International Journal of Learning, Teaching and Educational Research
Vol. 16, No. 5, pp. 118-140, May 2017

The Level of Implementation of ASEI/PDSI Classroom Practices in Science Subjects: A Case of SMASSE Project, Kenya

Dr. Caroline Ndirangu, Dr. Grace Nyagah and Prof. Gerald Kimani
University of Nairobi
Kenya

Abstract. A lot of time, effort and resources are invested to put innovations in education into practice. In far too many cases, these innovations seem to fade away at different stages and for various reasons. Some innovations may be adopted by implementers in ways that undercut the design principle or, they may not provide students with sufficient exposure to the activities that produce learning gains. In 1998, Kenya adopted the Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) in-service training programme, using a constructivist methodology to improve science performance. The emphasis was on Activity focused methods, Student-centred activities, Experimenting and Improvisation (ASEI) through the Plan, Do, See and Improve (PDSI) paradigm. The main objective of the study was to establish if there was a significant difference in the levels of implementation of the ASEI/PDSI classroom practices in the various science subjects, namely Physics, Chemistry and Biology. The survey design was used for a sample of 68 head teachers, 147 science teachers and 16 trainers. The instruments of the study were questionnaires, interviews and lesson observation schedules. The study established that the majority of the teachers (75%) were partial implementers and only (5%) were full implementers. The Fisher Exact Test result for the level of implementation among the science subjects was: Biology and Chemistry p-value $0.002 < 0.05$, Biology and Physics p-value $0.33 > 0.05$, and Chemistry and Physics p-value $0.01 < 0.05$. The conclusion was that the level of implementation of the ASEI/PDSI classroom practices was partial, partly due to the heavy teaching load. It was therefore recommended that the government employ more teachers to facilitate adequate preparation for ASEI lessons and apply learner-centred approaches that the innovation recommends.

Keywords: In-service training; innovation; learner–centred methodologies; Implementation; Sciences.

Introduction

UNESCO (2016), The Association for the Development of Education in Africa (ADEA) (2014) and Orado (2017), have all emphasised the need for teachers who are adequately prepared to implement science and mathematics curricula. It is on the premise that teachers influence learning outcomes and therefore one way African countries can move forward in building their human capital. Paine and Zeichner (2012) posit that many educational projects fail during the implementation phase, and before the effectiveness of the programme can even be tested. Some fail to be implemented by the teachers either because they are complex or because educators do not find value in them (Blumefeld, Fishman, Krajack, Maxx & Soloway, 2000). Other innovations may be adopted by educators in ways that undercut the design principle of the curricula (Brown & Adams, 2001) or, they may not provide students with sufficient exposure to the activities that produce learning gains (Lipsey & Condray, 2000).

Ndoye (2005) and Mulkeen (2010) observed that in Africa innovations generate a cycle of rising expectations and unfulfilled promises. A lot of time, effort and resources are invested to put the innovation into practice. In far too many cases however, these innovations seem to fade away at different stages and for various reasons. ADEA (2014) observed that the record of successful implementation of educational programmes and projects in sub- Saharan Africa is not good. The study carried out by Ruffini, Lindsay, Mcinerney, Waite, and Miskell (2016) in Milwaukee public schools to determine the measure of implementation of the Response to Intervention (RTI) found that 69% of the priority schools did not reach adequate levels of implementation. Further, schools with the lowest level of academic performance struggled most with implementation.

In 1998, Kenya adopted the Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) in-service training program for science teachers (Republic of Kenya, 2012). The in-service training uses a constructivist methodology to improve science performance. The emphasis is on Activity focused methods, Student-centred activities, Experimenting and Improvisation (ASEI) through the Plan, Do, See and Improve (PDSI) approach, hence the ASEI/PDSI classroom practices. Since 2014, SMASSE has been a fully funded Ministry of Education programme institutionalised and regularised as a teacher capacity development programme for mathematics and science teachers at both primary and secondary levels nationwide. Other African countries have started their own programs through the Third Country Training Program (TCTP) fully funded by JICA (Orado, 2017).

Despite the ASEI/PDSI classroom practice intervention, there has been minimal change in the students' performance in sciences (Ndirangu, 2006). The first cohort of teachers trained in 2003 to 2013 have been in the field for well over 10 years. Yet the Kenya National Examination Council (KNEC) results still indicate that majority of the students (over 65%) obtained between grades D and E at the end of the secondary school examination (KNEC, 2016). According to UNESCO (2016) well trained teachers can better manage diversity in the classroom therefore increasing chances of success.

Hypotheses of the study

The null hypotheses were:
Ho 1: There is no significant relationship between the levels of implementation of ASEI/PDSI classroom practices for the different science subjects; Biology, Chemistry and Physics.

Ho 2: There is no significant relationship between the level of implementation of ASEI/PDSI science classroom practices in schools whose head teachers had attended SMASSE in-service training and those whose head teachers had not attended.

Literature Review

This study adapted the Innovation Theory, which is also referred to as the Diffusion Theory. The proponent of the theory, Rogers (1995) defines diffusion as the process by which an innovation is adopted and gains acceptance by individuals or members of an institution. Diffusion has four elements which include: The innovation, which is an idea, practice or object that is perceived as new by individuals or a group of adopters. In this study ASEI/PDSI classroom practice is the innovation. The other elements are; Communication Channels, Time and a Social System - the latter being a set of interrelated units that are engaged in joint problem solving activities to accomplish a goal(s) (Rogers, 2004).

Marsh (2001) points out that the theory is a scientific approach to understanding the rate of adoption as well as factors which may lead to the rejection of an innovation. In its own simplicity, the Diffusion Theory may ironically be its strength; it is limited in explaining complex human systems. The theory may not explain the complex human systems in relation to the implementation of the ASEI/PDSI classroom practices by the teachers but, it gives an insight of the factors that influence the readiness of teachers to implement this innovation in Kenya.

