EFFECT OF ADOPTION OF STRENGHTENING MATHEMATICS AND SCIENCE SECONDARY EDUCATION (SMASSE) PEDAGOGY ON GIRLS' MATHEMATICS ACHIEVEMENT IN SECONDARY SCHOOLS, NAIROBI COUNTY, KENYA

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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This thesis is dedicated to my husband, Mohamed and my children, Abu Bakarr, Flematu and Lamin.

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ABSTRACT

In response to persistent poor performance in mathematics and science in the Kenya Certificate of Secondary Education (KCSE) Kenya and Japan set up the Strengthening Mathematics and Science Secondary Education (SMASSE) programme. The ASEI – PDSI pedagogy refers to a paradigm shift by SMASSE team that moves away from teacher-centred teaching to lesson delivery that focuses on activities that are student–centred, experimentation or practical work, and improvisation using materials in learners' environment. The study sought out to investigate the 'Influence of the adoption of ASEI-PDSI pedagogy on Girls' KCSE mathematics achievement'. The study was conducted in public secondary schools in Nairobi because it was the one county (out of 47) where girls sometimes outperformed boys in mathematics. The instruments included questionnaires for principals, mathematics teachers and girls as well as a lesson observation schedule. Data was analyzed using quantitative and qualitative techniques including hypotheses testing. The study found principals' support for the adoption of ASEI-PDSI had no influence but mathematics teachers' adoption and girls' attitude towards the pedagogy had an influence on girls' KCSE mathematics achievement. The study provides knowledge that is to be used by stakeholders in Kenya and the other African countries using the ASEI-PDSI pedagogy to improve girls' mathematics achievement. To this end the researcher recommends that countries incorporate Gender Responsive Pedagogy to enable all learners, particularly girls to improve their mathematics achievement.

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ABBREVIATIONS AND ACRONYMS

ASEI	Activity, Student, Experiment, Improvise
CBAM	Concerns Based Adoption Model
FAWE	Forum for African Women Educationist's
GoJ	Government of Japan
JICA	Japan International Cooperation Agency
KCSE	Kenya Certificate of Secondary Education
KNEC	Kenya National Examination Council
MoEST	Ministry of Education, Science and Technology
MPET	Master Plan on Education and Training
NACOSTI	National Commission for Science and Technology Innovation
PDSI	Plan, Do, See, Improve
QASO	Quality Assurance and Standards Officer
SMASSE	Strengthening Mathematics and Science in Secondary Education
SPIAS	SMASSE Project Impact Assessment Survey

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Concerns about education and achievement escalated in the early 1950s (John & Karaac, 2004). Getting detailed information on learner-centered pedagogy connections with student achievement remains indispensable to educators. Schools need this knowledge to support staff development, instructional management, and staff selection. Educators embrace learner-centered pedagogy because it encourages collaborative learning and student achievement (Houang & Cogan, 2002)

Learner-centered pedagogy raises student achievement, promote democratic classrooms, complex thinking, joint production, and meet student communication goals (Harris, 1999). This pedagogy supports the social and intellectual attributes of students with low socioeconomic status (SES). Taylor (2005) indicated that students from higher economic backgrounds performed better on standardized tests than students from low SES backgrounds. Low SES students often enter schools with exceptional shortfalls in social and cognitive skills (Ajewole, 2004); conditions learner-centered instructions address.

Effective adoption of appropriate pedagogical approaches yields higher learning achievement across the school system. The most effective teachers have deep knowledge of the subjects they teach, and when teachers' knowledge falls below a certain level it is a significant impediment to students' learning. As well as a strong understanding of the material being taught, teachers must also understand the ways students think about the content, be able to evaluate the thinking behind students' own methods, and identify students' common misconceptions. Harris, (1999) pointed out that learner-centered pedagogy promoted student achievement. In other research, Nykiel-Herbert (2004) found that learner-centered pedagogy raised student achievement. Reynolds (2007) and Carbo (2008) linked learner-centered instructional methods to student achievement.

Drawing from a personal experience as Headteacher, Sessay (2007) indicated that adoption of appropriate pedagogical approaches, focusing on classroom practice, she turned around a failing Boys' Secondary School in Birmingham, UK. Within two years she turned the school into a higher learner achievement institution with improved results rising from gaining 17 to 56 percent A* - C grades at the General Certificate of Secondary Education (GCSE). The effect of pedagogical techniques has been adequately linked to differences in girls and boys approaches to learning in mathematics (Gates, 2001). Furthermore, Westbrook, Durrani, Brown, Orr, Pryor, Boddy and Salvi (2013) examined the pedagogical approaches used by teachers in developing countries. This affirmed that three most commonly used approaches and practices in sub-Saharan Africa were learner-or student – centred, child – centred and activity-based learning with approaches reported as student-centred dominating.

Each school is required to have a pedagogical framework that is collaboratively developed with the school community to ensure 'high quality, evidence-based teaching practices focused on success for every student (Mukasa, 2001). This requirement acknowledges the impact of quality teaching and the evidence that research validated pedagogy – implemented with consistency across a school setting and supported by instructional leadership – improves student performance and develops successful learners. A teacher's abilities to make efficient use of lesson time, to coordinate classroom resources and space, and to manage students' behavior with clear rules that are consistently enforced, are all relevant to maximizing the learning that can take place. These environmental factors are necessary for good learning rather than its direct components.

Pedagogical approaches are anchored on constructivism and social constructivism. Constructivism supports learner-centered pedagogy more than the behaviorist and cognitive theories. The behaviorist and cognitive theories suggest that students need to connect with their learning in a personal way but constructivism stresses comprehensive learner-connectedness. Prince and Felder (2006) suggested that exploring, manipulating, and asking complex questions improve student cache of new information. Symlie (1992) argued that aligning a strategy with the constructivist view include learner interactions. The students' experience assists their effort to form new knowledge through discovery learning.

Prince and Felder (2006) research associated the inductive methods of discovery, inquiry, and problem-based learning with constructivist view of learner centeredness. In constructivist learning environments, student process and discover knowledge. The study focused on student achievement in middle schools and beyond, but the findings have implications for learning groups in elementary grades. Prince and Felder (2006) recommended that teachers should cut traditional lecturing and expand students‟ cognitive ability through inductive learning methods. Prince and Felder (2006) agreed that shifting the responsibility for learning from teachers to students provides experiences not attainable through deductive methods.

The learning context of instruction exposes effective teaching strategies. Nykiel-Hibbert (2004), cited by Musvosvi (1998) lists some of the learner-centered strategies including individualized instruction, cooperative grouping, and programmed instruction adapted to needs. Students' ability and needs influence the teacher’s learner-centered strategy choice. Advanced students show less teacher dependency at independent task than underachieving students do. Many educators recommend using individualized instruction with low-performing students to improve performance. Individualized and group instructions become teacher-centered when the teacher excludes students from investigating and providing information. In learner-centered instruction, the teacher and students work together, set learning goals, select tasks to meet these goals, and review learning outcomes (Musvosvi, 1998).

Learner-centered pedagogy contains features that support needs, interest, experience, and ability. Small group instruction supervised by experienced teachers support student-focus goals (Prince & Felder, 2006). Small group instruction helps the teacher’s effort to complete diversified instructions. It is easier to teach a small group of students that a large class. Teacher-centered instruction includes whole-class instruction, teacher-directed small group instruction, and teacher demonstrations. A short session of whole-class instruction allows teachers to clarify directions and rules.

Teachers chose to use learner-centered pedagogy based on several conditions. Several researchers explored the possible benefits of learner-centered instruction, and suggested ways to use them (Jones, 2007). The adoption of such learner centred instruction depends on the teacher’s philosophy about instruction and learning styles. Teachers use learning styles to support achievement. According to Musvosvi (1998), training prepares teachers to provide suitable instruction, analyze learner needs, and inspire learner success. Teachers and students benefit from professional staff development designed to improve instructional delivery. A teacher's increased knowledge about effectiveness of instructional strategies supports learner-success.

The ASEI – PDSI approach refers to a paradigm shift by the SMASSE team that moves away from teacher-centred teaching to lesson delivery that focuses on activities that are student–centred, experimentation or practical work, and improvisation in teaching and learning. Adoption is the process of putting change such as the ASEI-PDSI approach into practice. It involves a shift from knowledge/content–based approach, few teacher demonstrations, theoretical or lecture method (chalk and talk), teacher– centred teaching to learner- centred teaching. The ASEI-Condition (After INSET) refers to Activity-focused Teaching/Learning, Student-focused /Centred Learning, Small scale Experiment /Research based approach and Improvisation. To operationalize the ASEI condition, SMASSE came up with the Plan, Do, See and Improve (PDSI) approach to teaching and learning.

CEMASTEA (2013) reported that teachers at secondary level in Kenya had increased enthusiasm, knowledge and confidence as a result of effective ASEI-PDSI intervention. The teachers gained better knowledge of learners and were more able to view learning as linked to teaching and learning processes.

According to National Development Policy (Republic of Kenya, 2007), Kenya is aiming to be an industrialized country by 2030. As an intervention, the government of Kenya, through the Ministry of Education (MOE) and the Government of Japan (GOJ), through Japan International Cooperation Agency (JICA), started an in-service education and training known as Strengthening Mathematics and Science in Secondary Education (SMASSE) project for teachers, piloting it in 1998 and adopting it across the country in 2005. SMASSE aimed at upgrading the capability of youth in Mathematics through in-service education of teachers in response to poor performance and achievement witnessed in the Kenya Certificate of Secondary Education (KCSE) results (The Kenya National Examination Council) [KNEC], 2012). In 2004 the Government of Kenya (GOK) established the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA), with the mandate to provide Continuous Professional Development (CPD) for teachers. It collaborates with local and international institutions to achieve its mandate. Some of these include training needs from school assessments to inform development of its In-service Training (INSET) course content, the Teachers' Service Commission (TSC) to identify knowledge gaps of teachers to inform INSET course content as required by TSC Act 2012, the Kenya Institute for Curriculum Development (KICD) to collaborate INSET course content and training on curriculum implementation and enhance teacher's capacity to interpret and implement the curriculum, KNEC to provide feedback from assessment and evaluation to inform INSET course content and Kenya Institute of Special Education (KISE) to incorporate special needs in INSET course content. The Centre plans and implements INSET programmes for teachers of mathematics and science (CEMASTEA Report SPIAS 2012). Table 1.1 presents cycles of SMASSE INSETs for Mathematics and Science Teachers.

According to SMASSE Project (2009), the training consists of four cycles as in table 1.1. Each cycle of training takes 10 working days and adopts a "cascade" system of training the teachers; a gradual training system from central to regional teachers.

Table 1.1: Cycles of SMASSE INSETs for Mathematics and Science Teachers

Cycle	Theme	Focus
One	Attitude change of mathematics and science teachers (from negative to positive)	The development of positive attitude of teachers as a pre-requisite for quality teaching and learning of mathematics and science
Two	Activity-oriented teaching and learning (hands-on)	Creating and providing opportunities for learners to actively engage in the teaching and learning process
Three	Actualization of the ASEI-PDSI (minds-on) approaches	Participants (teachers) develop ASEI lessons which they first try out on their colleagues, and later go out to schools to teach actual students
Four	Enhancement and sustainability (impact transfer) of the ASEI-PDSI approaches	Participants learn monitoring and evaluation skills to ensure quality teaching and learning.

Under the cascade system, national trainers train district trainers and the district trainers in turn train school teachers in the districts (SMASSE, 2008). Following the INSETs attendance mathematics teachers are expected to adopt the ASEI-PDSI approach in the classroom. This involves implementing the following:

Plan and try out the teaching / learning activities, materials and examples before the lesson. Emphasize how instructional activities will enable learners to understand individual concepts and connections among them, get the rationale/value for the lesson, retain the learning and apply it in real life situations, get rid of learning difficulties and misconceptions and have more interest in the lessons.

Do by carrying out the planned lesson / activity as planned; be innovative in lesson presentation; present lessons in varied interesting ways to arouse learners' interest e.g. through role play, storytelling, ensure active learner participation, be a facilitator in the teaching/learning process, deal with students' questions and misconceptions and reinforce learning at each step

See by evaluating the teaching and learning process during and after lesson, using various techniques and feedback from students. Allow their colleagues to observe their lessons and offer feedback. Enables teachers to identify the good practices in the lesson and strengthen them, see mistakes made in earlier lesson, avoid earlier mistakes in future lessons. In the process teachers become more open to evaluation fellow teachers, school administrators, Quality and Standards Assurance Officers and the students.

