a result of the projects, 64,0% (79) of the SMASSE respondents and 57,9% (56) of the SbTD respondents respectively reported that they used a combination of pupil/student-centred teaching approaches alongside questioning and lecturing. An important teaching approach that emerged from the two programmes is the need to improvise in the use of teaching/learning materials and a generous use of materials to “bring reality into the classroom setting”. This was mentioned by 75,4% (79) of the SMASSE respondents and 54,4% (56) of the SbTD respondents respectively. The methods predominantly applied in the classroom situation included group work, field work, giving notes, asking questions and lecturing, which were cited by 65,8% (79) of the SMASSE respondents and 64,7% (56) of the SbTD respondents. The training programmes are also said to have placed a strong emphasis on giving pupils/students regular assessments and assignments, which was mentioned by 96,0% (79) of the SMASSE respondents and 81,3% (56) of SbTD respondents.

Challenges in the teaching of mathematics and science in schools: Teachers were asked to identify some of the challenges they experienced in the teaching of mathematics and science and how INSET projects had to be sustained. Their views are summarised in Table 3.

The key challenges in the teaching of mathematics and sciences in secondary and primary schools include the negative attitudes that students have towards these subjects, which were mentioned by 61,3% (79) of the SMASSE respondents and 57,2% (56) of the SbTD respondents. Also, large and overcrowded classes as well as a lack of

Table 3: Teachers' challenges in teaching mathematics and science

Item	SMASSE				SbTD			
	Total No. of Teachers 79				Total No. of Teachers 56			
			Not specified				Not specified	
	No.	%	No.	%	No.	%	No.	%
Negative attitudes by pupils/students	48	61.3	31	38.7	32	57.2	24	42.8
Large and overcrowded classes	44	56.2	39	43.8	31	54.8	25	45.2
Lack of teaching facilities and equipments/ materials	45	58.4	34	41.6	42	74.6	14	25.4
Weak support from schools	43	54.8	36	44.2	35	61.9	21	39.1
Lack of in-service education and training programmes by Ministry of Education	70	88.1	9	21.9	51	91.0	5	9.0
Lack of motivation for teachers	55	68.6	24	31.4	40	75.5	16	31.4

teaching facilities and equipment were mentioned by 56,2% (79) and 5,4% (79) of the SMASSE respondents and 54,8% (56) and 74,6% (56) of the SbTD respondents respectively. Teachers also mentioned the poor support they get from their schools in teaching these subjects, which was attributed to a lack of adequate funding. This was mentioned by 54,8% (79) of the SMASSE respondents and 61,9% (56) of the SbTD respondents. The Ministry of Education came under very severe criticism for the lack of regular INSET programmes, which was mentioned by 88,1% (79) of the SMASSE respondents and 91,0% (56) of the SbTD respondents. They are also poorly motivated, not only in the teaching of mathematics and sciences, but also towards their entire teaching career. This is mainly due to bad working conditions and remuneration, as well as a lack of recognition from the Ministry of Education by way of promotion or some form of other professional advancement for teachers who had participated in those projects. This particular aspect was cited by 68,6% (79) of the SMASSE respondents and 75,5% (56) of the SbTD respondents.

Pupils'/students' perceptions about classroom interaction

Pupils'/students' attitudes and views were captured through the FGDs. It should be noted from the outset that a majority of pupils/students were not aware that specific in-service projects for their teachers had been running, in this case either SbTD or SMASSE.

As a way of assessing their classroom interactions with teachers, pupils/students were asked to first of all discuss what they had liked most about mathematics and science subjects. It is apparent from their answers that the things they liked most had more to do with being given more opportunity to participate in the lessons. For example, secondary school students liked mathematics more when they worked in groups, as well as when given individual attention by their teachers to enable them to clearly understand "the concepts". They also mentioned being given chances to work out examples on

the chalkboard before the entire class. Also commonly cited were teachers' friendly attitudes, teachers giving students a chance to ask questions on aspects they did seem to understand, and demonstrating the application of the subject in everyday life, especially when teachers asked them more challenging questions. These views were not different from those of primary school pupils. They, for example, specifically mentioned "the teacher making the lesson quite interesting by putting in humour, which makes us find it easy to learn, in particular the art of playing with numbers". This was said to be done by teachers who seemed to have a strong command of the subject and went beyond what was contained in the class textbook. Pupils also appeared to like teachers who gave explanations using diagrams and practical illustrations.