In-service training and its effects on implementation of innovations

According to USAID (2010) study, the effectiveness of teacher in-service professional development programmes is often questioned, particularly in relation to the high cost of even modestly budgeted programmes. The study provided key principles in developing effective in-service professional development programmes. These principles, consider in-service programmes as part of a continuum of professional development that starts with pre-service education and graduating into full time teaching (Britton, Paine, Pimm & Raizen, 2003). They also entail involving teachers in planning and implementation of programmes. However, most in-service programmes, including the SMASSE project under study, are organized at three levels: national, regional, and local, often with support and assistance from international donors and NGOs (USAID, 2010). The district trainers, selected from different secondary schools are involved in the preparation of the in-service training materials and the actual training of the teachers during the four cycles. The Trainers of Trainers (TOTs) prepare the district trainers at the national SMASSE in-service training centre, before training the rest of the teachers. SMASSE in-service training adopted the cascade model of in-service training (SMASSE, 2006; Centre for Mathematics, Science and Technology Education (CEMASTEA), 2008).

In-service training also emphasizes on pedagogical content knowledge in designing programme content. Feiman-Nemser (2008) asserts that in-service content should focus on subject matter and its implications for pedagogy. Pedagogical content knowledge serves as a bridge between the teacher's knowledge of the subject matter and knowledge and skill in planning and managing their interaction with students in ways that facilitate learning. It is subject specific and focuses on the ways that teachers can strengthen and monitor students' understanding of the subject at different levels (Grossman, 2005).

According to SMASSE (2006) and CEMASTEA, (2008), the SMASSE in-service training curriculum is designed to cover difficult areas in each of the science subjects. The teachers and learners identify the difficult topics in each of the sciences during the needs assessment phase. The in-service training facilitators then identify appropriate approaches of tackling the topics identified as challenging. These approaches are then introduced to the trainees during the in-service training who are also encouraged to bring their input. The SMASSE in-service training emphasizes on learner-centred teaching methodologies even to the trainees unlike pre-service programmes.

The approach urges the inclusion of all teachers in learning opportunities and the base of most of the in-service at the school cluster level, be facilitated by teachers and supported by school administrators. Further, in-service training incorporates strong instructional leadership by school administrators and local supervisors (Barrow et.al, 2007; Ginsburg, 2010). This also provides guidance and pedagogical support to teachers as they implement innovations or improve practice within their schools.

USAID (2010), observed that although many teachers were intrinsically motivated to work. They, like other professionals deserve fair compensation, good conditions of service and opportunities for progress. The sheer size of the teaching force is a problem because it is the largest personnel group on most governments' payroll. The science teachers are issued with a certificate after attending each cycle of the SMASSE In-service training. These certificates are recognized tools for promotion. However, they are not remunerated for attending the in-service training which was a bone of contention during the training.

In-service programmes require considerable financial resources. According to Len and Ginsburg (2011) cost is the main reason that programmes are often fragmented, ad-hoc and of varying quality. Cost determines who will be trained; For example, a selection of teachers rather than all teachers are selected for the SMASE in-service training in primary schools in Kenya (CEMASTEA, 2008, MOEST, 2005). Costs cause in-service training to rely on the relatively ineffective cascade mechanism of in-servicing trainees. The teacher trainers who attend the workshops are meant to disseminate new knowledge and skills to the rest of the teachers. Cascading model of in-service has been adapted by SMASSE.

However, it "lacks the multiplier effect of disseminating knowledge and skills and hence it is ineffective although cost effective" in training at large scale level (Republic of Kenya, 2012 p.41).

According to CEMASTEA (2008), the ASEI/PDSI classroom practices paradigm shift was to enhance the capability of young Kenyans in mathematics and sciences, by providing in-service education and training for the serving teachers in public secondary schools. The ASEI/PDSI premises are based on the realization that the quality of the classroom activities is critical for effective teaching and learning. Deliberate efforts are made to bridge experiments with concepts in order to reinforce concept formation (GoK, 2007). The Banda, Mudenda, Tindi and Nakai (2015) study, *Lesson Study Practice of Science Teachers in Zambia* following in-service training revealed that the teaching skills of teachers were improved and the students' pass rates in national examinations increased in science compared with provinces which were not implementing the practice. The survey further revealed that the support from school managers and allocation of well-trained lesson study facilitators enhanced the implementation. However, despite these interventions and slight improvements, the students' performance in science is still at an unsatisfactory level. The teachers in both countries, Zambia and Kenya, were struggling to implement learner-centred methodologies.

Level of implementation of an innovation

According to Hall, Dirksen and George (2008), research methodology has somewhat neglected the understanding and systematic address of the importance of documenting the extent of implementation. Researchers exercise rigor and precision in measuring student outcomes while, trusting the sampling designs to control for implementation. Traditionally the implementation of an innovation has been viewed as dichotomous, the teacher either uses the approach or does not, and in that case, there would be either users or nonusers of an innovation. The Concerns-Based Approach Model (CBAM) however, breaks use and non-use into several Levels of Use (LoU). The model views Levels of Use as a behavioral phenomenon. It does not deal with attitudes, emotions, or feelings nor does it deal with the quality of the innovation. Instead, LoU presents behavioral profiles of eight different approaches to using an innovation. Level of Implementation or Use is defined as:

> *"Distinct states that represent observably different types of behavior and patterns of innovation use as exhibited by individuals and groups. These Levels characterize a user's development in acquiring new skills and varying use of the innovation. Each Level encompasses a range of behaviors" (Hall, Dirksen & George, 2008 p.3)*

Concerns-Based Adoption Model identified 8 Levels of Use of an innovation. Table 1 indicates these levels.

Table 1: Levels of implementation of an innovation

Level of implementation	Description of the level
Non-use (0)	State in which the user has little or no knowledge of the innovation, no involvement with the innovation, and is doing nothing towards becoming involved.
Orientation (1)	State in which the user has acquired information about the innovation and has explored its value orientation and its demands upon the user and the user system
Preparation (11)	State in which the user is preparing for first use of the innovation.
Mechanical Use (111)	State in which the user focuses most effort on the short term, day-to-day use of the innovation with little time on reflection. often results in disjointed and superficial use of the innovation
Routine (1V-A)	Use of the innovation is stabilized. Few if any changes are being made in ongoing use.
Refinement (IV-B)	State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence.
Integration (V)	State in which the user is combining own efforts to use the innovation with the related activities of colleagues to achieve a collective effect on clients within their common sphere of influence.
Renewal (VI)	State, in which the user reevaluates the quality of use of the innovation, seeks major modification or alternatives to the present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system.