Improve by reflecting on the performance, evaluation report and effectiveness in achieving the lesson objectives. This enables the teacher to: observe the good practices in the lesson and strengthen them, identify mistakes made in earlier lesson, avoid such mistakes in future lessons. The teacher makes use of such information in planning subsequent lessons so as to improve the lessons, to enhance student learning and improve achievement of all learners (Wafula & Njore, 2005).

It has been pointed out that the ASEI-PDSI approach is innovative approach of teaching championed by the SMASSE INSET programme. As CEMASTEA (2013) observe, innovation is one major type of change in which something new is added to an existing phenomenon; it means introducing something new that deviates from the standard practice. They stress that an innovation must be simple enough to be understood and utilized. Innovation as a deliberate attempt to improve practice in relation to certain desired objectives; it is a form of change (www.amazon.com). Innovation as a form of change should be technically sound; require change in structure of a traditional school; must be manageable; must be flexible; and must be focused on efforts, timing and resources.

In order for the ASEI-PDSI approach to be effectively implemented, teachers require an adequate understanding of the approach and its components. The components include activity focus, student-centeredness, experimentation and improvisation. Activity focused teaching and learning calls for use of varied, appropriate and interesting teaching and learning activities by teachers, as well as having students conduct practical work. Student-centred teaching and learning, requires greater involvement of the learner in the learning process-this is done through effectively encouraging students to give their prior experiences and explaining their ideas related to the content, effectively encouraging students to give their own predictions and helped to discuss how they differed from those held by others and encouraging students to evaluate the lesson. For experimentation students should be given opportunities to perform experiments which enhance understanding of concepts in mathematics and science. Improvisation involves using local materials in the students' environment.

The adoption is evidenced by the ability of students to solve related problems; ability of students to make deductions from practical work and the ability of students to verify hypotheses and predictions. Improvisation calls for innovativeness and creativity on the part of the teacher and it involves improvising using materials available in the immediate environment of the students to give experiments and also arouse interest and curiosity in the learners. This is evidenced by the conduct of modified/simplified experiments; utilization of materials available in the students' immediate environment; teacher producing and or utilizing improvised materials; ability of the students to effectively use improvised materials; and enhanced students' participation.

The following are the principles of ASEI: Knowledge-based teaching to be replaced by activity-based teaching; Student-centred learning to prevail over teacher centred teaching; Experiment and research-based approaches to replace the traditional lecture approach; and Improvisation and small-scale experiments to replace large-scale experiments. Evaluation relating to the extent of usage of an innovative teaching approach is critical in any programme or training. According to Mulwa and Nguluu (2003), evaluation facilitates informed decision-making that will lead to improvement. The authors also observe that evaluation attempts to show the cause-effect relationships between programme activities, and the change they may have observed; is important for accountability; and is an educational process that assesses the extent of people's participation, how well participants are doing, and what effect the programme is having on the intended beneficiaries.

Principals and deputy principals on the other hand attend workshops at national level. Following the workshops principals and deputies are expected to support the adoption of the ASEI-PDSI approach. They are expected to support the teachers mobilize teaching and learning resources, encourage collaboration among teachers, supervise classroom practice and monitor learning outcomes and learner achievement. Learners should feel the effects of their mathematics teachers' adoption of the ASEI-PDSI practice through their participation in goup work, whole class discussions, individual work, question and answer sessions involving their own questions and practical work. They should be able to feel the student and activity centred characteristic of the ASEI-PDSI approach. They should experience the principals' support through the mobilization of teaching and learning resources, promotion of mathematics, support for teachers, supervision of classroom practice and monitoring of learning outcomes to enhance learner achievement.

In Kenya's education system, the quality of effective teaching is measured by examination results (Ndirangu, 2006). Despite mathematics being seen by society as the foundation of scientific and technological knowledge that is vital for socio-economic development of a nation (Njuguna 1998), poor performance in the subject has persisted in Kenya as demonstrated by the major counties. Until 2010 Kenya was divided geographically into eight provinces (Ndirangu, 2006) namely, Eastern, Western, North Eastern, Central, Coast, Rift Valley, Nyanza and Nairobi. In the constitution of 2010, the provinces were divided into forty seven counties which were further sub-divided into a total of seventy districts. KCSE data was presented by districts and provinces until 2011 but are now presented by counties which make it necessary to convert district data to counties to provide uniformity of data. Ten of the major counties are mapped in Table 1.2. The counties were deemed to be major based on their population density and regional representation, to make sure parts of the country and population were fairly represented. Data from the counties were the used to compare the KCSE mean mathematics mean scores.

Table 1.2: Mapping of Districts and Counties

County	Districts
Garissa	Fafi , Garissa, Ijara, Lagdera
Kakamega	Butere, Kakamega Central, Kakamega East, Kakamega North, Kakamega South, Lugari, Mumias,
Murang'a	Gatanga, Muranga North, Muranga South, Thika East
Kilifi	Kaloleni, Kilifi, Malindi
Kisumu	Kisumu East, Kisumu West, Nyando
Mombasa	Kilindini, Mombasa
Nairobi	Nairobi East, Nairobi North, Nairobi West, Westlands
Nakuru	Molo, Naivasha, Nakuru, Nakuru North
Turkana	Turkana Central, Turkana North, Turkana South

The mathematics mean scores in table 1.3 show boys outperforming girls from 2009 to 2013 in the major counties except for Nairobi County. This is the trend nationally, just as it is in many developing countries.

Table 1.3: Girls' and Boys' Mathematics Mean Scores (2009-2013)

In Nairobi, girls outperformed boys in 2009 (3.46/3.76), 2010 (3.47/3.90) and 2011 (3.64/4.05). However, the trend was reversed in 2012 (4.12/4.02) and 2013 (4.12/3.95) with boys outperforming girls. Nairobi was chosen for the study to explore the change in performance.

Major Counties	**2009**		**2010**		**2011**		**2012**		**2013**	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Nairobi	3.46	3.76	3.47	3.90	3.64	4.05	4.15	4.02	4.12	3.95
Kisumu	4.55	3.37	4.47	3.01	4.53	3.10	5.04	3.69	4.97	3.61
Murang'a	3.94	2.72	3.67	2.71	3.31	2.00	4.54	3.33	4.44	3.33
Nakuru	3.79	2.93	3.99	3.16	4.12	3.32	4.70	3.60	4.51	3.62
Mombasa	3.64	2.87	3.46	3.19	3.58	3.19	3.40	2.84	3.31	2.67
Turkana	3.40	2.26	3.14	1.82	2.97	1.67	3.62	2.74	3.40	2.73
Uasin Gishu	3.81	2.92	4.31	3.10	4.24	3.28	4.62	4.12	4.60	4.01
Kilifi	2.67	2.14	2.82	2.18	2.70	2.28	2.92	2.54	2.93	2.41
Garissa	1.74	1.29	1.85	1.32	2.64	1.22	2.07	1.51	2.30	1.67
Kakamega	3.64	2.96	3.69	2.90	3.79	3.13	4.14	3.31	4.07	3.31

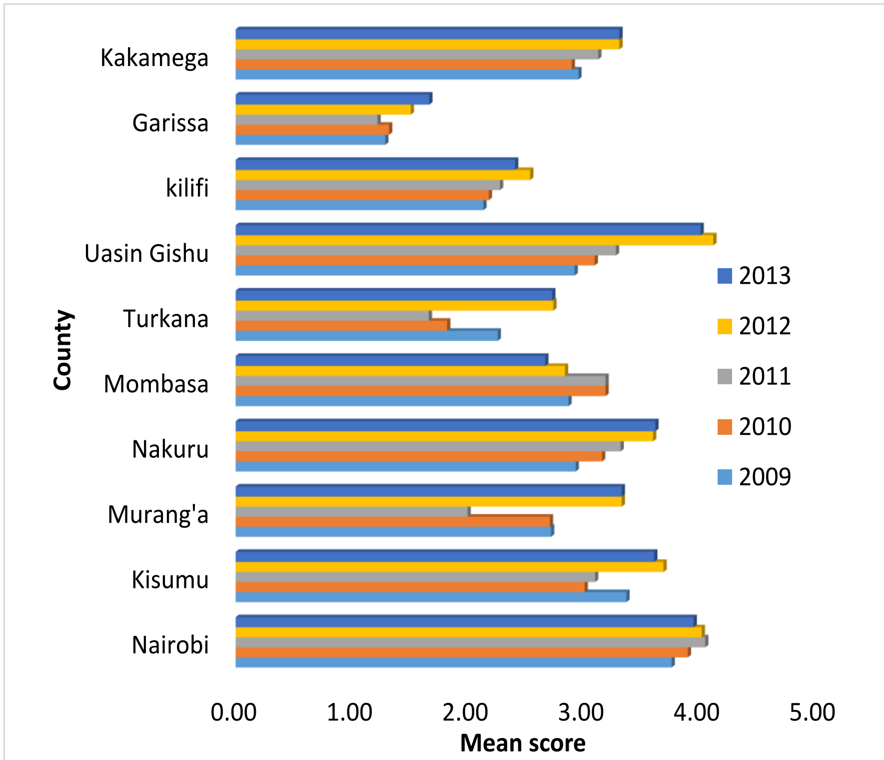

Figure 1.1: Girls' KCSE Mathematics Mean Scores in Major Counties (2009-2013) – KNEC Report 2014

The performance of girls in mathematics is poor, irregular and declining in most of the counties, as shown in figure 1.1 In Nairobi, the average mathematics mean score rose steadily from 2009 to 2011 but declined in 2012 and 2013.

1.2 Statement of the Problem

According to Bryant (2011) 'Mathematics is commonly identified as the primary gateway to high paying employment, financial independence, and high status occupations. It has been deemed the 'critical filter for employment and full participation in our society. Thus gender, racial, and socioeconomic inequities in mathematics participation could be a source of cultural and social inequity in our society'. Macharia (2008), in a paper on 'Girls Education in Kenya: Towards the Millennium Development Goals and Vision 2030, maintains that 'Despite increased access to education since the introduction of free primary education (FPE) in January 2003, gender disparities in enrolment and in performance at the Kenya Certificate of Secondary Education (KCSE) persist. This means that women continue to be underrepresented in mathematics related courses in public universities in Kenya, they are less empowered as mothers, wives and employees and the gender representation as required in the Kenyan Constitution (two thirds gender rule), remains a mirage.

The Education for All (EFA) Global Monitoring Report (GMR, 2015) confirms that among the EFA goal, the greatest progress has been achieved in gender parity. However, this has not been matched by gender equality in education. The report points to the fact that teaching strategies are central in improving education quality and specific pedagogic practices were linked with positive student achievement. For example, cites Aslam and Kingdom (2011) as noting that in Pakistan, a school-based survey in one district in 2002/03 found that lesson planning and interactive teaching increased language and mathematics achievement. The report further cites Westbrook et al. (2013) who carried out a systematic review of 489 studies and an in-depth study of 54 empirical studies in low and middle income countries and highlighted various effective pedagogic strategies: group and pair work, informative feedback, student questioning, use of local languages, the planning and varying of lesson sequences and use of a range of learning materials.

The SMMASSE pedagogy known as the ASEI – PDSI approach refers to a paradigm shift away from teacher-centred teaching to lesson delivery that focuses on activities that are student–centred, experimentation or practical work, and improvisation in teaching and learning. This is expected to be achieved through the teachers Planning, Doing, Seeing and Improving (PDSI). It is not known how and to what extent the adoption of the SMASSE pedagogy or ASEI-PDSI approach affects girls' mathematics achievement in secondary schools in Nairobi County, Kenya.

CEMASTEA carried out a series of studies on the SMASSE programme including (i) A Lesson Observation Study, the Practice of ASEI-PDSI by Teachers of Mathematics and Science in Secondary Schools in Kenya (2011), (ii) Effects of ASEI-PDSI Approach to Teaching and Learning on Mean Attitude – Score-Towards–Mathematics, Mathematics-Mean-Achievement-Score and Retention of Secondary School Students in Nairobi Province, Kenya (2012) (iii)

A 2008/2012 Comparative Study on the Supervision and Practice of ASEI-PDSI Approach in Secondary Schools in Kenya (2013) and (iv) A SMMASSE Project Impact Assessment Survey (SPIAS) 2012 in Secondary Schools in Kenya. Notwithstanding this, none of the studies addressed the gender perspective; a lost opportunity.

Furthermore, other researchers also looked at the effect of the SMASSE project in various forms. These include Macharia (2008) on the Impact of SMASSE Programme on Teaching Mathematics in Murang'a District, Ndirangu (2013) on the Factors Influencing Teachers' Level of Implementation of SMASSE Innovation in Nyeri County and Ombati (2009) on The Impact of INSET of Mathematics Teachers on the Quality of Teaching and Learning in Public Secondary Schools in Kisii Central District, to name a few. None of these studies particularly looked at girls' achievement in mathematics in secondary school.