It was more or less for similar reasons that pupils/students seemed to enjoy the science subjects. Secondary school students, for example, tended to like science subjects when their teachers engaged them in "experiments and practicals". In this way, they said, they ended up discovering their own information and acquiring knowledge. Students also liked the teaching of sciences through the use of illustrations and demonstrations, as well as being given the opportunity to discuss and relate the scientific knowledge to real situations in life. They also seemed to like a subject when teachers made deliberate efforts to interest them in those subjects, especially by asking them questions that required reasoning and encouraging them to learn more on their own through assignments. While primary school pupils shared the same views with secondary school students on things that made them like science subjects, they appeared to take more interest in learning sciences when they were taught through "nature" or "the surrounding environment".

Conversely, pupils/students tended to have the least interest in mathematics and sciences when there was not much involvement in the teaching and learning process. For example, secondary school students tended not to like the teaching of mathematics when their teachers bored them with long explanations and calculations on the chalkboards. They also tended to dislike the subject when it was taught without application to practical situations and the teachers appeared to be "rushing in order to complete the syllabus", and did not give students the opportunity to clearly understand what was being taught. Students also felt that some mathematics teachers handled them in a manner that discouraged them, especially in response to their (students') self-initiated questions. Such teachers, it was pointed out, resorted to using abusive language, like referring to students as *majambazi* (gangsters) and the like. The students also seemed not to like the idea of some teachers frequently them to mark their own work without sufficient guidance. Primary school pupils also shared these perceptions, but added the demand by teachers for them to memorise formulae that had not been clearly explained and understood, and the frequent use of punishments when they failed to get correct answers to certain mathematical problems as reasons why they did not like the subject.

Pupils/students did not like most of the teaching of science subjects for similar reasons. However, they added that the teaching, and hence understanding, of sciences became difficult because many practicals were skipped due to the lack of necessary apparatus and the fact that their teachers made little or no effort to improvise for them.

Many of the secondary schools not only lacked science laboratories for specific science subjects, but also had no laboratories and science apparatus of any kind, and yet a number of science subjects were compulsory in the Kenya Certificate of Secondary Education (KCSE) examination. In one focus group discussion, students mentioned cases in which students had never seen or used certain scientific instruments before the KCSE examination, for example when candidates in their school were asked to use a microscope for the first time during the final practical biology examination paper. In many cases during science lessons, teachers normally carried out the experiments, denying students a “hands-on experience”. Due to the lack of apparatus, many science topics were taught “theoretically”. Students also mentioned that their teachers normally dictated long and incomprehensible notes. This was made even more difficult as a result of the lack of textbooks. In one particular secondary school in Nairobi, there were 3 textbooks for chemistry, 9 for biology and none at all for physics in a class of 43 students. Some primary school science teachers who were not conversant with their subject content, tended to resort to the use of vernacular in trying to explain difficult scientific concepts. In this regard, the lack of interest in the learning of sciences would already begin in the primary school, where the subject was not taught practically, and the main source of information, the textbook, was unavailable.

In the context of a lack of teaching and learning facilities, when students were asked to mention some ways in which they were practically involved in the learning of mathematics and sciences, the use of group work and discovery learning methods (which were key approaches advocated by both SbTD and SMASSE) were very rarely mentioned. Although students occasionally mentioned being divided by their teachers into groups for purposes of discussion, this was not necessarily confined to teachers who had participated in these in-service programmes. The main classroom activities which both pupils and students indicated they had participated in most, included answering the teacher’s questions, working out exercises in their exercise books, copying the teacher’s notes, solving problems on the chalkboard, listening to the teacher’s explanations, observing demonstrations by the teacher, doing tests, exchanging exercise books to mark assignments, occasionally being allowed to ask questions and to do experiments on their own. These were given as the main ways in which most teachers involved the pupils/students in the science and mathematics lessons.