Source: Hall, Dirksen and George, 2008, p.5

Level of implementation, in this study, will provide an opportunity to carry out an analysis of the relationship between using and not using the ASEI/PDSI innovation and its outcomes. The LoU assessment also provides valuable information for those who are facilitating implementation. According to Hall and Hord (2011), change facilitators understand the descriptions and logic of LoU, which are grounded in the day-to-day realities of implementation. LoU can provide the trainers of the SMASSE In-service training, and the principals, with diagnostic information about the facilitating interventions that should be put in place to further advance the change process. Regular Level of Implementation assessments provide systematic measurement of how well, fast, and far the implementation effort of an innovation has gone.

According to Hopkins (2011), the nature of the individual teacher has an impact on their eventual implementation of an innovation. A teacher who is self-actualizing is more willing to try new teaching methods and to adopt a new innovation. Further, there is a relationship between the degree of implementation of a new innovation and the commitment to the innovation by teachers, over time and experience, with the innovation. George, Hall and

Stiegelbauer (2014) found those with higher LoU had extensive knowledge and expertise, had a greater sense of responsibility for student success, evaluated learning materials, expressed a greater need to teach students skills and concepts and spent more time on guided practice with students.

While a number of factors can positively or negatively impact the implementation of an innovation, Newhouse (2015) found the level of use (LoU) to be strongly correlated with the nature of the curriculum, such that, if the curriculum directly supports the use of an innovation, it is much more likely to be implemented. Confounding variables such as equipment, materials and classroom management were likely to impede LoU. Other barriers to implementation include time, differences in personal priorities of the teachers, demands to meet new requirements, and academic demands.

Additionally, innovations are adopted more by teachers who use student-centered approaches of instruction. Most teachers require 2-3 years with an innovation to become good users of the innovation, progressing beyond LoU III or Mechanical Use (Dirksen, 2002). Falkenberg (2002), Loucks and Melle (1982), on the other hand noted that components of an innovation on which teachers had total control were the most successfully implemented. Schiller (2002) argues that no matter the innovation, teachers have different levels, require different activities and different interventions to support the adoption and implementation of an innovation. According to a study conducted by Gwanyi (2009), self-assessment is a reliable method of collecting data on the use of an innovation. In this study the researchers requested the teachers to assess themselves on their use of the ASEI/PDSI classroom practices. The head teachers were also asked to indicate how the teachers were using the innovation as a way of further cross checking the teachers' self- assessment.

Methodology

The study used a survey design methodology. It adopted the purposive, stratified random and simple random sampling procedures. To carry out the sampling process for the target population, the schools were categorised as high performing, medium and low performing schools, with regard to the Kenya Certificate of Secondary Education national examination mean scores. Stratified sampling based on this criterion identified 68 schools, whose head teachers participated in the study.

Purposive sampling of 147 science teachers was carried out, targeting those who had attended the SMASSE in-service training. Simple random sampling was applied to select 16 key informants, namely the SMASSE Science sub-county trainers who included Quality Assurance and Standards Officers (QASOs). The data was collected using questionnaires, interviews and lesson observation schedule. The lessons were observed without giving the teachers prior notice.

To enhance the validity of the instruments a pilot study was conducted in 8 schools. The pilot sample was 10 %, according to Mugenda (2008). The pilot study selected: 8 head teachers, 38 teachers, 5 district trainers and two lessons were observed. The reliability test was carried out using the Cronbach's Alpha

(Kothari, 2004). Item analysis resulted in coefficients of internal reliability of 0.80 for the head teachers' questionnaire and 0.78 for the teachers' questionnaire. The instruments were considered reliable for use in collecting data for the main study. The hypotheses were tested using the Chi-square statistic and the Fisher Exact Test.

Findings of the study

This section presents background information of the respondents, and findings based on the analysis of the field data and the results of testing of the two hypotheses of the study.

Background information of respondents

In order to gain understanding of the respondents involved in the study each respondent was asked to provide their personal data. The background data from the head teachers and teachers included their gender, their teaching experience, and the work load of the teachers. The data provided important information on the calibre of all the respondents involved in the study. The questionnaires returned were 51 out of 68 for the head teachers (75.0 %) and 147 out of 147 for teachers (100.0%). The lessons observed were 15.

Table 2 shows the ages of the head teachers and teachers involved in the study according to age and gender.

Table 2: Head Teachers and teachers Age by Gender

	Head teachers		**Teachers**	
Age Category	**Male**	**Female**	**Male**	**Female**
(Years)	%	%	%	%
20-29	-	-	8.9	6.9
30-39	11.8	2.0	25.5	9.8
40-49	43.1	21.6	32.4	8.9
50-60	13.7	7.8	6.9	0.7
Total	**68.6**	**31.4**	**73.7**	**26.3**

Data indicates that majority (68.5%) of the head teachers were male while only 31.4% were female. Data on the age of the head teacher indicate that most were in the age category of 40-49 years (64.7%), followed by age group 50-60 years (21.6%); the lower age bracket 30-39 years was 13.9%. Most of the head teachers involved in this study were mature and majority may probably be in a leadership position for another ten years since the retirement age is 60. It is therefore important to involve them in the proper implementation of the innovation.

The findings also indicate that majority (73.7%) of the science teachers were male and 26.3% were female. This implies that there is gender disparity in the teaching of sciences. With regard to age of the teachers, the data shows that 41.4% were in the age bracket of 40-49 years. This was followed by age group 30-39 years with 35.2%, with the lower age bracket of 20-29 years at 15.8 %. The older teachers in the age bracket of 50-60 were only 7.6%. Most of the science teachers involved in the study may be teaching for another ten years or more, thus continuing to influence science learning in schools.

The teachers were also asked to indicate their teaching experience. The findings are presented in Table 3.