This study looking at the 'Effect of SMASSE pedagogy (ASEI-PDSI approach) on girls' mathematics achievement in secondary schools in Nairobi County was a step in the right direction. In doing so the study will investigate how (i) principals' rating of their support for the adoption of the SMASSE pedagogy affects girls' mathematics achievement in secondary schools (ii) principals' and deputies' attendance of SMASSE workshops affects girls' mathematics achievement in secondary schools (iii) mathematics teachers' rating of their adoption of SMASSE pedagogy affects girls' mathematics achievement in secondary schools (iv) mathematics teachers' attendance of SMASSE INSETs affects girls' mathematics achievement in secondary schools (v) the researcher's rating of mathematics teachers' adoption of SMASSE pedagogy from classroom observation affects girls' mathematics achievement in secondary schools (vi) girls' rating of their mathematics teachers' adoption of SMASSE pedagogy affects girls' mathematics achievement in secondary schools (vii) girls' attitude towards their mathematics teachers' adoption of SMASSE pedagogy affects girls' mathematics achievement in secondary schools in Nairobi County.

1.3 Purpose of the Study

The purpose of the study was to investigate the influence of the ASEI - PDSI pedagogical approaches on girls' achievement in KCSE Mathematics in public secondary schools in Nairobi County.

1.4 Objectives of the Study

The study sought to address the following specific objectives:

1. To determine the relationship between principals' rating of their support for the adoption of the ASEI – PDSI approach in teaching Mathematics and girls' achievement in KCSE Mathematics
2. To establish the relationship between the extent to which principals and their deputies attend SMASSE workshops and girls' achievement in KCSE Mathematics

3. To determine the relationship between mathematics teachers' rating of their adoption of the ASEI - PDSI approaches and girls' achievement in KCSE Mathematics
4. To assess the relationship between the extent to which mathematics teachers attend SMASSE INSETs and girls' achievement in KCSE Mathematics
5. To establish the relationship between the level of adoption of the ASEI – PDSI approach by mathematics teachers and girls' achievement in KCSE Mathematics
6. To identify the relationship between learners' rating of their teachers' adoption of the ASEI – PDSI approach and girls' achievement in KCSE Mathematics
7. To determine the relationship between girl learners' attitude towards the ASEI – PDSI approach used by their mathematics teachers and girls' achievement in KCSE Mathematics

1.5 Null Hypothesis

H_{O1} There is no significant relationship between principals' rating of their management of the ASEI PDSI approach and girls' achievement in KCSE Mathematics

H_{O2} There is no significant relationship between the extent to which principals and their deputies attend SMASSE workshops and girls' achievement in KCSE mathematics

H_{O3} There is no significant relationship between mathematics teachers' rating of their adoption of the ASEI – PDSI approach and girls' achievement in KCSE mathematics.

H_{O4} There is no significant relationship between the extent to which mathematics teachers attend SMASSE INSETs and girls' achievement in KCSE mathematics

H_{O5} There is no significant relationship between mathematics teachers' adoption of the ASEI –PDSI approach and girls' achievement in KCSE mathematics

H_{O6} There is no significant relationship between learners' rating of their teachers' adoption of the ASEI – PDSI approach and girls' achievement in KCSE mathematics

H_{O7} There is no significant relationship between girl learners' attitude towards the ASEI – PDSI approach used their mathematics teachers and girls' achievement in KCSE mathematics.

1.6 Significance of the Study

The Education for All (EFA, 2000-2015) confirms that 'among the six EFA goals (Early Child hood care and education, Universal primary education, Youth and adult skills, Adult literacy, gender equality and quality education), the greatest progress has been achieved in gender parity. However, it is less clear how much progress has been achieved towards actual equality.' What this means is that a post-2015 global education agenda should be looking beyond parity. This includes paying attention to the continuous debate about girls' mathematics achievement and its implications for choosing mathematics related tertiary courses or careers. This study provides empirical evidence on 'the influence of the adoption of the ASEI-PDSI pedagogical approaches on girls' mathematics achievement in secondary schools in Nairobi County, Kenya'. Such evidence is useful in a variety of ways to a wide audience such as policy makers, curriculum developers, teacher trainers, CEMASTEA, QASOs, international organizations and donors as well as stakeholders.

In Kenya, the evidence may inform the MOEST on policy relating to teaching and learning, adoption of interventions in schools, roles of school leaders and teachers as well as CEMASTEA. It could be utilized by the Kenya Institute of Curriculum Development (KICD) in making decisions regarding how areas covered in the SMASSE INSET could be included in the pre-service teacher curriculum. The study has produced new understanding to help CEMASTEA to enhance SMASSE workshops and INSET programmes for principals and mathematics teachers respectively. Teacher trainers in tertiary institutions can use the findings to inform their curriculum reviews for trainee teachers. In addition, teachers and school principals can use the findings to improve the adoption of the ASEI-PDSI approaches. The findings should enhance the supervisory roles of

Quality Assurance and Standards Officers (QASOs), principals, deputies and heads of mathematics departments as well as enhance the adoption of the ASEI-PDSI mathematics teachers to improve the achievement of girls in KCSE Mathematics long term. Finally, the evidence could be used by international organizations and donors like WESCA, UNESCO, UNGEI, USAID, and IIEP as they see fit and researchers could use it as a starting point.

1.7 Limitations of the Study

Limitations are potential weaknesses in your study that are mostly out of your control, given limited funding, choice of research design, statistical model constraints or other factors. They are often not something that can be solved by the researcher. In addition, a limitation is a restriction on your study that cannot be reasonably dismissed and can affect your design and results (phdstudent, 2015). Limitations relate to participants, generalizability of findings, instruments utilized the sample, time constraints, data analysis and the nature of self-reporting constraints, data analysis and the nature of self –reporting). (http://www.othmanismail.com/classes/BEL600/5_Significance_Limitaions.htm

This study is limited in its findings in several ways. The participants are limited to principals, deputies, and mathematics teachers and form three girls in public secondary schools in Nairobi County, Kenya. As a result the findings from public secondary schools in Nairobi County could not be generalized to private schools or all secondary schools in the country. The instruments utilized included questionnaires for principals, mathematics teachers and form three girls, lesson observation schedule and a focus group discussion with a selection of form three girls. The administration of questionnaire raises concerns about truthful responding, the nature of self-reporting and access to participants. Null hypotheses testing involved determining correlation, but not causation. The amount of budget available for a self- sponsored research and the time limit for successfully completing the study were also limiting factors.

1.8 Delimitations of the Study

Delimitations are the definitions you set as the boundaries of your own thesis or dissertation, so delimitations are in your control. Delimitations are set so that your goals do not become impossibly large to complete. Examples of delimitations include objectives, research questions, variables, theoretical objectives that you have adopted, and populations chosen as targets to study. Delimitations are not good or bad; they are simply a detailed description of the scope of interest for your study as it relates to the research design (PhD student, 2015). Delimitations are set so that your goals do not become impossible to complete.

This study aims to investigate the effect of SMASSE pedagogy on girls' mathematics achievement in public secondary schools in Nairobi County. Nairobi County was chosen because it was the only County in which girls were outperforming boys in KCSE mathematics. The trend in the remaining 46 counties was boys outperforming girls in KCSE mathematics. Girls were chosen over boys because although they were outperforming boys, girls KCSE mean scores in 2012 and 2013 saw a decline creating curiosity for investigation. The target population comprised of 57 public secondary schools, 57 principals, 57 deputies and 21,547 girls in the 9 districts of Nairobi County. The sample was made of 22 schools, 22 principals, 22 deputies, 68 mathematics teachers and 4,310 girls. The results of the study will be generalizable to principals and deputies, mathematics teachers and girls in public secondary schools in Nairobi, where the SMASSE pedagogy is mandatory. The dependent variable is girls' mathematics achievement in secondary school in Nairobi County. There are six independent variables, namely: principals' rating of their support for adoption of SMASSE pedagogy, principals and deputies attendance of SMASSE workshops, mathematics teachers' rating of their adoption of SMASSE pedagogy, mathematics teachers' attendance of SMASSE INSETs, girls' rating of their mathematics teachers' adoption of SMASSE pedagogy and girls' attitude towards adoption of SMASSE pedagogy.

The theoretical and conceptual frameworks adopted for the study are constructivism and Daniel Stufflebeam's Context, Input, Process, Product (CIPP) model respectively.

1.9 Assumptions of the Study

> Assumptions are things that are accepted as true, or at least plausible, by researchers and peers who will read your dissertation or thesis. In other words, any scholar reading your paper will assume that certain aspects of your study is true given your population, statistical test, research design, or other delimitations. Limitations and assumptions should not contradict one another (Assoc. Prof Dr Ismail, 2004).

Assumptions in your study are things that are somewhat out of your control but if they disappear your study would become irrelevant. Assumptions are so basic that, without them, the research problem itself could not exist (Simon, 2011).

Several assumptions have been made in this study. It was assumed that (i) quality workshops were conducted for principals and deputies (ii) quality INSETs were conducted for mathematics teachers (iii) principals and deputies attended SMASSE workshops and supported the adoption of SMASSE pedagogy (v) lesson observations to rate the adoption of SMASSE pedagogy were objective (vi) girls were aware of the adoption of SMASSE pedagogy by their mathematics teachers and had an attitude towards the adoption of SMASSE pedagogy (vii) that sample size is representative of the population (viii) participants will answer honestly when their anonymity and confidentiality are explained.

It is also assumed that assumptions about statistical models of quantitative research designs relating to characteristics of data such as distributions, correlational trends and variable types are not violated. Violating these assumptions can lead to drastically invalid results depending on the sample size and other considerations (http://www.phdstudent.com/Choosing-a-Research-Design/stating-the-obvious-writing-assumptions-limitations-and-delimitations).

1.10 Definitions of Operational Terms

The following is a list of terms with their definitions to assist the clarification of specific vocabulary in the study.

Achievement refers to a measure of attainment in national examinations at the end of an educational stage such as secondary, such as the Kenya Certificate of Secondary Education Mean Scores (KCSE Mean Score).

Activity-focus refers to students working with various objects individually and in small groups, solving problems and exploring spaces other than the classroom. Or it may involve students working in pairs to make meaning of the lesson supported the teacher's skill in eliciting information, asking questions and following up questions to support learning.

Adoption refers to the decision one or more individuals to move along from becoming aware of an innovation such as the ASEI-PDSI, to the eventual regular usage of the practice; that is the decision to make full use of the innovation as the best course of action available.

ASEI-PDSI approaches refer to lesson delivery that focuses on activities that are student–centred, experimentation or practical work, and improvisation in teaching and learning.

Attitude refers to the way one thinks, feels about something which may be positive or negative.

Do refers to the teacher acting as a facilitator, carrying out instructional activities as planned in an innovative, interesting way, ensuring active learner participation, reinforcing learning , dealing with learners questions and misconceptions

Experimentation refers to a scientific test that is done to study what happens and gain knowledge

Gender Responsive Pedagogy (GRP) refers to a model of pedagogy involving the training of teachers and school leaders to be more gender aware and equips them with the skills to understand and address the specific learning needs of both sexes. It develops teaching practices that engender equal treatment and participation of girls and boys in the classroom

Improve refers to the teacher reflecting on the performance, evaluation and effectiveness of the lesson objectives. It should enable the teacher to take note of the strengths, weaknesses of the lesson and address them accordingly

Improvise refers to doing something with whatever is available or use similar versions when standard approaches or equipment are insufficient or unavailable

INSET cycle is a 10-day SMASSE INSET per year for mathematics teachers

Pedagogy refers to all teaching and learning processes, including what is taught, how teaching takes place and how what is taught is learnt

Plan refers to the careful preparation and trying out of activities which will enable learners to understand individual concepts and connect them, get rationale/value of lesson, retain the learning and apply it to real life situations, get rid of misconceptions and have interest in the lesson

Principals' support refers to the ability to mobilize mathematics teaching and learning resources, promote mathematics, encourage mathematics teacher collaboration, supervise the adoption of the ASEI-PDSI approach and monitor student progress

See refers to a teacher's evaluation of the teaching and learning process during and after the lesson using various techniques and feedback from students and colleagues. It should enable the teacher to note good practices and mistakes to be addressed, be more open to evaluation students, peers and seniors

Student-centred refers to the shift of activity from teacher to student; it includes active learning, cooperative learning, inductive teaching and learning, explicit skill instruction, encourages students to reflect on what is learnt and how it is learnt, gives students some control over the learning and encourages collaboration

1.11 Organization of the Rest of the Study

The rest of the study is organized into four chapters. Chapter two consists of literature review. This involves looking at related researches and/or studies, critically analyzing them and linking them to the objectives of the study as well as identifying gaps. Chapter three describes the researcher's methodology which includes the description of the research designs, study population, sampling procedure, research instruments, validity and reliability of the research instruments and the data collection procedure. This part also describes the data analysis plan detailing how the data collected was analyzed. Chapter four contains data analysis and interpretation while chapter five presents the summary, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews and summarizes literature related to the study. It introduces Mathematics education and girls' achievement, an overview of pedagogical approaches, adoption of innovation and the adoption of the ASEI-PDSI as a pedagogical approach. This is followed the theoretical and conceptual frameworks.