On the basis of our discussions with the pupils/students, it was therefore difficult to attribute any teaching approaches to changes brought about by the SMASSE and SbTD programmes. This was more so, given the fact that, to many of the pupils/students, there was no difference in approaches to teaching between those teachers who had participated in the SbTD and SMASSE projects and those who had not. Any difference between them was adjudged by the pupils/students to stem from the personality and character of the individual teacher. In other words, there were good “project” teachers and good “non-project” teachers, just as there were less capable “project” and “non-project” teachers.

The dominant classroom interaction practices

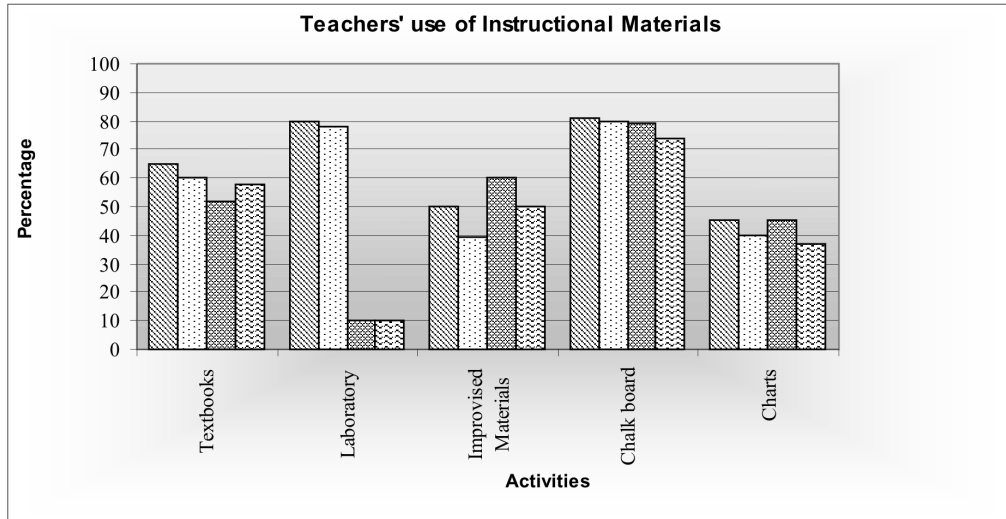
Classroom observations aimed at describing what teachers and pupils/students did during the lesson, that is, teacher-pupil, pupil-teacher and pupil-pupil interaction. The observations focused on three main areas, namely the frequency with which instructional materials were used, pupils'/students' dominant classroom activities and how the teacher utilised class time.

Teachers' use of instructional materials: Figure 1 illustrates the general findings about the teachers' use of instructional materials in the secondary and primary schools for both SMASSE and SbTD trained teachers and teachers who did not participate in the two projects. These behaviours emanated from the science and mathematics lessons observed by the researchers.

The figure shows that in most of the classrooms observed, the chalkboard was a commonly utilised material in the schools for about 81% (45) of the SMASSE, 80% (23) of the non-SMASSE, 79% (33) of the SbTD and 75% (16) of the non-SbTD teachers. This was followed by the use of laboratories in the sciences by 80% (45) and 78% (23) respectively of the SMASSE and non-SMASSE teachers in secondary schools, as this was not a common facility in most primary schools. Another commonly used material was the textbook, which was used by 65% (45) and 60% (23) of the SMASSE and non-SMASSE teachers and by 52% (33) of the SbTD and 58% (16) of the non-SbTD teachers respectively. In situations in which most pupils lacked textbooks, the teachers normally read from their own textbooks. Textbooks were in use by 65% (45) and 60% (23) of the SMASSE and non-SMASSE teachers and by 52% (33) and 58% (16) of the SbTD and non-SbTD teachers respectively. While both the SbTD and SMASSE projects placed considerable emphasis on the need to improvise the teaching/learning materials provided by the local environment, this seemed to be a common feature with 60% (33) and 50% (16) of the SbTD and non-SbTD teachers respectively, compared with 50% (45) and 40% (23) of the SMASSE and non-SMASSE teachers respectively. Though hampered by a lack of manila paper, charts were more commonly used in secondary schools by 45% (45) of the SMASSE and 40% (33) of the non-SMASSE teachers, and by 45% (33) and 38% (16) of the SbTD and non-SbTD teachers respectively.