Table 3: Teaching Experience of the Teachers

Years of Teaching	**Frequency**	**Percentage**
1-10	61	42.1
11-20	62	42.7
21-30	22	15.2
Total	**145**	**100.0**

Results indicate that majority of the teachers, 42.7% had a teaching experience of between 11-20 years. The data further indicated that 42.1% of the science teachers had a teaching experience of 1-10 years while 15.2% had taught for 21-30 years. This implies that the majority of teachers, involved in this study, are highly experienced in their areas of specialization and majority have had a chance to interact with the skills and knowledge acquired from the SMASSE in-service training for more than 10 years. The teachers had other responsibilities other than teaching as indicated in Table 4.

Table 4: Teachers' other responsibilities by gender

Category	**Male**	**Female**	**Total**	**Percentage**
Deputy Head teacher	6	1	7	4.8
Head of Department	43	12	55	37.9
Subject Head	15	7	22	15.1
Class Teacher	24	13	37	25.5
SMASSE Trainer	15	12	27	18.6

n=145

Results indicate that a substantial number of the teachers involved in the study were Heads of Departments, that is, 37.9%. This implies that they were familiar with the requirements of the ASEI/PDSI classroom practices and what should be implemented. The subject heads were 15.1% and the class teachers were 25.5%. Those involved in the SMASSE in-service training were 27 or 18.6% and were familiar with the ASEI/PDSI classroom practices skills and knowledge. This suggests that other than having heavy teaching loads, science teachers were engaged in other demanding responsibilities and this could interfere in their preparation of ASEI/PDSI lessons. The study also sought to find out the weekly teaching load of the science teachers and the findings are represented in Table 5.

Table 5: Teaching Load of Science Teachers

Teaching Load (Lesson per Week)	**Frequency**	**Percentage**	**Cumulative (%)**
Less than 15	2	1.4	1.4
15-20	16	11.0	12.4
21-25	63	43.5	55.9
26-30	62	42.7	98.6
No lessons	2	1.4	100
Total	**145**	**100.0**	**100.0**

Many of the science teachers (43.5%) had a weekly load of 21- 25 lessons. The lightest load was 14 lessons and the heaviest load was 30 lessons per week. The recommended maximum teaching load for secondary school teachers is 30 lessons per week. This implies that 62 or 42.7% of the science teachers have the recommended load of 26-30 lessons per week. However, they can be considered to have heavy loads because they also indicated that they have other duties other than teaching. Most schools have on average 35 lessons per week. This means that on average teachers have about 5 free lessons per week to prepare lessons, mark students' work and attend to other duties assigned to them.

The respondents were asked to indicate whether they had attended the SMASSE in-service training , roles played and to indicate the cycles they had attended. Results presented in Table 6 show the head teachers' roles in the SMASSE in-service training.

Table 6: Head Teachers' Roles during the SMASSE in-service training

Responsibilities	**Total**	**Percentage**
Trainees	22	43.1
Trainers	2	3.9
Centre Organizers	3	5.8
SMASSE INSET Organizers	8	15.7

n=51

There were 22 head teachers or 43.1% who attended as trainees in Mathematics, Chemistry, Biology or Physics. Data also implies that 29 or 56.9% did not attend the teachers SMASSE In-service training. Among the head teachers involved in the study there were 2 trainers, 3 centre organizers and 7 SMASSE in-service training organizers. This implies the study had a representation of head teachers from the various categories of SMASSE in-service training activities.

The head teachers' attendance of the two SMASSE in-service training programmes, that is, the teachers and the heads is presented in Table 7.

Table 7: Head Teachers' Attendance of the Teachers and Heads' SMASSE In-service Training

Attendance	Male	Female	Total	Percentage
Teachers INSET				
YES	19	3	22	43.1
NO	16	13	29	56.9
Heads INSET				
YES	5	2	7	13.7
NO	30	14	44	86.3

n=51

Results on head teachers' attendance of the teachers' SMASSE in-service training indicated that only 43.1% of the head teachers' involved in this study attended the teachers' SMASSE in-service training while 56.9% had not attended. Those who attended the teachers SMASSE in-service training were mainly science oriented head teachers. Both the arts and the science oriented head teachers are also expected to attend the heads SMASSE in-service training which guides them on monitoring and implementation of the ASEI/PDSI classroom practices. Results further, indicate that 7 or 13.7% of the head teachers attended while 86.6% did not attend.

This means that the majority of the head teachers had missed the opportunity of being trained on the SMASSE ASEI/PDSI classroom practices and what was required of them in order to support the implementation.

Science teachers are expected to attend all the four cycles of the SMASSE in-service training in one area of specialisation. If they fail to attend any of them they are given an opportunity to attend the mop-up in-service training offered periodically.

Table 8 presents data on the teachers' attendance of the SMASSE in-service training by subject.

Table 8: Teachers' Attendance of in-service training by Subject

Subject	Frequency	Percentage
Chemistry	50	34.5
Biology	42	29.0
Physics	33	22.7
Mathematics	20	13.8
Total	**145**	**100.0**

The data indicates that 34.5% attended the Chemistry, 29% Biology and 22.7% the Physics in-service training programmes respectively. They were offered in-service training for only

The implication is that teachers are handling science subjects without having gone through the SMASSE in-service training in the specific subject areas. This is likely to impact on their level of implementation of the ASEI/PDSI classroom practices. Table 9 presents the data of the teachers' attendance of SMASSE in-service training cycles.

Table 9: Teachers' attendance of SMASSE in-service training cycles

Attendance		Frequency	Percentage (%)
Cycle 1	YES	119	83.2
	NO	24	16.8
Cycle 2	YES	120	83.9
	NO	23	16.1
Cycle 3	YES	113	79.0
	NO	30	21.0
Cycle 4	YES	117	81.8
	NO	26	18.2

n=143

The data indicated that Cycle 1 was well attended; 83.2% of the teachers involved in this study attended and only 16.8% did not attend. It also indicated Cycle 2 was the best attended cycle by the science teachers, whereby 83.9% attended and 16.1% did not attend. The lowest teachers' attendance was in Cycle 3 at 79% and only 21%of the teachers involved in this study did not attend. Cycle 4 was attended by 81.8% while 18.2% did not attend. Failure to attend all the in-service training s implies that the science teachers have knowledge gaps about the ASEI/PDSI innovation and are therefore unlikely to use all its paradigms in the classroom.