2.2 Mathematics Education and Girls' Mathematics Achievement in Secondary School

According to the Organization for Economic Cooperation and Development (OECD,1998), professional development signifies any activity that develops an individual's skills, expertise and other characteristics as a teacher. Development is achieved through a set of planned activities that are aimed at moving teachers to more responsible positions within the school system (Parker & Harley, 1999).

Instructional management, supervision, and training influence academic achievement. Success with pedagogy depends on teacher competence and student participation. Learner-centered pedagogy promotes student participation, resulting in increased achievement (Gonzalez & Nelson, 2005). A combination of instructional technology, classroom arrangements, and teaching techniques induces participation. The No Child Left Behind Act of 2001 promotes individualized and small-group instruction. Challenges to student achievement include inadequate teachers" training, students' diversity, and eagerness to learn (Cartledge & Kourea, 2008; Mawhinney, 2007; White-Clarke, 2005).

The learning context of instruction exposes effective teaching strategies. Nykiel-Hibbert (2004) lists some of the learner-centered strategies including individualized instruction, cooperative grouping, and programmed instruction adapted to needs. Students' ability and needs influence the teacher's learner-centered strategy choice. Advanced students show less teacher dependency at independent task than underachieving students do. Many educators recommend using individualized instruction with low-performing students to improve performance. Individualized and group instructions become teacher-centered when the teacher excludes students from investigating and providing information. In learner-centered instruction, the teacher and students work together, set learning goals, select tasks to meet these goals, and review learning outcomes (Richards, Pouri, Golez, Canges, & Murphy, 2007).

Implementation of the ASEI-PDSI approach means putting the approach, an innovation into practice. According to Oluoch (2002), implementation means taking the innovation to schools after the try-out has been completed. It involves among other things, persuading a variety of people to accept the innovation, keeping the general public informed, training the teachers, provision of necessary facilities, supply of materials and equipment, actual practice of the innovation, and providing continuous support for teachers.

The history of gender equality goals spans six decades (1948-2015). A Department for International Development (DFID) document 'Girls' Education: Towards a Better Future for All' outlines international commitments including the Universal Declaration of Human Rights (UNDHR) in 1948, the Convention on the Elimination of all forms of Discrimination against Women (CEDAW) in 1979, Convention on the Rights of the Child (CRC) in 1990, and in 2000 the World Education Forum in Dakar set out the Education For All (EFA) goals and the Millennium Summit that set out the Millennium Development Goals (MGDs) to all of which Kenya is a signatory. This study pays particular attention to the EFA goal 5: to 'achieve gender parity' and MDG goal 3: to 'promote gender equality in education', which were set as targets to be met 2005 and 2015 respectively. The importance of empowering girls through education cannot be overemphasized and stakeholders in education including the girls themselves know it, as an Ethiopian schoolgirl, Meda Wagtole, summed up:

> 'To be educated means ….. I will not only be able to help myself, but also to help my family, my country and my people. The benefits are many.'

In a keynote address on International Evidence on Gender Equality at the International Institute for Educational Planning (IIEP) Evidence-Based Policy Forum (2011), Nelly Stromquist emphasized that assessment of students' learning happens at four main levels: classroom, school, national, and international. She pointed out that the closer assessments are to students, the greater the chance that they will influence their learning. And yet, she maintains, little time is devoted to student assessment in teacher-training programmes. She suggested that despite the benefits of international assessments, some results cannot be used to improve learning in a specific classroom and tend to have a low impact on equality issues focusing on abstract numerical data, we lose sight of the important contextual factors. For example, when presented with a mean score, we should also complement with the factors that underlie it. What was the length of the school day? Did students have access to regular meals? What social expectations did they face? Even within the same international assessment initiative or national assessment, a score of 250 from one country should not necessarily be treated the same way as the same score from another country.

In the UK, for example, a 'value added' component is introduced for students of compulsory school age (4-16 years) and their schools at key stage 2, 3 and 4 when the students aged 11, 14 and 16 do national assessments. The value added is a measure intended to allow a fairer comparison between schools with different pupil intake. There is a simple value added which based on prior attainment only and a more complex 'contextualized' value added score based on a range of factors and calculated using multilevel models. Value added modelling is now use in Performance Tables to provide information to parents and hold schools to account; in systems for school improvement, where data is used for self-evaluation and target setting; to inform school inspections, which are now tied into the school improvement process; to help select schools for particular initiatives and to provide information on the effectiveness of particular types of school or policy initiatives.

Stromquist (2012) points out that gender differences in achievement vary region and country and tend to diminish as countries achieve higher levels of development and democratic practice, indicating that gender differences are not due to innate cognitive capacity. Social expectations also affect performance in subjects like mathematics reading and science but levels of social and personal development are often ignored in favour of cognitive performance. Ms Stromquist suggests that teachers can assist in this assessment but more needs to be done regarding training with a gender perspective.

In the Forum, Saito (2011) and Amugisha (2011) are cited as reporting evidence that suggests that the improvement in access in enrolment has not been mirrored in an improvement in gender equality performance. Gender gaps vary considerably from country to country and are closely related to gender differences in student attitudes and behavior. Of serious concern is the fact that gender gaps in mathematics and reading in Southern and Eastern Africa have not changed over time, implying gender–related interventions in these countries might have focused too much on school access and participation, rather than on education quality. Another keynote speaker, Ms Dibba Wada opened her presentation on gender equality intervention and strategies arguing that despite the progress being made in terms of parity and overall enrolment, quality remains a major concern. She maintains that curriculum content must be gender responsive and so should the training for those who deliver it. She points out that often the school learning environment and the attitudes of teachers serve to reinforce, rather than challenge, prevalent stereotypes and injustices. She recommends FAWE's Gender

Responsive School model as an example of good practice, where the academic, social and physical environments of the school and local community recognize the specific needs of boys and girls; all stakeholders understand and practice gender equality.

A very important element of the model is the development of gender-responsive pedagogy (GRP) which focuses on lesson planning, language use in the classroom, classroom interactions, and the role of management in supporting gender-responsive approaches in schools. Ms Wadda identified key lessons learnt from FAWE's gender equality interventions and strategies as follows. A holistic approaches where policy level, school environment and community, and classroom interactions must all be tackled simultaneously; gender equality means equality in terms of completion rates, performance and life opportunities; partnerships and networks between ministries teachers, parents, and local communities are vital in order to transform education systems. Evidence- based advocacy is a critical factor in influencing governments to integrate gender into national frameworks and policies; female role models, particularly in leadership positions in schools, are important in encouraging the enrolment and retention of female students.

Kutnick, Jules, Layne (1997) looked at Gender and School Achievement in the Caribbean-Trinad, Barbados and St Vincent. They collected information in secondary schools focusing on observational and comparative approach using ethnographic techniques to note classroom strategies and interactions. The researchers found that girls performed better than boys including in mathematics overall but in schools with a culture of high attainment there is no difference in attainment gender. Despite didactic teaching techniques performance was high for all students where there was a culture of high attainment.

UNESCO (2015) published the EFA Global Monitoring Report, ‘Education for All 2000-2015: Achievements and Challenges’. In the report UNESCO calculates a standard EFA Development Index (EDI) as a composite index that allows evaluation of overall progress towards EFA. Due to data constraints, the standard index captures only four of the six goals, with goals 1 (Early Childhood Education) and 3 (Youth and Adult Skills) being excluded. The value of the standard EDI for a given country is the arithmetic mean of the four components. The report collated data on 113(55%) out of 207 countries which had data on all four components and asserts that progress towards gender parity goal has been one of the greatest EFA successes, although 12% of countries are projected to be far from the target. In 2012, U K and Japan had the highest EDI scores at 0.996 and 0.994 respectively, and Central African Republic, Niger and Chad had the lowest scores at 0.559, 0.534 and 0.520 respectively. No country in South and West Asia or sub-Saharan Africa was part of this group because the data in even countries that had achieved parity was unavailable. The report also calculated the Gender Specific EFA Index (GEI). Of the 113 countries, 98 (87%) have GEI in favour of boys or men. The few countries with GEI in favour of girls or women include UK, Japan, Jordan, Chile and Burkina Faso. The report points out that quality education should be defined learning outcomes as measured international, regional or national assessments but other dimensions including more and better trained teachers, pedagogical renewal, and school time in which teachers and pupils are actively engaged in learning activities.

2.3 Overview of Pedagogical Approaches

Chapuis (2003) defines pedagogy as a combination of knowledge and skills required for teaching; the science of teaching that makes a difference in the intellectual and social development of students.

2.3.1 Traditional Versus Progressive Pedagogy

A very typical feature of traditional methodology, as Broughton and his colleagues claim, is the "teacher-dominated interaction" (Broughton, 1994). The teaching is deeply teacher-centred. The reason for this approach is explained by the statement of Kuzu (2007), who asserts that it is based on the "traditional view of education, where teachers serve as the source of knowledge while learners serve as passive receivers" (Kuzu, 2007). This idea corresponds to the simile of Jim Scrivener, who claims that "traditional teaching [is imagined to work as] 'jug and mug' – the knowledge being poured from one receptacle into an empty one." This widespread attitude is based on a precondition that "being in a class in the presence of a teacher and 'listening attentively' is enough to ensure that learning will take place" (Scrivener, 2005). In his book Communicative Language Teaching Today, Jack C. Richards highlights that in traditional methodology “learning was very much seen as under the control of the teacher” (Richards, 2008). To sum up, the traditional methodology puts the responsibility for teaching and learning mainly on the teacher and it is believed that if students are present in the lesson and listen to the teacher’s explanations and examples, they will be able to use the knowledge.

Unlike traditional methodology, modern methodology is much more student-centred. According to Jim Scrivener, the teacher’s main role is to “help learning to happen,” which includes “involving” students in what is going on “by enabling them to work at their own speed, by not giving long explanations, by encouraging them to participate, talk, interact, do things, etc.” (Scrivener 18, 19). Broughton adds that “the language student is best motivated by practice in which he senses the language is truly communicative, that it is appropriate to its context, that his teacher’s skills are moving him forward to a fuller competence in a foreign language” (Broughton 47). Briefly put, the students are the most active element in this process. The teacher is here not to explain but to encourage and help students to explore, try out, make learning interesting, etc. Though being essential, the aim of learning a foreign language according to modern methodology is still discussed, and there is a variety of possible aims. In his book Learning Teaching, Jim Scrivener claims, that nowadays a great emphasis is put on “communication of meaning” (Scrivener 31). Jack C. Richards also highlights the communicative competence which is, as he defines it, “being able to use the language for meaningful communication” (Richards 4). Thus many professionals refer to this methodology as the Communicative Language approach. Another group of authors headed by Broughton propose a different idea. They point out that foreign languages are taught “not simply for the learner to be able to write to a foreign pen friend” but to broaden his or her horizons by introducing certain ways of thinking about time, space and quantity [and] attitudes toward issues we have to face in everyday life (Broughton, 19940). Briefly put, some people learn a foreign language most importantly to be able to communicate with foreign people and other people learn a foreign language above all to see the world from a different point of view, to discover new approaches to life or to find out about other cultures. Since modern methodology is aiming for something different, also the way to achieve the goal has changed. As pointed out by Jack C. Richards, “attention shifted to the knowledge and skills needed to use grammar and other aspects of language appropriately for different communicative purposes such as making requests, giving advice, making suggestions, describing wishes and needs and so on” (Richards, 2008). Teachers’ methods, courses, and books had to be adjusted to new needs of the learners to fulfil their expectations. Instead of grammatical competence, communicative competence became the priority. Ronald V. White articulates three principles of modern methodology: firstly, “the primacy of speech”; secondly, an emphasis on “the centrality of connected text as the heart of teaching-learning process”; and thirdly, an “absolute priority of an oral methodology in the classroom” (White, 1998). Instead of memorizing grammatical rules and isolated vocabulary, modern methodology prefers to present contextualized language and to develop skills. Table 2.1 presents a summary of traditional versus progressive pedagogy.