Dominant pupil/student activities: Figure 2 shows the dominant classroom behaviour in which a majority of the pupils/students were engaged. It is evident that small groups of pupils very rarely engaged in separate activities. In secondary schools, 80% (45) and 82% (23) of the students in SMASSE and non-SMASSE lessons were observed to be passively listening to the teacher lecturing, compared with 72% (33) and 71% (16) in SbTD and non-SbTD classes. Another very dominant behaviour was the answering of questions, which was observed in 43% (45) and 40% (23) of the SMASSE and non-SMASSE classes and 55% (33) and 57% (16) of the SbTD and non-SbTD classes respectively. Copying notes represented 45% (45) and 48% (23) of the SMASSE and non-SMASSE lessons and 30% (33) and 31% (16) of the SbTD and non-SbTD lessons respectively. Written classroom assignments accounted for 28% (45) and 30% (23) of the SMASSE and non-SMASSE lessons and 25% (33) and 20% (16) of the SbTD and non-SbTD lessons respectively.

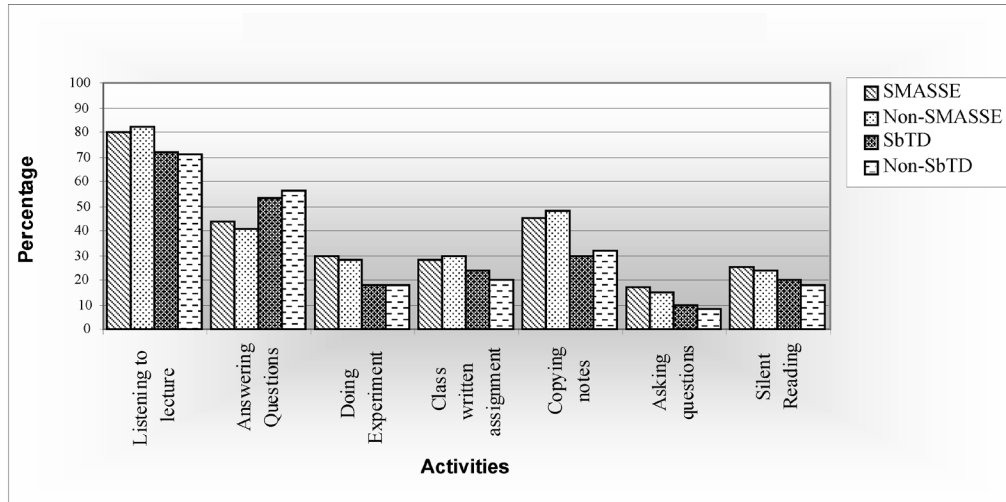
Figure 1: Teachers' use of instructional materials