This information on the overall attendance raises two concerns. First, the majority of the head teachers did not attend any of the SMASSE in-service training implying that they do not have information on the innovation whose implementation they are supposed oversee. Over 86% of the head teachers did not attend the head teachers' forum that informs them how to handle change during the implementation of innovations. Secondly, majority of the head teachers who had missed the in-service training were aged between 40 and49 years, and were likely to be in leadership for another 20 years. Therefore, efforts should be made to ensure they attend the SMASSE in-service training s to guarantee successful implementation of the ASEI/PDSI classroom practices.

Head Teachers' Supervision of Implementation of ASEI/PDSI Classroom practices

The paradigms of ASEI/PDSI classroom practices: are improvisation of practical materials, use of learner-centred approaches in teaching and, ensuring more practical lessons. To find out how the head teachers were carrying supervision of the implementation, the researchers asked them several questions related to their supervision of the science teachers on issues touching on the ASEI/PDSI classroom practices. They indicated how often they supervised various aspects on a five point Likert scale.

Table 12 indicated in percentage (%) how the teachers were supporting the implementation of the ASEI/PDSI classroom practices.

Key: Always (A) = 5; Often(O) =4; Sometimes(S)=3; Rarely (R)=2; Not at all(N)=1.

Table 10: Head Teachers' Supervision of ASEI/PDSI Classroom Practices Implementation

Statement: As a head teacher how often do you do the following:	**A**	**O**	**S**	**R**	**N**
Check the science schemes of work every term	67	22	8	2	1
Visit the science laboratories	8	47	37	4	4
Check the record of work	53	25	8	10	4
Receive a report from heads of department on teaching and learning	20	43	25	10	2
See science teachers' improvise materials during the science lessons	16	43	37	4	0
Supply the materials requisitioned by science departments during the term	72	16	6	2	4
Delegate implementation of ASEI/PDSI to the Heads of Department	22	32	22	12	12
Delegate implementation of ASEI/PDSI to the Deputy head teacher	6	18	25	20	20
Check the science teachers' use of ASEI lesson plan format	25	24	33	16	2
Check the teachers' lesson notes	18	24	16	24	20
Seat in class and observe lessons in progress	6	10	16	31	37
Witness teacher- centred lessons	6	16	24	45	10
Witness learner- centred lessons	14	39	31	8	8
Find science teachers conducting theory lessons during double lessons meant for practical	4	8	45	25	18

N=51

Head teachers' supervision data indicated that the majority of the head teachers (67%) check the science schemes of work every term. However, only 25% always check whether teachers had ASEI lesson plans. The ASEI/PDSI lesson preparation and execution is the central emphasis of the SMASSE in-service training innovation. However, it appears that head teachers' hardly pay attention to it, 16% rarely check them and 33% only check them sometimes. When asked how often they observed the science lessons, the data indicated that 6% observed lessons always, while 37% never observed lessons in progress. Yet, this is one of the best ways of checking the Level of Implementation of the ASEI/PDSI innovation.

The head teachers indicated that they received reports from the heads of departments on the teaching and learning; 43% of respondents indicated they received the reports often. During the interview, head teachers, indicated that they did not ask for reports specifically on the implementation of ASEI/PDSI classroom practices. Some of the head teachers during the interview were quick to admit that they did not know what the ASEI/PDSI implementation entailed.

This data implies that learner-centred methodology was not being implemented fully. The head teachers were asked to indicate whether the teachers used the ASEI/PDSI classroom practices paradigm. Forty five percent indicated the teachers used it, 29% indicated they used it sometimes while 16% said it was rarely used. This suggests partial application of the ASEI/PDSI classroom practices.

Asked whether they delegated the supervision of the implementation of the ASEI/PDSI classroom practices, 22% of the head teachers indicated that they always delegated the implementation to the heads of department whereas 12% rarely delegated and another 12% never delegated to the HODs. The data indicated that 18% of the head teachers delegated the implementation to the Deputy Head teachers while 25% delegated sometimes and 20% never delegated to their deputies. Overall results suggest that the head teachers prefer to delegate the implementation of ASEI/PDSI classroom practices to the Heads of Department who have knowledge of what the innovation entails.

Level of Implementation of the ASEI/PDSI Classroom Practices: Self-Assessment

In the teachers' questionnaire, the respondents were asked to state whether they implemented ASEI/PDSI classroom practices fully, partially or not at all. This self- assessment method was used by the researchers to determine their level of implementation of the ASEI/PDSI classroom practices. The head teachers were also asked to state their opinion of the teachers' level of implementation of the ASEI/PDSI classroom practice by asking whether they thought the teachers implemented the innovation fully, partially, not at all, or if they were undecided.

Table 11 illustrates how the science teachers implemented the ASEI/PDSI classroom practices.

Table 11: Level of implementation of ASEI/PDSI in Biology, Chemistry and Physics

Biology Assessment	**Fully %**	**Partially %**	**Not at all %**	**Undecided %**
Self	20	68	12	n/a
Head teachers	27	60	3	10
Chemistry Assessment	**Fully %**	**Partially %**	**Not at all %**	**Undecided %**
Self	10	78	12	n/a
Head teachers	18	68	2	12
Physics Assessment	**Fully %**	**Partially %**	**Not at all %**	**Undecided**
Self	14	78	8	n/a
Head teachers	28	56	4	12

Data indicates that only 20% of the Biology teachers implemented the ASEI/PDSI classroom practices fully, 68% partially and 12% reported that they do not use these classroom practices at all. This means that the Biology teachers do not use the ASEI/PDSI classroom practices fully and, when they do, they implemented aspects selectively. When the Biology teachers were asked what they mainly implemented in an interview, they indicated the aspect of improvisation of practical materials during some of the practical lessons.

The same question was put to the head teachers, in order to verify the level of implementation of the teachers, in the ASEI/PDSI classroom practices. Results from head teachers shows, 60% of the Biology teachers implement ASEI/PDSI classroom practices partially, 27% fully, while 3% do not implement at all and 10% were undecided. The difference between their assessment and the teachers' self-assessment is slight but the general consensus is that the level of implementation ASEI/PDSI classroom practices by biology teachers was partial.