Table 2.1 Traditional Versus Progressive Pedagogy

Traditional	**Progressive**
School is a preparation for life.	School is a part of life.
Learners are passive absorbers of information and authority	Learners are active participants, problem solvers, and planners.
Teachers are sources of information and authority	Teachers are facilitators, guides who foster thinking.
Decision-making is centrally based and administratively delivered	Decision-making is shared all constituent groups.
Knowledge is absorbed through lectures, worksheets, and texts	Knowledge is constructed through play, direct experience, social interaction.
Instruction is linear and largely based on correct answers	Instruction is related to questions and inquiry, generated by the children
Skills are taught discretely and are viewed as goals	Skills are related to content and are viewed as tools.
Assessment is norm-referenced, external, and graded	Assessment is benchmarked, varied, and is progress-oriented.
Success is competitive, recall and memory, and specific to time/place	Success is determined over time and through collaboration.

Adapted from: http://www.wingraschool.org/who/progressive.htm

Sherrington (March 15, 2014) posted his vies online, stating ‘My general argument is that, however we define the supposedly opposing poles of traditional and progressive pedagogy, they both have a vital role to play in a child’s education. The two camps are real enough. However, for me, the important thing is that they are not inherently in opposition; they are intrinsically linked facets of excellent learning and an excellent education overall. They might even be considered to exist in a symbiotic relationship’. I could not agree more. Table 1.4 presents Teacher- Centered (Traditional) Versus Student-Centered (Progressive)

Table 2.2 Teacher- Centered (Traditional) Versus Student-Centered (Progressive)

Teacher–Centred	**Student-Centred**
Teacher is the authority	Teacher is facilitator
Teacher is the expert	Teacher is the guide
Teacher delivers knowledge	Student explores a range of sources and has choices and say in what she or he learns
Rigid rows of desks	Learning activities and spaces are flexible
Rote learning and recall	Understanding and application
Focus on testing and grades	On-going formative assessment
Power and control	Trust and openness

Adapted from http://headguruteacher.com/2014/03/15/the-progressive-traditional-pedagogy-tree/

Traditional and progressive pedagogies have also been compared to teacher – centred and student – centred pedagogy as in the table below. The ASEI –PDSI was a paradigm shift from teacher-centred to student - centred pedagogy. It involves mathematics teachers using the knowledge and skills from the SMASSE INSETs to plan, do, see and improve lessons that were activity-focused, student-centred, experimental and improvised to make use of materials in students' immediate environment, thereby making the students' learning relevant to his or her community or society. The paradigm shift is a move towards personalized learning for students as indicated in the arrow.

2.3.2 Twenty First Century Pedagogy

The diagram of 21st century pedagogy (figure 2.1) is another representation of progressive pedagogy. It displays a huge amount of information 21st century learners have to sift through. To do this effectively and efficiently, learners need higher level thinking skills like analysis and evaluation. Evaluating information depends on context, circumstance and the nature of the data. The diagram captures this from the perspective of the teacher and various pedagogical components.

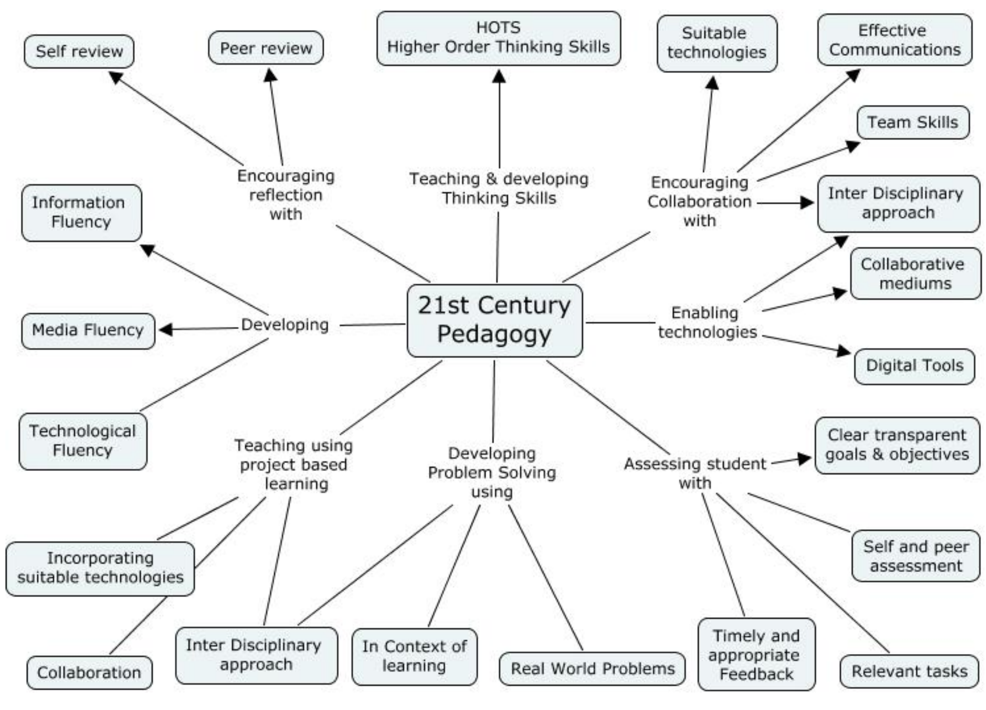

Figure 2.1: A 21st Century Pedagogy

Source:http://www.teachthought.com/technology/a-diagram-of-21st-century-pedagogy/

It focuses on several core components of modern learning: metacognition (reflection), critical thinking, technology, and problem and project-based learning. Like other representations of progressive pedagogy, it is both student-centred and activity – focused.

Westbrook, Durrani, Brown, Orr, Pryor, Boddy and Salvi (2013) in an 'Education Rigorous Literature Review of Pedagogy, Curriculum, Teaching practices and Teacher Education in Developing Countries' indicated active pedagogy and student/learner-centred as popular pedagogical approaches in these countries. For their review the researchers adopted Alexander's definition of pedagogy as comprising teachers' ideas, beliefs, attitudes, knowledge and understanding about the curriculum, the teaching and learning process and their students, and which impact on their 'teaching practices', that is, what teachers actually think, do and say in the classroom. The SMASSE training of teachers advocates active and student - centred pedagogy for the ASEI-PDSI approaches.

The INSET curriculum includes attitudinal change (from negative to positive), activity-oriented teaching and learning (hands-on) and actualization of the ASEI-PDSI (minds-on) approaches. Active pedagogy is characterized students working with various objects individually and in small groups, solving problems and exploring spaces other than the classroom. Or it may involve students working in pairs to make meaning of the lesson supported the teacher's skill in eliciting information, asking questions and following up questions to support learning". Student-centred practices are characterized examples and questions drawing on students' previous knowledge and experiences, problem solving and higher order thinking skills, instructional aids, good relationships and interaction between teachers and students, as well as pair and group work.

According to Cech (2012), gender researchers in the west have presented mathematics as having a girl problem which is not due to innate mathematics skill, but rather the contexts in which the students learn math; contexts that give girls less encouragement and less confidence in their Mathematics abilities. Often when educators and policy makers want to solve the problem they think about 'fixing the girls rather than fixing their learning environments. Cech (2012) quotes Professor Boaler of Mathematics Education at Stanford University in the US as stating that 'it's the mathematics classrooms, not the girls, which really need fixing'. Boaler explains that traditional ways of teaching mathematics through memorization have not worked and her research found that simply changing the way mathematics is taught, gender differences in mathematics achievement and mathematics confidence disappear. Boaler found that myths that girls were worse at mathematics were baseless as gender gaps in mathematics achievement have rapidly decreased in the last century, far outpacing the shifts in human genetics. She points out that girls' preferences are not a result of genetics but rather the different ways boys and girls are treated their peers, teachers and parents. In her research Boaler identified two similar schools to compare their differing learning environments and see the impact on learner mathematics achievement.

In school A mathematics was taught in the traditional way involving copying noes from the board, completed worksheets and split into ability groups. The boys outperformed girls in mathematics achievement. In school B they were taught the progressive way involving collaboration, group work to solve complex multi-dimensional, open-ended problems. In this school boys and girls performed equally well in their mathematics achievement. The boys in the school performed better than those in school A. Boaler suggested that realigning mathematics education to be more like the gender equitable school B we can move the debate from what is wrong with girls to how we can make mathematics education better for all students.

2.3.3 Gender Responsive Pedagogy

Teaching quality has a significant impact on academic access, retention and performance. Yet many teachers in sub-Saharan Africa, conditioned male-dominated values in their communities, employ teaching methods that do not provide equal opportunity to participation for girls and boys. Neither do these methods take into account the individual needs of learners, especially girls. (Mlama, Dioum, Makaye, Murage, Wagah, & Wahika, (2005).

Forum of African Women Educationalists (FAWE) of Kenya investigated gender responsive pedagogy (GRP) piloted it in schools in Kenya, Rwanda and Tanzania; the researchers found that teachers lacked knowledge and skills in adopting their model pedagogy. The GRP model trains teachers to be more gender aware and equips them with the skills to understand and address the specific learning needs of both sexes. It develops teaching practices that engender equal treatment and participation of girls and boys in the classroom with an intervention in the form of ‘A Teachers’ Handbook’. The Gender-Responsive Pedagogy model demonstrates how to transform teaching and learning processes to become gender-responsive in relation to lesson planning, teaching and learning materials, language use in the classroom, classroom set-up, classroom interaction and the role of school management in supporting gender-responsive pedagogical approaches in the school. The two key elements of FAWE’s GRP model are GRP training of teachers that targets practical skills and GRP training of the school management team. GRP training is delivered primarily through school-based in-service teacher training. However, in order to ensure that all teacher trainee graduates acquire gender-responsive pedagogical skills, FAWE is also working with teacher training colleges in selected countries to influence the mainstreaming of GRP in teacher training college curricula in order to train pre-service teachers and lecturers in gender responsiveness. To date, the model has been introduced in 10 teacher training colleges in five countries and in 21 existing FAWE Centre of Excellence (COE) schools in 19 countries including Burkina Faso, Chad, Ethiopia, The Gambia, Guinea, Kenya, Malawi, Namibia, Rwanda, Senegal, Tanzania, Uganda and Zambia. In some countries, the GRP model has also been introduced in non-COE schools. Impact of the FAWE’s GRP model includes improvement in girls’ retention and performance, greater participation of girls’ in the classroom, and improved gender relations within schools.

FAWE works with partners at continental, national and local levels to create positive societal attitudes, policies and practices that promote equity for girls in terms of access, retention, performance and quality influencing the transformation of education in Africa. However, in many countries including Kenya GRP has not been adopted as a government programmme. FAWE is encouraged to carryout teacher sensitization workshops to equip them with knowledge and skills in GRP across the country. Due to financial constraints and the fact that it is not compulsory for teachers to attend the organization is not usually able to reach all teachers. For example, FAWE Kenya (FAWEK) has only been able to reach teachers in about ten percent of the country although the organization aims to improve on this. It is the aim of FAWE to make as many schools as possible to become Gender Responsive Schools; these are schools in which the academic, social and physical environment and its surrounding community take into account the specific needs of both boys and girls. To achieve gender responsiveness, the teachers, parents, community leaders and members as well as the boys and girls have to be aware of and practice gender equality.

2.4 Adoption of Innovation

According to Baron and Graham (2007) a key factor in the adoption of innovative practices is that internal change agents must be more proactive in creating positive experiences via information sources, pedagogical understanding, technical support, and innovative reinvention. Understanding the process of adopting innovative practices, stakeholders can pinpoint the precise areas where faculty support is most needed. Improved support in the adoption process is critical in order to achieve smoother technical and pedagogical implementation in teaching and learning. Researchers discovered better ways to accelerate and improve the adoption of innovative practices in teaching with technology using Everett Rogers' five stages to the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation. Researchers interviewed instructors and local change agents in an effort to document the adoption of innovative practices, identify techniques that change agents use to facilitate the adoption process, determine which change agents are most influential to the adoption process, and discover the role of innovation reinvention in the decision making process. The need to support innovations is present in a wide variety of teaching circumstances. The concept of adopting innovative practices involves supporting instructors in developing and utilizing new ways of teaching and learning. Distance learning, instructional projects, and course management systems are just a few examples of the process of adopting innovative practices. Understanding this process, academic support organizations and other education staff can determine where faculty support is needed most and allocate resources accordingly.

Researchers found no evidence to suggest that reinvention ability played a role in the knowledge, persuasion, or decision stages of the adoption process. Reinvention could be integrated into these stages, however, when change agents take the initiative to promote new ways to use the audience response system.

Regardless of the amount of training instructors receive, if they do not have technical support and resources immediately available, then their confidence about the process begins to wane. Instructors do not need temporary scaffolding to help them through the initial training and start-up; they need reliable technical expertise to provide immediate solutions while in the classroom.