Number of teachers

SMASSE:	45	SbTD:	33
Non-SMASSE:	23	Non-SbTD:	16

Figure 2: Dominant pupil behaviour in class

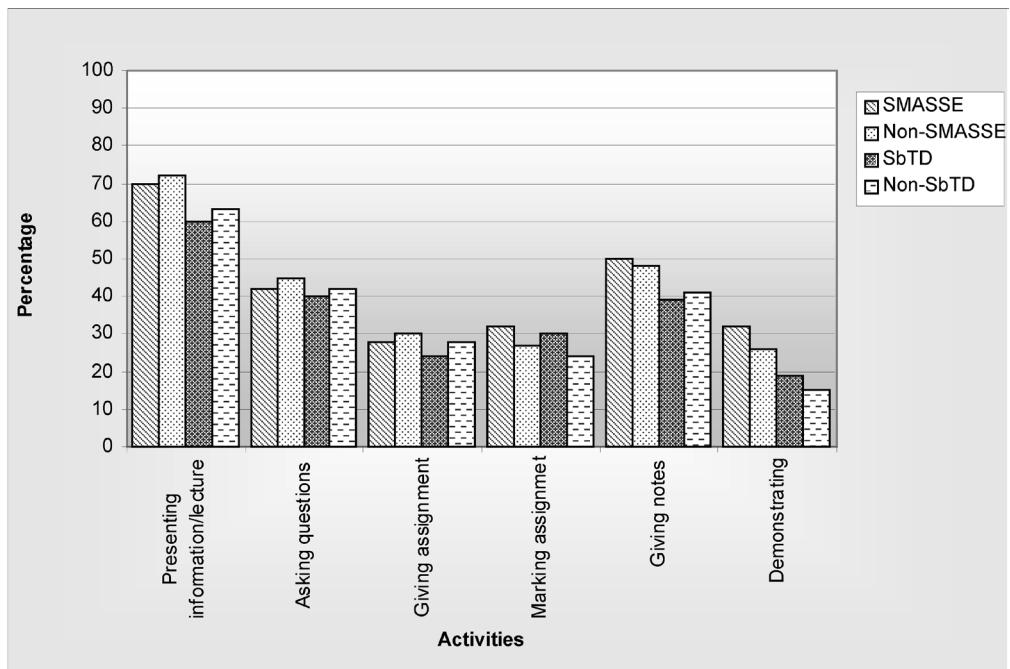


Estimated number of pupils

SMASSE:	1800	SbTD:	1915
Non-SMASSE:	920	Non-SbTD:	760

Teachers' time use and teaching behaviour: Figure 3 presents an indication of how teachers used their class time. It shows that 70% (45) and 72% (23) of the SMASSE and non-SMASSE teachers and 60% (33) and 63% (16) of the SbTD and non-SbTD teachers respectively used much of their time presenting material or lecturing to the entire class. Giving notes was another dominant activity occupying 50% (45) and 48% (23) of the SMASSE and non-SMASSE teachers respectively, while occupying 39% (33) and 41% (16) of the SbTD and non-SbTD teachers' time respectively. Asking questions was an equally major feature of the classroom approach, and was employed by 42% (45) and 45% (23) of the SMASSE and non-SMASSE teachers, and 40% (33) and 42% (16) of the SbTD and non-SbTD teachers. These were followed by giving and marking assignments and demonstrations.

Figure 3: Dominant pupil behaviour in class



No of teachers

SMASSE	45
Non-SMASSE	23
SbTD	33
Non-SbTD	16

Nature of the dominant teaching/learning activities

The following section focuses on the nature of the dominant teaching/learning activities, namely lecturing, question and answer exchange and written exercises.

Presenting information/lecture: The main teaching strategy that characterised primary and secondary school teaching was the large amount of teacher talk, which involved mainly the teacher presenting information or lecturing to the pupils/students, interspersed with questions, generally set to the whole class, with predetermined answers. A minimal amount of time was spent by teachers talking to pupils on an individual basis and, throughout most of the lessons observed, the pupils/students played a passive role. A considerable amount of teaching-learning time was also spent with pupils silently working on teacher assigned tasks. These tasks were generally “whole class” assignments at which the pupils were expected to work independently at the same rate.

Moving from this individual lesson to the wider school day, one was immediately and forcefully struck by the sameness of the lessons. Allowing for the individual teacher differences in style, it seemed that, irrespective of the subject under consideration or whether the pupils were in primary or secondary school, all lessons were characterised by this same routine, namely the teacher presenting information/lecturing to pupils or asking whole-class directed questions and pupils working silently at the teacher assigned tasks. In both of these routines, the pupils played an almost totally passive role in terms of verbal and hands-on involvement.