The findings revealed a similar trend for Chemistry teachers. The majority of the chemistry teachers (78%) indicated that they implemented the ASEI/PDSI classroom practices partially; less than 10% of the teachers implemented fully, while 11% of the teachers indicated that they did not implement the ASEI/PDSI classroom practices at all.

Results indicated that 68% of the Chemistry teachers, according to the head teachers; implemented ASEI/PDSI classroom practices partially, 18% implemented fully, 2% not at all and 12% of the head teachers were undecided on the teachers' level of implementation of the ASEI/PDSI classroom practices. Head teachers' were of the opinion that most of the Chemistry teachers were not implementing ASEI/PDSI classroom practices as they should.

Data further, indicated that 78% of the Physics teachers, implemented the ASEI/PDSI classroom practices partially, 10% fully and 8% not at all. Compared to the Chemistry and Biology teachers' self-assessment more of the Physics teachers (28%) implemented the ASEI/PDSI classroom practices fully. Yet, according to the assessment by the head teachers it is the opposite of their self-assessment as indicated by the teachers where 14% fully implemented. Those that implemented partially were 56%, however, 12% were undecided on the level of implementation in Physics.

During the interviews, the Physics and Biology teachers indicated that one of the aspects they were implementing often from the ASEI/PDSI classroom practices was the improvisation of materials and apparatus. When the Chemistry teachers were asked to comment on their reasons for not improvising, one teacher said that:

> " their (chemistry) apparatus are hard to improvise, such as the burettes and the beakers used for the titration technique and improvising them introduces errors yet, the subject requires accuracy."

On the issue of improvisation a number of teachers argued that students needed to work with actual apparatus before they are taught how to improvise. Yet another teacher felt that:

> "Improvisation was lowering the quality of teaching because the materials used were sub-standard. The improvised material also took a long time to prepare and some of them called for expertise to prepare"

One of the Chemistry teachers observed that whereas improvisation was a good idea, it was important to be careful of how it is done. The respondent noted that in subjects like Chemistry and Physics where accuracy was absolutely necessary, learners should only practice with the original apparatus in order to enhance good techniques.

Level of Implementation of ASEI/PDSI Classroom Practices: Observed Lessons

The Level of Implementation of the ASEI/PDSI classroom practices was also determined through lesson observation. The researchers used a Lesson Observation Schedule, designed on the basis of the ASEI/PDSI training to observe 15 lessons. The instrument covered five main areas these were: planning, lesson development, student participation, learning activities, learning resources, evaluation and the facilities.

The data from lesson observations indicated that, 87% of the teachers did not prepare ASEI/PDSI lesson plans and only 13% prepared lesson plans. It was also observed that 50% per cent of the teachers whose lessons were observed, carried text books to class, which they referred to directly throughout the lesson, with no notes of their own. The learners, in these lessons spent most of the time copying notes from their own text books, as the teacher taught.

According to the teachers interviewed on the preparation of the ASEI/PDSI lesson plan, the teachers thought that the requirements were rather tedious. One teacher whose lesson was observed pointed out two areas they perceived as difficult:

> "That the ASEI lesson plan required that teachers develop a rationale for every lesson…the lesson plan required that the teachers' evaluation every section of the lesson, for example the introduction, lesson development and the conclusion"

This may explain why teachers' intentions to adopt the ASEI lesson plan tends to be resisted, only 2 out of the 15 teachers observed had prepared them, yet, this is the central theme of the ASEI/PDSI innovation.

One of the teachers observed during a Biology lesson was applying a Biology technique acquired during SMASSE in-service training , in a genetics lesson in a Form 3 class. Though the teacher did not have an ASEI lesson plan, the teacher had prepared a practical manual as required and the lesson observed was learner centred. The teachers' were selecting which parts of the training to put to practice, hence partial implementation of the innovation.

The strength of the ASEI/PDSI classroom practices, according to the district trainers, is in the preparation of the ASEI lesson plan and executing it during teaching, ensuring that the lessons are learner- centred, with students actively participating. Yet, these are paradigms that the teachers are choosing not to practice.

The findings of this study are in line with other studies that have identified that the Level of Implementation is dichotomous, either use of or non-use of an innovation. According to George, Hall and Stiegelbauer (2014), having two categories of subjects, those who use the innovation and those who do not, instead the level of implementation construct shifts perspective from one of either use or non-use to one that encompasses multiple approaches to using the innovation.

Hypothesis One

The study was premised on two (2) null hypotheses and each hypothesis was tested using the Chi-Square statistic. The hypotheses were rejected or accepted at the 0.05 level of significance. If the calculated value of the chi-square was much higher than the critical value it implied that the calculated chi-square value was significant and had not arisen because of chance. In this case, the null hypotheses were rejected and the alternative hypotheses accepted. If, on the other hand, the chi-square value was lower than the critical value then the null hypotheses were accepted.

Hypothesis One was that there was no significant relationship between the levels of implementation of ASEI/PDSI classroom practices among the science subjects: Biology, Chemistry and Physics. To test whether there was a significant relationship in the way the teachers implemented the innovation among the science subjects the Chi-square test was computed by pairing the different subjects.

The results for the level of implementation and the paired subjects are shown in Table 12.

Table 12: Chi-Square Results the Level of Implementation among the Science Subjects

(i) Biology and Chemistry

Level of implementation	Not at all	Partially	Fully	Total
Not at all	3	2	0	5
Partially	0	11	1	12
Fully	0	0	1	1
Total	**3**	**13**	**2**	**18**

(X^2 Value = 17.6192, Critical Value = 4, df = 1, Pr = 0.001)

(ii)Biology and Physics

Level of implementation	Not at all	Partially	Fully	Total
Not at all	2	0	0	2
Partially	0	1	0	1
Fully	0	0	0	0
Total	**2**	**1**	**0**	**3**

(X^2 Value = 3.000, Critical Value = 1, df = 1, Pr = 0.083)

(iii)Chemistry and Physics

Level of implementation	Not at all	Partially	Fully	Total
Not at all	2	0	0	2
Partially	0	9	0	9
Fully	0	0	0	0
Total	**2**	**9**	**0**	**11**

(X^2 Value = 11.000, Critical Value = 1, df = 1, Pr = 0.001)

The results indicate that the chi-square value is greater than the critical value at one degree of freedom; Biology and Chemistry X^2 =17. 6192>4, Biology and Physics X^2 =3>1, X^2 and, Physics and Chemistry X^2=11>1 meaning that there was a significant relationship in the level of implementation among the science subjects.