The adoption process will improve as all stakeholders focus on pedagogy in the classroom. Supporting faculty members in adopting innovative practices, support staff can create integrated technological and pedagogical learning environments. These environments are long-term and self-sustaining. Faculty and support staffs need to think of the adoption of innovative practices as a long-term educational outcome process. Faculty and staff must continuously formulate and assess educational goals and the means to achieve those goals. Such means may include adoption of a variety of innovations over the course of the educational outcome process. Faculty and staff must develop a vision of the educational pathway and view technology as an integral part in achieving that vision. Change agents must play a more active role in the knowledge, persuasion, decision, implementation, and confirmation phases of the adoption process.

One of the most important theories discussed Rogers is the Innovation-Decision Process Model. As shown in Figure 2.2, this model suggests that the adoption of an innovation is not a single act, but a process that occurs over time. Potential adopters go through five stages when interacting with an innovation. The first stage is “Knowledge” in which potential adopters find out about an innovation and gain a basic understanding of what it is and how it works. The second stage is “Persuasion” in which potential adopters form a positive or negative impression of the innovation. It is only in the third stage, “Decision”, that the innovation is actually adopted or rejected. The fourth stage, “Implementation”, occurs when the innovation is actually used. In the fifth stage, “Confirmation”, the adopter seeks information about the innovation and either continues or discontinues use of the innovation. The Confirmation Stage might also describe the adoption of an innovation that was previously rejected.

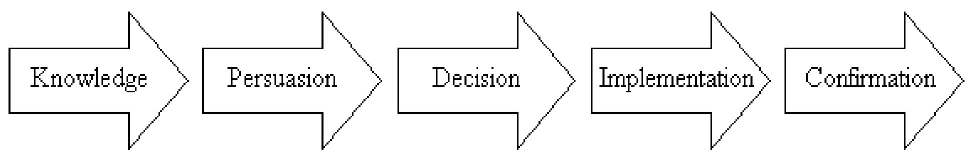

Figure 2.2: Five Stages of Rogers’ (1995) Innovation-Decision Process Model
Source: Surry and Ely- Adoption, Diffusion, Implementation, and Institutionalization of Educational Technology (www.usouthal.edu/coe/bset/surry/papers/adoption/chap.htm)

A second important and influential idea discussed Rogers is the concept of adopter categories. This concept states that, for any given innovation, a certain percentage of the population will readily adopt the innovation, while others will be less likely to adopt. According to Rogers, there is usually a normal distribution of the various adopter categories that forms the shape of a bell curve (figure 2.3). “Innovators”, those who readily adopt an innovation, make up about 2.5% of any population. “Early Adopters” make up approximately 13.5% of the population.

Most people will fall into either the Early Majority (34%) or the Late Majority (34%) categories. “Laggards”, those who will resist an innovation until the bitter end, comprise about 16% of the population. The concept of adopter categories is important because it shows that all innovations go through a natural, predictable, and sometimes lengthy process before becoming widely adopted within a population.

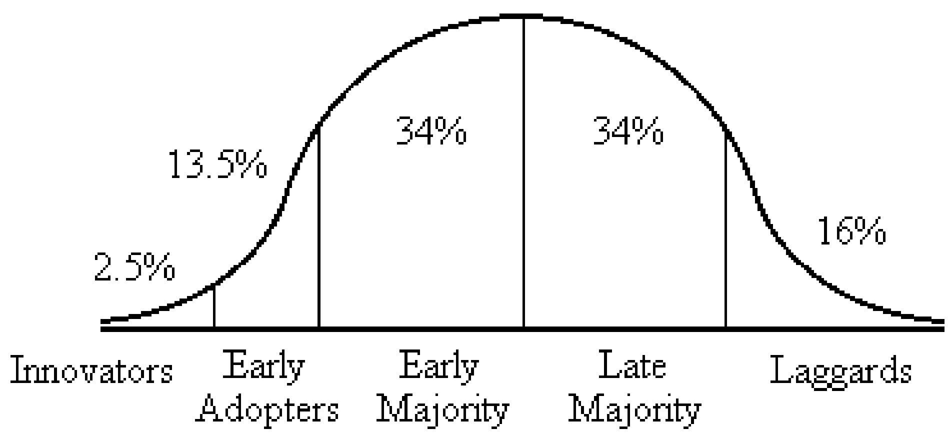

Figure 2.3: Hypothesized distributions of adopter categories within a typical population (early majority, late majority and laggards refer to adopters).

Source: Surry and Ely- Adoption, Diffusion, Implementation, and Institutionalization of Educational Technology (www.usouthal.edu/coe/bset/surry/papers/adoption/chap.htm).

The concept of perceived attributes (Rogers, 1995) has served as the basis for a number of diffusion studies (e.g., Fliegel & Kivlin, 1966; Wyner, 1974). Perceived attributes refers to the opinions of potential adopters who base their feelings about of an innovation on how they perceive that innovation in regard to five key attributes: Relative Advantage; Compatibility; Complexity; Trial ability, and; Observability. This construct states that people are more likely to adopt an innovation if the innovation offers them a better way to do something, is compatible with their values, beliefs and needs, is not too complex, can be tried out before adoption, and has observable benefits. Perceived attributes are important because they show that potential adopters base their opinions of an innovation on a variety attributes, not just relative advantage. Educational technologists, therefore, should try to think about how potential adopters will perceive their innovations in terms of all of the five attributes, and not focus exclusively on technical superiority.

Another important idea that Rogers (1995) has described is the S-shaped adoption curve. This curve shows that a successful innovation will go through a period of slow adoption before experiencing a sudden period of rapid adoption and then a gradual leveling off. When depicted on a graph, this slow growth, rapid expansion and leveling off form an S-shaped curve. The period of rapid expansion, for most successful innovations, occurs when social and technical factors combine to permit the innovation to experience dramatic growth.

Studies of diffusion, adoption, implementation and institutionalization conducted in many organizations and settings conclude that there is no formula for this process. There are many elements that should be considered in the process; however, simple transfer of these principles to specific environments would likely be futile. Like most instructional developments the change process requires systemic approaches; there is no substitute for a "front-end analysis" or needs assessment that yields the goals and objectives to be attained. Communication among all participants throughout the process is essential. A strategy or plan for achieving the goals is the best way to proceed when considering the many variables that are likely to affect the outcomes.

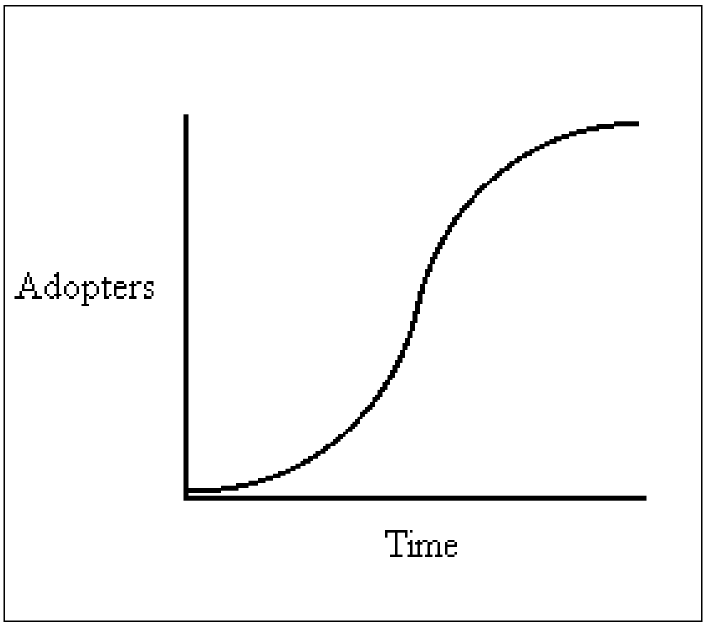

Figure 2.4: Examples of S-curve

Source: Surry and Ely- Adoption, Diffusion, Implementation, and Institutionalization of Educational Technology (www.usouthal.edu/coe/bset/surry/papers/adoption/chap.htm).

Evaluation should be a constant partner during the process. All of this activity should be coordinated a change agent--a person who is sensitive to the variables that will impinge on the process. The change agent could be an internal person or an external specialist. Awareness and experience with the change process is essential for a successful outcome.

2.5 Adoption of ASEI – PDSI as a Pedagogical Approach

The ASEI – PDSI approach refers to a paradigm shift by the SMASSE team that moves away from teacher-centred teaching to lesson delivery that focuses on activities that are student–centred, experimentation or practical work, and improvisation in teaching and learning. Adoption is the process of putting change such as the ASEI-PDSI approach into practice. It involves a shift from knowledge/content–based approach, few teacher demonstrations, theoretical or lecture method (chalk and talk), teacher– centred teaching to learner- centred teaching. The ASEI-Condition (After INSET) refers to Activity-focused Teaching/Learning, Student-focused /Centred Learning, Small scale Experiment /Research based approach and Improvisation. To operationalize the ASEI condition, SMASSE came up with the Plan, Do, See and Improve (PDSI) approach to teaching and learning.

Plan means that apart from schemes of work and lesson plans, the teacher carefully plans and tries out the Teaching / Learning activities, materials and examples before the lesson. Emphasis is on how instructional activities will enable learners to: Understand individual concepts and connections among them, get the rationale/value for the lesson, retain the learning and apply it in real life situations, get rid of learning difficulties and misconceptions and have more interest in the lessons.

Do refer to the teacher carrying out the planned lesson / activity as planned. Teachers are encouraged to be innovative in lesson presentation, present lessons in varied interesting ways to arouse learners' interest e.g. through role play, storytelling, ensure active learner participation, be a facilitator in the teaching/learning process., deal with students' questions and misconceptions and reinforce learning at each step. During INSETS, teachers carry out peer teaching on the ASEI lessons.

See involves the teacher evaluating the teaching and learning process during and after lesson, using various techniques and feedback from students. Teachers also allow their colleagues to observe their lessons and offer feedback. Enables teachers to; See the good practices in the lesson and strengthen them, see mistakes made in earlier lesson, avoid earlier mistakes in future lessons. In the process teachers become more open to evaluation fellow teachers, school administrators, Quality and Standards Assurance Officers and the students.

Improve means for the teacher to reflect on the performance, evaluation report and effectiveness in achieving the lesson objectives. This enables the teacher to: observe the good practices in the lesson and strengthen them, identify mistakes made in earlier lesson, avoid such mistakes in future lessons. The teacher makes use of such information in planning subsequent lessons so as to improve the lessons, to enhance student learning and improve achievement of all learners.

2.5.1 Principals' Rating of their Support for the Adoption of the ASEI – PDSI Approach in Teaching Mathematics and Attendance of SMASSE Workshops

CEMASTEA (2013) carried out a SMASSE Project Impact Survey (SPIAS) 2012 in Secondary Schools in Kenya to provide information on the influence of the ASEI-PDSI approach on mathematics and science achievement students. In a questionnaire, most of principals responded to mobilizing mathematics and science resources, promoting mathematics and science subjects and teachers said principals often supervised their ASEI-PDSI practice. A paired sample t-test between 2008 and 2012 revealed a difference in mean score management of mathematics and science in school over the period in favour of 2008 in resource mobilization, promotion of mathematics and science subjects and the supervision of the ASEI-PDSI practice in the classroom, with supervision showing the worst decline. This decline could be attributed to the irregular implementation of the SMASSE workshops for principals which were not conducted between 2008 and 2009, conducted in 2010 and 2011 but cancelled in 2012 due to teachers' strikes.

For the effective adoption of the SMASSE pedagogy or ASEI-PDSI approach principals and deputies are required to attend SMASSE workshops to understand the approaches as well as their roles and responsibilities in the management of the ASEI-PDSI approach. The SPIAS found that there was a 15.3% increase in principals attendance of workshops from 2008 (77.80%) and 2012 (93.10%), and a 13.10% drop in non-attendance from 2008 (20.00%) to 2012 (6.90%).

A correlation analysis revealed a (r = - .358) relationship between principals' workshop attendance and resource mobilization $p < .05$. However, there was no relationship between workshop attendance and promotion of mathematics and science subjects or supervision of the ASEI-PDSI practice. The researchers found that the extent of the relation between principals' workshop attendance and perception of management of mathematics and science indicates that principals are yet to respond positively to mathematics and science resource management as a result of workshop attendance. The researchers point out that there is still room for improvement of the ability of principals to promote these subjects among key stake holders and to improve the support of good classroom practices involving the ASEI-PDSI practices. The survey established that there was a positive relationship between principals and deputies attendance of SMASSE workshops. The researchers concluded that principals were motivating learners in maintaining positive attitudes towards mathematics and science subjects and as result students' achievements improved in the subjects. They observed some principals use knowledge acquired in the workshops to promote mathematics and science in their school assemblies.