Question and answer exchange: This was the principal form of oral exchange in the classroom. Pupils/students were required to provide very brief answers to the teachers’ questions, based on the recall of topics encountered in the previous lesson. The teacher rarely probed for the students’ thinking following an incomplete or incorrect response, the approach being more usual to pass from one pupil to another until the correct response, as designed by the teacher, was provided.

A common technique was for the teacher to ask a question and then to select a volunteer from those pupils who had raised their hands. Another frequently used technique was for the teacher to ask a question and then direct it to a specific pupil by name.

In the question and answer routines during lessons, the rapidity with which the teacher fired the questions and the fractional time allowed for a response were deterrents to pupil participation. Pupils/students needed time to organize their thoughts, and even more so if these were to be presented in a second language. The “waiting time” in the order of several seconds not only provided little “thinking space” for the pupils, but also increased the chances of the pupils constructing unacceptable responses.

One important feature of the classroom exchanges was questions asked by the teacher about some “known information”. The teacher knew the answer to the question, and the teacher’s reaction to the pupil’s response told the pupil how well he/she had met the teacher’s expectations. This kind of classroom talk was entirely teacher-directed and gave virtually no recognition to the ideas that pupils brought with them to the lessons. The question and answer exchanges were generally routine at the beginning of lessons,

but could also occur at the conclusion of a lesson, when the teacher had completed the topic more rapidly than anticipated and was left with five or ten minutes to fill. Associated with the question and answer exchange was the common practice of students completing the teacher's sentences in a chorus form.

Written exercises: The working out of examples by both primary and secondary school learners to provide practice in writing and computing skills was quite common in mathematics and the science subjects observed. On the whole, textbooks provided a sequential series of exercises through which each class progressed. After a review of the previous lesson and an introduction of the new topic, the lessons routinely proceeded with the teacher working through one or two examples on the board, after which a series of questions were assigned to the pupils/students for working on in their exercise books. While the students were working out the assignment, the teacher walked round the classroom, checking and marking individual work. As the students completed the questions, the teacher, if there was still enough time, intervened to work through the same questions on the board. The written exercises were often continued as homework, which could be taken in by the teacher for marking and for reviewing during the next lesson. As a variation of the written exercises, the teacher would invite student volunteers to work out examples on the board, while the rest of the class watched.

Discussion

The key objectives of the SMASSE and SbTD programmes were premised on making the primary and secondary school syllabuses pupil-centred, with large and essential components of practical work being done in the classroom, laboratory or science room, and use of the discovery method to transfer useful skills and knowledge to pupils. The starting point for all the activities was the pupils' own environment, experiences and skills that were to be developed in a problem-solving context. The two programmes emphasised the fact that pupils would acquire skills in observing, measuring and estimating; indeed the main concept was to involve pupils practically in learning science and mathematics by using a wide range of measuring instruments with skill and accuracy.

The analysis of classroom observation data shows that the main areas stressed by these programmes, namely the pupil-centred practical component and the development of concepts relating to the physical environment, were quite problematic to attain. It was observed that the practical component based on "discovery learning", which was presumed to be an essential part of the science lessons, had very little to do with the observed classroom processes, probably due to lack of time or equipment. Teacher demonstrations were also not common, and where they occurred, it was with the teacher usually "doing" and the class "observing" and answering simple routine questions. The major form of verbal interaction within the classroom, apart from the teacher lecturing and pupils listening silently, was the teacher asking questions and pupils giving answers. The questions mainly involved simple factual recall, and pupils' answers often consisted

of a single word or a repetition of the question that included the answer. The teachers generally seldom asked “Why?” or “What do you think?”, although this tended to vary from one teacher to another and from subject to subject. The pupils themselves rarely spoke, except when they were spoken to. Throughout the classroom lesson observations, very few instances were noted of pupils asking questions.

From the lesson observations, as already noted, classroom activities did revolve around the transmission of knowledge, and the teachers’ main concern was to “teach” something they considered important, while the learners’ main concern was to “learn” the given content. It was generally difficult to discern and describe the pedagogical principles behind the teachers’ actions, especially after having undergone the intensive SMASSE and SbTD in-service training. The teachers’ methods appeared to be strongly based on the rote learning approach. This style was quite widespread and was representative of what took place in the primary and secondary school classrooms in the country.