The Fisher Exact Test result for the level of implementation among the science subjects was: Biology and Chemistry p-value 0.002 < 0.05, Biology and Physics p-value 0.33 > 0.05, and Chemistry and Physics p-value 0.01 < 0.05. The Fisher Exact Test p-values are not significant at the 5% level of significance as the p-values are greater than 0.05 for Biology and Chemistry. However, they were significant for Biology and Chemistry, Chemistry and Physics where the p-value was less than the 0.05 significance level.

The conclusion was to reject the null hypothesis and accept the alternative hypothesis that there is a significant relationship in the level of implementation of the ASEI/PDSI classroom practices among the science subjects. It means the science teachers were having the same concerns while implementing the ASEI/PDSI classroom practices. Majority of the science teachers were partially implementing the classroom practices.

Hypothesis Two

Hypothesis Two stated that, "there is no significant relationship between the level of implementation of ASEI/PDSI science classroom practices in schools whose head teachers had attended SMASSE in-service training and those whose head teachers had not attended the SMASSE In-service training." Chi-Square was used to test the hypothesis by relating the level of implementation to the two school categories of head teachers who had attended SMASSE in-service training and those who had not attended.

The results are presented in Table 13.

Table 13: Chi-Square Results on the Level of Implementation and Head Teachers' Attendance of SMASSE in-service training

(i) Biology

Attendance of INSET	Not at all	Partially	Fully	Total
YES	6	32	8	46
NO	1	0	0	1
Total	**7**	**32**	**8**	**47**

(X^2 Value 5.5385, Critical Value =2, df = 1, Pr = 0.0278)

(ii) Chemistry

Attendance of INSET	Not at all	Partially	Fully	Total
YES	7	45	7	59
NO	1	1	0	2
Total	**8**	**46**	**7**	**61**

(X^2 Value = 2.555, Critical Value =2, df = 1, Pr = 0.0278)

(iii) Physics

Attendance of INSET	Not at all	Partially	Fully	Total
YES	5	41	6	46
NO	1	0	0	1
Total	**6**	**41**	**6**	**47**

(X^2 Value = 7.987, Critical Value =2, df = 1, Pr = 0.018)

The results indicate that the chi-square value is greater than the critical value at one degree of freedom, Biology X^2=5.8385>2, Chemistry, X^2 Value = 2.555>2 and, X^2 Physics 7.984>2. This means that there was a significant relationship in the level of implementation in schools whose head teachers have attended SMASSE INSET and those who have not. The conclusion would have been to reject the null hypothesis and accept the alternative hypothesis that there is a significant relationship the level of implementation of the ASEI/PDSI classroom practices in schools whose head teachers had attended SMASSE in-service training than in those whose head teachers' had not attended. Since the table values were less than 5 the Fisher Exact Test was carried out to test the significance of the Chi-Square test.

The Fisher Exact Test results for level of implementation and the head teachers attendance of SMASSE in-service training was Biology p-value 0.23 > 0.05, Chemistry p-value 0.68 > 0.05 and Physics p-value 0.27 > 0.05. The Fisher Exact Test p-values are not significant at the 5% level of significance as the p-values are greater than 0.05. The null hypothesis was therefore neither rejected nor accepted. Head teachers 'attendance cannot determine how the teachers will implement ASEI/PDSI classroom practices.

The head teachers should be encouraged to attend either the head teachers' or the teachers' SMASSE In-service training. This will equip the heads with necessary knowledge and skills on the ASEI/PDSI classroom practices to help support the teachers' efforts in the implementation of the innovation. One of the teachers suggested that the administration should be fully involved in supporting and enforcing the implementation of the innovation.

Conclusion

Based on the findings, the level of implementation of the ASEI/PDSI classroom practices in the public secondary schools was found to be partial. This was partly due to the heavy teaching load the teachers carried. It was therefore recommended that the government employ more teachers to facilitate adequate preparation for ASEI lessons and apply learner-centred approaches that the innovation recommends. The study also found that the head teachers' supervision of the implementation of ASEI/PDSI classroom practices was limited. Hence, there is need for the head teachers to strengthen the supervision of the ASEI/PDSI classroom practices implementation. Further training should be provided to the head teachers for effective management of teachers after in-service programmes. It is further recommended that the facilitators of the implementation of the innovation, that is, the head teachers, Quality Assurance Officers urgently address the self and task concerns of the teachers so that they can start implementing the innovation fully. The Ministry of Education should develop a follow-up strategy to ensure that innovations are being implemented in the classrooms after an in-service training. This can be done by the QASOs to ensure quality is maintained and to assist those having difficulties implementing the new practices.

On policy issues the study recommends that the Ministry of Education develops a tool to establish the level of implementation of innovations. It should also put in place intervention strategies for those implementers who are struggling to implement the ASEI/PDSI classroom practices. According to ADEA (2016) policy brief, effective In-service Training calls for significant changes in policies, approaches, processes, structures and strategies with a dual goal of teacher quality and student learning outcomes.

References

ADEA, (2014*). The integration of ICT into education and training systems in Africa; The cases of Argentina, Burkina Faso, Cote de Voire, Paraguay, Senegal, Tunisia.* Abidjan*:* ADEA.

ADEA, (2016). *Policy Brief: In-service teacher education in Sub-Saharan Africa.* Abidjan: ADEA

Banda, B., Mudenda, V., Tindi, E.,& Nakai, K. (2015). Towards learner centred science lessons in Zambia: An experience of problem solving approach in biology lessons special distribution. *Zambia journal of Teacher Professional growth 2(1) 86-92*

Barrow, K., Boyle, H., Ginsburg, M., Leu, E., Peir, D., & Prince-Rom, A. (2007). *Cross national synthesis on educational quality report No. 3 professional developing and implementing active learning student-centered pedagogies.* Washington DC: EQUIP 1 and American Institute for Research.