2.5.2 Mathematics Teachers' rating of their Adoption of the ASEI - PDSI Approach and SMASSE Inset Attendance

Mathematics teachers are required to attend four basic cycles of SMASSE INSETs to prepare them for their role in the classroom. A comparative study (2008 and 2012) of the supervision and practice of the approaches in secondary schools in Kenya CEMASTEA (2013) found that mathematics and science teachers showed a negative attitudinal change (-11.21%). The average attendance of mathematics and science teachers rose from 19.30% in 2008 to 55.75% in 2012; this increase though encouraging is still not good enough considering that teacher are at the forefront of adopting the approaches in the classroom. CEMASTEA maintains the need for teachers to embrace SMASSE INSETs as Continuous Professional Development (CPD) in line with the Teachers' Service Commission (TSC, 2012) Act. The practice of the approaches improved showing a range of 58.70% (lowest) to 94.10% (highest). From the CEMASTEA situational analysis of 2009 & 2012, it was observed that despite attending INSETS, 72% of teachers rarely or never made a written lesson plan, 51% of teachers do/practice improvisation of teaching and learning materials, 30% of teachers considered improvisation unnecessary especially where convectional materials were available and 68% of the teachers never or rarely invited other teachers to observe their lessons. These challenges CEMASTEA attribute to weak classroom supervision school leadership. The attendance of INSET is good. Those who fail to attend are mostly doing other courses at the universities and other colleges. Thus majority of our teachers are aware of ASEI-PDSI approach but many of them perceive it as demanding and delays syllabus coverage as well as preparing learners for national examinations; the good principles are yet to take root and translate into better achievement scores. The SPIAS achievement tests require that learners are grounded more in the how and why questions than what types of questions; ‘what’ questions require lower cognitive level (one word) responses. The researchers suggest that national examinations should not determine what is taught in mathematics and science lessons, despite the crucial role the examination results play in a learner’s life beyond school.

2.5.3 Learners’ Rating of their Teachers’ Adoption of and their Attitude to the ASEI – PDSI Approach

The SMASSE programme Impact Assessment Survey (SPIAS 2012) CEMASTEA found that when learners have an opportunity to participate in lessons they tend to appreciate the ASEI-PDSI approaches. Student attitude and perception of the approaches improved between 2008 and 2012. A correlation analysis between students’ participation in lessons, their attitude towards learning and achievement in mathematics and science revealed a significant relationship between students’ participation in lessons, attitude towards learning and achievement in mathematics and science, $p<.01$.

This implies that there is a relationship between the variables. The researchers concluded that students appreciated their active involvement in lessons and this made them have a positive attitude towards the subject. The improved SMASSE INSET attendance by mathematics teachers is improving their classroom practice and culture, though only to a minimal extent. The small impact is making learners have a positive attitude towards the ASEI-PDSI approach which in turn is improving learner achievement. Between 2008 and 2012 the researchers found that students' attitude towards and perception of the ASEI-PDSI approach were positive during the period. Student participation also improved with students participating at least once a week. Generally the attitude of girls is quite good, just like that of the boys. All learners want to be taught using ASEI-PDSI approach. However, few of their teachers use ASEI-PDSI approach

2.6 ASEI – PDSI in Kenya and Africa

The programme is fully entrenched in Kenya and is done through the cascade system, i.e. the national & county levels. CEMASTEA staff trains the county trainers who in turn train other mathematics & science teachers at the county level. The Ministry of Education, Science & Technology (MOEST) funds this programme through the Free Secondary Programme (FSE) – for each student the government contributes 200 Ksh towards SMASE activities in the county. This money is shared between the school (30 Ksh) for resources, sub-county (50Ksh) for logistics and county (150 Ksh) for managing meeting and training sessions across the country. This has helped in the sustainability of the programme. CEMASTEA also carries out workshops for Principals, D/principals & HODs for the purposes of support & sustainability. CEMASTEA is also carrying out ICT Integration in teaching & learning to teachers in each county.

The member countries have started their SMASE like organizations – some started the programme in primary while others in secondary. Kenya acts as the secretariat. CEMASTEA trains the teachers and other education stakeholders from member countries between Sept & Oct of each year.

CEMASTEA used to train both the Anglophone & Francophone countries. However, the last Francophone countries were trained in 2013. The Anglophone countries are continually being trained

2.7 Summary of Literature Review

Six decades on, of debating gender equality in education is far from being achieved. The World Education Forum in Dakar (2000) set out the Education For All (EFA) goals and the Millennium Summit that set out the Millennium Development Goals (MGDs). Regarding the EFA goal 5: to 'achieve gender parity' and MDG goal 3: to 'promote gender equality in education', which were set as targets to be met 2005 and 2015 respectively, the EFA Global Monitoring Report (2015) confirms that these targets have not been fully achieved, particularly in Sub Saharan Africa where data to the effect was unavailable. Although data available points to the fact that among the EFA goal, the greatest progress has been achieved in gender parity, the report is less clear how much has been achieved towards actual equality.

Researchers have attributed the failings to a host of reasons. First and foremost is the fact that policy makers focus on numerical data, losing sight of contextual factors; there is no value added when mean scores or grades are reported within or outside countries although learners would have been assessed in different contexts. Second, in most cases, there is lack of training of teachers in assessment for learning. Third, schools are not gender responsive. Fourth, Teachers need to change their attitude of reinforcing rather challenging gender stereotypes. Fifth, Schools should develop a culture of high attainment for all learners to mitigate other school factors that negatively impact learner achievement. Sixth, all educators should engage in effective data collection and use. As a result, quality education should be defined not only by learning outcomes, but by more and better trained teachers, pedagogical renewal, school time in which teachers and learners are actively engaged. Principals currently only require teachers' qualification and experience for appointment; this is insufficient. They require specialist training and adequate remuneration in their new role so as to acquire the knowledge and skills required for the job. For example, in the UK, senior teachers undergo a year of training while on the job, to acquire the National Professional Qualification for Headship (NPQH) before they are eligible to apply for headship. The course is paid for by the government is supported by the school establishment.

Traditional and progressive education have their merits and exist in a symbiotic relationship. As found in the Caribbean study, even where there is traditional didactic teaching in schools where there is a culture of high attainment there is no difference in attainment by gender. Progressive education takes many forms including twenty first century teaching, activity focus, student-centred, GRP pedagogies and the ASEI-PDSI approach. Many researchers advocate GRP with its benefits to both boys and girls, thereby avoiding future gender gaps in mathematics and education for that matter. Reasons identified for girls not performing to their full potential in Mathematics include contexts that give less encouragement and less confidence in their mathematics abilities, negative treatment of their peers, teachers and parents, policy makers who focus on "fixing girls" rather than fixing their learning environment. If pedagogy comprises teachers' ideas, beliefs, attitude, knowledge and understanding of their subject and learners, all of which impact on their teaching practices, it is important that teacher trainers including CEMASTEA and principals support teachers to make sure these characteristics have a positive impact on teachers' classroom practice and the progress of their students. What comes out loud and clear from the literature is at as much as the pedagogical approach is important, the role of the principal in the supporting and leading any approach is very crucial to the effective implementation of the approach. The monitoring and evaluation of classroom practice as well as of student progress is extremely important; just as is creating a school culture of achievement.

Principals, deputies and Heads of Mathematics departments, the senior leadership team (SLT) have responsibility for availing teaching and learning resources, leading and managing teaching and learning, as well as monitoring and evaluating learner progress. For an effective and efficient adoption of the ASEI-PDSI approach the SLT must be committed to their responsibilities, the school and all learners. This commitment creates a culture of high attainment of learners and enhances the continuous professional development of teachers. It is essential for the principal to create and lead an effective team to achieve set targets. Teachers' passion for their subject, commitment to the school and the learners, as well as a quest for their own personal development are all important for high levels of adoption of the ASI-PDSI pedagogical approach. These characteristics enable the teacher to be an effective facilitator in the classroom as required by the ASEI-PDSI approach. aS active participants, learners will be able to take control of their own learning, thereby becoming producers rather than consumers of knowledge. They will be able to upload information on their own and become lifelong learners and creators of knowledge.

2.8 Theoretical Framework

The theoretical framework guiding the study is constructivism. According to Gane and Medsker (1996) constructivists assume that knowledge is constructed by learners as they try to make sense of their experiences, and that the resulting internal representations, to be useful, may not correspond to external reality.

Constructivist Theory

According to Jordan, Carlile and Stack (2009), constructivism is a broad group of theories that explain knowledge acquisition and learning. It is based on the idea that knowledge is constructed the knower based on mental activity. Learners are considered to be active organisms seeking meaning. Constructivism is founded on the premise that, reflecting on our experiences, we construct our own understanding of the world consciously we live in. Each of us generates our own "rules" and "mental models," which we use to make sense of our experiences. Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences. Constructions of meaning may initially bear little relationship to reality (as in the naive theories of children), but will become increasing more complex, differentiated and realistic as time goes on. There are several categories of constructivism with each being "points of view", perspectives loosely defined a collection of writings of particular individuals in each case. Trivial, social, and critical constructivism, the categories most relevant to learning and education but critical constructivism is particularly applicable to adult and community education context so the other two are discussed here.

Jordan et al (2009) define trivial constructivism as a common-sense view that knowledge is actively constructed the learner, not acquired through a process of transmission from an external source to the individual or passively received from the environment. People construct mental models or constructs of how things are and these form personal understandings. New constructs formed as a result of new information received are accommodated within existing constructs and the new knowledge is adapted rather than being adopted. In cases where new constructs conflict with old ones, learners become puzzled, causing them to reconsider and reconfigure mental constructs, leading to a richer understanding and improved learning. Learners receive and form constructs differently; this has implications for teaching and learning in that teachers have to be aware that learners bring different mental frameworks to the classroom. However, although constructivism claims that learning is a personal act, it is not to the extent that learning is completely different for every individual. Constructivism is underpinned the belief that we and our mental constructs are more alike than unlike. The principle of trivial has been credited to Jean Piaget, a pioneer of constructivist thought, and Brunner.

Jordan et al, (2009) point to critics who maintain that trivial constructivism reacts against other epistemologies promoting simplistic models of communication as simple transmission of meaning from one person to another. The prior knowledge of the learner is essential to be able to "actively" construct new knowledge. Learning is work - effective learning requires concentration. There are some things you have to learn before others. The education system has always been built on a progression of ideas from simple to complex. Questions arise as to what "the environment" and "knowledge" are, what the relation of knowledge to the ‘environment’ is and what environments are better for learning. Trivial constructivism alone cannot address these issues; other faces of constructivism attempt to address them.

Social Constructivism or Socio-Constructivist Learning Theory

Jordan, Carlile and Stack (2009) define social constructivism or socio-constructivism as a theory which emphasizes the role played in learning culture and social communities which shape the manner in which individuals perceive, interpret and attach meanings to their experiences and forms how and what people think. It is concerned with the impact of collaboration, and negotiation on thinking and learning. A central notion is assisted learning, a concept that is influenced socio-culturalism and its concept of proximal learning. Some also would include situatedness, i.e. interaction with the social and physical context.

The social world of a learner includes the people that directly affect that person, including teachers, friends, students, administrators, and participants in all forms of activities. Accordingly, learning designs should enhance local collaboration and dialogue but also engage other actors (e.g. domain experts) to participate in certain ways. The theory points out that it is possible for people to have shared meanings and understandings that are negotiated through discussion. At the same time, it acknowledges that no two people will have exactly the same discussions with exactly the same people. That means it allows that multiple realities exist. Proponents of social constructivism are Lev Vygotsky and Albert Badura. Vygotsky (1978) who focused on the roles that society plays in the development of an individual. Assisted learning for example, occurs in the now-familiar zone of proximal development (Vygotsky, 1978) where more able others actively scaffold the individual's performance at a level beyond which the individual could perform alone.

Teaching strategies using social constructivism as a referent include teaching in contexts that might be personally meaningful to students, negotiating taken-as-shared meanings with students, class discussion, small-group collaboration, and valuing meaningful activity over correct answers (Wood et al, 1995). Cobb (1994) contrasts the approaches of delivering mathematics as "content" against the technique of fostering the emergence of mathematical ideas from the collective practices of the classroom community. Emphasis is growing on the teacher's use of multiple epistemologies, to maintain dialectic tension between teacher guidance and student-initiated exploration, as well as between social learning and individual learning. Key functionalities of a socio-constructivist learning environment include: reflection and change, scaffolding and story boarding, facilitation and content, monitoring and assessment, production and investigation, psychological support and community.