With all the emphasis on pupil-centred approaches in the INSET projects, there was little evidence that this had translated into practice in the actual classroom processes. Pupils had greater opportunities to participate in the teaching/learning process by answering the teacher’s questions, but their own contributions were generally ignored. The extended question and answer sessions were a common feature at the start of lessons and also at the end of long sessions of teacher talk. In both cases, the teacher seemed to view this as both a revision and an evaluation exercise. Within these sessions, it was common practice for the teacher to completely ignore many pupils’ responses and only acknowledge certain “correct” answers. There might be a variety of reasons why teachers used this kind of technique. First, they could have felt that time was short and they did not wish to be sidetracked by the incorrect answers. Second, they might not have had the knowledge base to deal with the pupils’ suggested answers. From a teaching-learning perspective, the arbitrary nature of rejection precluded opportunities for pupils’ cognitive development (Prophet & Rowell, 1990). As a response to the arbitrary rejection of pupil responses by the teacher, pupils in turn appeared to answer teachers’ questions in a random manner. Guesses were the accepted order of things, and it seemed more important for the pupils to participate by saying something, however wrong, rather than not respond at all.

One of the most commonly used question and answer techniques for the science subjects involved pupils completing the teacher’s sentences, often in chorus. The completed sentences or words were then often repeated by the teacher. This seemed to be a result of a number of issues. Notably, in some classes observed, especially at the primary school level, pupils had major difficulty expressing their ideas in English. Often the teacher was impatient and did not allow time for the pupils to organise and express their thoughts. In situations where teachers were aware of the problem, and allowed pupils time to organise their thoughts, and also gave them encouragement for the expression of ideas in their own words, the amount of content covered was normally reduced, and therefore appeared as if less work was being done.

Conclusion

In conclusion, the SMASSE and SbTD projects set out a child-centred learning experience which pupils/students were expected to be exposed to in the teaching situation, an approach that would draw on their everyday experiences in order to give them the opportunity to express and develop their own ideas. This was to be achieved by offering a programme of studies with a greater emphasis on “practical” rather than the usual rote learning exposure. The classroom interactions documented in this study showed that such an approach remained a long time ideal. The teaching portrayed in these observations placed emphasis on the acquisition of limited skills associated with the specific responses required for achieving success in the terminal examinations. The dominant mode of interaction was that of the transmission of information from teachers to students, accompanied by repetition and drilling. What appeared to be lacking from these interactions was any recognition of the beliefs and values which students brought with them to the classroom or even an acknowledgement that students had already-constructed structures for interpreting their world.

The fact that students were communicating in a second language raised the question of the extent to which this impeded the articulation of thoughts through oral or written expression. The lack of confidence in the usage of the English language was frequently reinforced overtly by the teacher’s impatience and covertly by the teacher’s avoidance of student contributions. Many teachers attempted to compensate for the students’ language difficulties by reducing the content of the lesson to a simplistic account of ideas.

Faced with large classes, syllabuses overloaded with content, high expectations from pupils, parents, head teachers and the local communities who perceived examination success as the priority of the schools, and examinations which still emphasised and rewarded simple rote learning and recall skills, it was no surprise that teachers utilised a set of strategies that ensured their survival in the classroom, but failed to take cognizance of individual pupils and their development.

The findings of this study, however, in no way negate the need for in-service training programmes. The Ministry of Education needs to recognise the fact that there are many key players in the education system and that indeed in-servicing of teachers cannot be the responsibility of any one player, be it a donor agency or NGO. There are many providers with different focuses. All these efforts need to be appreciated and properly harmonised and guided. There is consequently a need to put mechanisms in place for the continuous processes of in-service training for primary and secondary school teachers. In order to improve the coordination of in-service providers and programmes, especially at primary and secondary school levels, the INSET Unit in the Ministry of Education should coordinate and ensure that in-service initiatives are decentralised, institutionalised and sustained.

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