Blumenfeld, P., Fishman, B.J., Krjack, J., Maxx, R.W., & Soloway, E. (2000). Creating usable innovations in systematic reform: scaling up technology- embedded project- based science in urban schools, *Educational Psychologist,* 35 (3), 149-164.

Britton, E., Paine, L., Pimm, D., & Raizen, S. (2003). *Comprehensive teacher induction: systems for early career learning.* Dordrecht, Netherlands: Kuklwer Academic Publishers.

Brown, J. & Adams, A. (2001). *Constructivist teaching strategies.* Springfield: Charles C. Thomas.

CEMASTEA, (2008). *Handbook on management of district SMASSE programmes.* Nairobi: SMASSE-JICA.

Dirksen, D.J. (2002). *An evaluation of the laptop initiative for Albertson College*. Caldwell,ID: Albertson College.

Falkenberg, K.L. (2002). *An exploration of elementary sciences teachers' expertise creativity skills and motivation in relation to the use of an innovation and the delivery of high quality science instruction.* Emory University, Retrieved June 20th 2005, from ProQuest Digital Dissertations Database.Fast Track Initiative Capacity Development Task Team, (2008). *Teacher learning. Guidelines for capacity development in the education sector.* Washington DC: Education for All Fast Track Initiative.

Feiman-Nemser, S. (2008). *Teacher Learning: How do teachers learn to teach?* In M. Cochran-Smith, S. Feinman- Nemser & D.J. Mclntyre. *Handbook of Research on teacher* *education: Enduring questions in changing contexts (3rd Ed., pp.697-705)* New York: Routledge.

George, A., Hall, G. & Stiegelbauer, S. (2014). *Measuring implementation in school: the stages of concern questionnaire:* Austin, TX: Southern Educational Development Laboratory.

Ginsburg, M. (2010). Improving educational quality through active-learning pedagogies: A comparison of five case studies. *Educational Research 1(3), 62-74*

Government of Kenya, (2007). *Education for Sustainable Development (ESD) implementation strategy 2005-2014*. Nairobi: Government Press

Grossman, P. (2005). *Research on pedagogical approaches in teacher education:* Washington DC

Gwanyi, S.M. (2009). *Perceptions of innovation as predictors of tabular implementation levels among secondary science teachers in Malawi: A diffusion of innovative perspective PHD dissertation.* Virginia Polytechnic Institution and State University.

Hall, F. G. & Hord, S.H. (2011). *Implementing change: patterns, principles, and potholes*. (3rd ed) Upper Saddle River, New Jersey: Pearson.

Hall, G.E, Dirksen, D.J., & George, A.A (2008*). Measuring implementation in schools: levels of use.* Austin: SEDL

Hopkins, D. (2011). *Powerful learning: Taking educational reform to scale.* Melbourne: Education Policy and Research Division (EECD).

KNEC, (2016). *Kenya National Examination Council Newsletters*. Nairobi. KNEC.

Kothari, C.R. (2004). *Research Methodology: Methods and Techniques* (2nd ed) New Delhi: New Age International Publishers.

Lipsey, M.W., & Condray, D.S. (2000). Evaluation methods for social intervention. *Annual Review of* Loucks – Horsley, S. (1996). *Professional Development for Science Education: An Immediate Challenge*, In Bybee (Ed.), National Standards & Science Curriculum. Dubuque: Kendall.

Loucks, S.F & Melle, M. (1982). *Implementation of a district-wide science curriculum: The effects of a three year effort*. Paper presented at the annual meeting of the American Research Association, Boston, MA. (ERIC Document Reproduction Service No. 204181). *Psychology.* 51,345-375.

Marsh,D.D.(2001). Educational leadership for the twenty-first century: Integrating three essential perspectives. San Franscisco: Jossey-Bass.

MOEST, (2005). *Sessional Paper No. 1 of 2005 on a policy framework for education, training and research.* Nairobi: Government Printers.

Mugenda, A.B. (2008). *Social science research.* Nairobi: Applied Research & Training Services Press.

Mulkeen, A. (2010). *Teachers in Anglo-phone Africa: issues in teacher supply training and management*. Washington: World Bank.

Ndirangu, C. W. (2006). An evaluation of SMASSE in-service project in Biology in Kajiado district, Kenya. Master in Education Project: Germany: VDM.

Ndoye, M. (2005). *Scaling up and sustaining promising experiences in Africa: Lessons from here and elsewhere. Paper in ADEA in ADEA Biennial Meeting Reaching Out, Reaching all:* Paris: ADEA.

Newhouse, C. P. (2015). Measuring the meaningful use of ICT in schools: A learning environments attributes approach. *International Journal of Technology Enhanced Learning 7(4), 309-325.*

Orado, G. (2017). *Revitalizing education: Towards the 2030 Global Agenda and Africa's Agenda 2063: Sub-theme Promoting Mathematics, Science and ICT Triennale Meeting*. Dakar: ADEA.

Paine, L.W., & Zeichner, K. (2012). The local and the global in reforming teaching and teacher education. *Comparative Review 56(4), 569-583.*

Republic of Kenya, (2012). *A policy framework for education: Aligning education and training to the constitution of Kenya 2010 and Kenya vision 2030 and beyond.* Nairobi: Government Press.

Rogers, E. M. (2004). A perspective and retrospective look at diffusion model. *Journal of Health Communication 9(1), 13-19.*

Ruffini, S.J., Lindsay, J., Mcinerney, M., Waite, W., and Miskell, R. (2016). *Measuring implementation of the response to intervention framework in Milwaukee public schools.* (REL.2017-192). Washington DC: Institute of Educational Sciences.

Schiller, J. (2002). Interventions by school leaders in effective implementation of information and communications technology: Perceptions of Australian principals. *Journal of Information Technology for Teacher Education*, *11*(3), 289-301.

SMASSE, (2006). *CEMASTEA strategic plan.* Nairobi. SMASSE

SMASSE, (2006). *Principals' workshop report.* Nairobi: SMASSE.

UNESCO, (2016). Education for people and planet: Creating sustainable future for all. Paris: UNESCO

USAID (2010). *First Principles: Designing effective education programmes for in-service development.* Compendium: EQUIP 1/USAID. American Institute for Research/AED.