Proponents of constructivism like Ekland believe that constructivism is the best philosophy of education because it best meets the needs of students. It encourages students in the learning process, and requires students to apply knowledge to new situations. Many educational practices are directly influenced constructivism because it underpins much of what educators do even if they are not aware of it. For example, the current interest in group and project work at educational levels ranging from primary school to university level suggests that shared meaning-making is important for reasons ranging from increased motivation to enhanced task performance. Ekland believes that three types of readiness are required for the success of constructivism, namely, teacher readiness, curriculum readiness and societal readiness.

Jordan, Carlile and Stack (2009) point out that constructivism is primarily a theory about how people learn and they draw many educational implications from the work of key constructivist theorists. These include, the diagnosis of learners' individual learning styles, the identification of learners' strengths or intelligences, curricular practices such as Individual Learning Plans (ILPs), attention to cultural inclusivity, innovative learning and teaching strategies such as problem-based learning, links between community-based learning and formal education and authentic assessment practices, which incorporate learners' views. Discovery, hands-on, experiential, collaboration, project-based and task-based learning are all applications that base teaching and learning on constructivism.

Critics argue that it is still difficult to see constructivist principles acted out in the classroom. Teachers might resist constructivist practices for several reasons including, the use of imposed curricular, the rigidity of which often makes it difficult for teachers to respond to pupils' constructions of knowledge. Teachers are inadequately trained in constructivist teaching and learning, as well as scaffolding strategies; class sizes can make individual appraisals of pupils' progression difficult; teachers may feel or find that classroom discussion is inefficient in facilitating learning; and teachers attempting to apply constructivist principles may have concerns about classroom control and behavior.

To mitigate the negative effects of constructivism it is essential to have an effective and efficient leadership that supports the adoption of the ASEI-PDSI but at the same time encourages flexibility in the use of constructivism. The principals need to be proactive in participating in the SMASSE workshops, providing the resources for mathematics teaching and learning, encouraging mathematics teachers not only to attend the SMASSE INSETs but to facilitate collaboration among teachers in planning, assessment, feedback and sharing good practice. Principals should also make effective use of information on the monitoring and evaluation of the adoption of the ASEI-PDSI approaches and ensure that class sizes are such that individual appraisals of pupils' progression are possible.

The instruments (questionnaires for principals, mathematics teachers and girl learners, observation schedule and focus group discussion) will be used to establish how constructivism is used in the adoption of the ASEI-PDSI in mathematics classrooms in the sample schools. Triangulation of findings from the instruments will be used to achieve this so as to establish the influence of the independent variables (principals' rating of their support for the adoption of the ASEI-PDSI approaches, the extent to which principals and deputy principals attend SMASSE workshops, mathematics teachers' rating of the adoption of the ASEI-PDSI approaches, the extent to which mathematics teachers attend SMASSE INSETs, the level of adoption of the ASEI-PDSI approaches, girl learners' rating of their mathematics teachers' adoption of the ASEI-PDSI approaches and girl learners' attitude towards the ASEI-PDSI techniques used their teachers) on the dependent variable (girls' achievement in KCSE mathematics).

2.9 Conceptual Framework

The conceptual framework for the study is based on Daniel Stufflebeam's Content, Input, Process and Product Model (2003) as in figure 2.5.

Figure 2.5: Components of Stufflebeam's (2003) CIPP Model

Source: (https://ambermazur.wordpress.com/2013/06/10/the-cipp-evaluation-model-a-summary/).

> The model is a decision orientated approach in which programme evaluation is defined as the ' systematic collection of information about the activities , characteristics and outcomes of the programme to make judgements about the programme, improve the programme effectiveness and /or inform decisions about future programming' (Manzur, 2013).

An adaptation of the above model is used in the interrelatedness between the independent and dependent variables as described in figure 2.6. The context or goals are missing because these are not included in the study. In this case the inputs are represented by the independent variables: principals' rating of their support for the adoption of ASEI-PDSI, principals/deputies attendance of SMASSE workshops, mathematics teachers' rating of their adoption of ASEI-PDSI, mathematics teachers' attendance of SMASSE INSETs, researcher's rating of mathematics teachers' adoption of ASEI-PDSI, girls' rating of the adoption of ASI-PDSI by their mathematics teachers and girls' attitude to the adoption of ASEI-PDSI by their mathematics teachers. The process component is represented by the PDSI of ASEI; that is the planning, doing, seeing and improving the activity focus, student centeredness, experimentation and improvisation to obtain the product in the form of the KCSE mathematics mean scores, with the provision of feedback. The study will evaluate the effect of each the independent variables on the dependent variable by rating the adoption of the process.

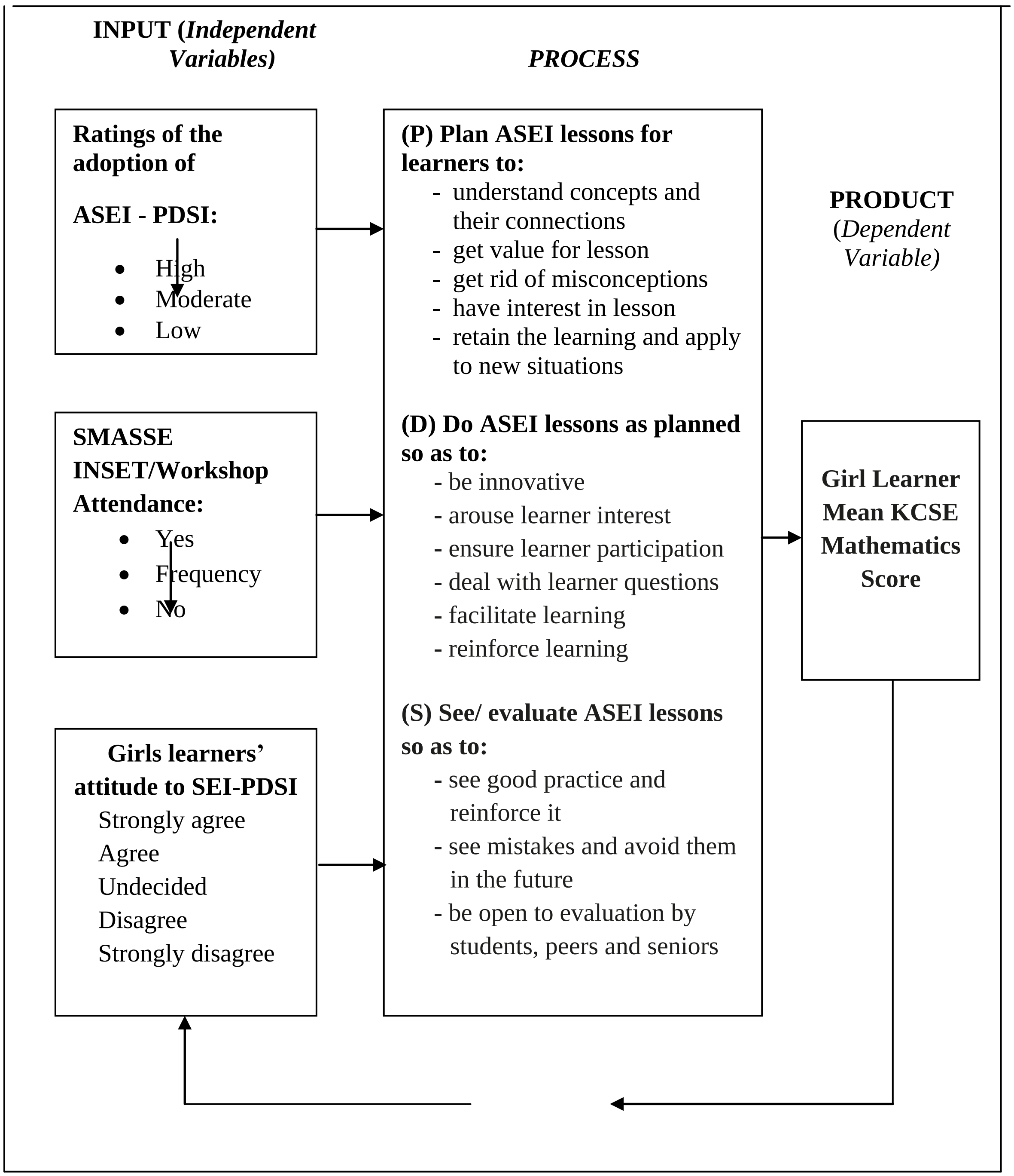

Figure 2.6: Interrelationships among variables – Adapted from Stufflebeam's context, Input, process, and Product (CIPP)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology and the rationale for choice of the method of study. It discusses the research design, the target population, sample size and sampling procedure, the research instruments, validity and reliability of the instruments, data collection procedures and data analysis techniques.

The study investigated the effect of adoption “effect of adoption of SMASSE pedagogy on girls’ mathematics achievement in Nairobi county. Nairobi county and girls were chosen for the study because Nairobi was the only county (out of 47) where for a period (2009-2011) girls out- performed boys in mathematics. However, in 2012 and 2013 the trend was reversed where boys out-performed girls (Table 3.1).

Table 3.1: Girls’ and Boys’ KCSE Mathematics Means Scores in Nairobi County (2009-2013)

2009		**2010**		**2011**		**2012**		**2013**	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
3.46	3.76	3.47	3.90	3.64	4.05	4.15	4.02	4.12	3.95

In the remaining 46 counties, boys consistently outperformed girls (2009-2013) in the major counties (table 1.3).

3.2 Research Design

A research method refers to the techniques that the researcher users to gather information e.g. interview, survey, observation, questionnaire (Nedha (2011) A research method is a general framework guiding a research project. Different methods can be used to tackle different questions (Lee, 2015).

The study adopted a mixed research method. Johnson and Christensen (2012) define mixed research as involving the mixing of quantitative and qualitative methods or other paradigm characteristics. Maina (2014) cites Creswell and Clark (2011) who justified the use of mixed methods because the combination of qualitative and quantitative data provides a more complete understanding of the research problem than either approach by itself. Furthermore, Best and Kahn (2006) points out that qualitative and quantitative research should be viewed as a continuum, and not mutually exclusive dichotomies, reinforces the justification for adopting mixed methods approach.

Both quantitative and qualitative research have strengths and weaknesses as shown in tables 3.2 and 3.3.

Table 3.2: Strengths and Weaknesses of Quantitative Research

Strengths
Useful for testing hypotheses before data is collected
One can generalize research findings when it has been replicated on many different populations and subpopulations
Is useful for obtaining data that allow quantitative predictions to be made
The researcher may construct a situation that eliminates the cofounding influence of many variables, allowing one more credibly to establish cause-and-effect relationships
Data collection using quantitative methods is relatively quick (e.g. questionnaires, telephone interviews)
Provides precise, quantitative, numerical data
Data analysis is relatively less time consuming (using statistical software)
The research results are relatively independent of the researcher (e.g. statistical significance).
Study may have more credibility with many people in power (e.g. administrators, politicians, donors).
Weaknesses
The researcher's categories that are used might not reflect local constituencies' understandings.
The researcher's theories that are used might not reflect local constituencies' understandings.
The researcher might miss out on phenomena occurring because of focus on theory or hypothesis testing rather than on theory or hypothesis generation (called confirmation bias).
Knowledge produced might be too abstract and general for direct application to specific local situations, contexts and individuals.

Source: Adapted from Johnson & Christensen pp 429

Table 3.3: Strengths and Weaknesses of Qualitative Research

Strengths

Data are based on the participants non categories of meaning

One can construct cross-case comparison and analysis

Provides understanding and description of peoples personal experiences of phenomena (i.e. the emic or insider's view point)

Data are usually collected in naturalistic setting

Qualitative data in the words and categories of participants led themselves to exploring how and why phenomena occur.

One can use an important case to demonstrate a phenomenon vividly to the readers of a report.

It is useful for determining idiographic causation (i.e. causes that we see and experience and so on.

Weaknesses

Knowledge produced might not generalize to other people or other settings.

It is difficult to make quantitative predictions

It is more difficult to test hypotheses and theories with large participant pools.

The study might have less credibility with some administrators and commissioners of programs

Data analysis is often time consuming

The results are more easily influenced by the researcher's personal bias and idiosyncrasies.

Source: Adapted from Johnson & Christensen pp 430

Nedha (2011) refers to a research design as the blue print that you prepare using the chosen research method; research design thus tells how goals of a research project can be accomplished. Key features of any research design are methodologies, collection and assignment of samples, collection and analysis of data along with procedures and instruments used. Lee (2015) defines research design as a specific outline detailing how a chosen method will be applied to a particular research question. He points out that choice of research method and design should be thought as a reciprocal process extending well into the study. For example, it may arise over the cause of your study that there is a flow in the design. Changing the design of the study may lead to the choice (or addition) of a different method which, in turn, may lead to subsequent changes to accommodate the new methods.

The study adopted the non-experimental designs ex post facto design and cross sectional survey design. Simon and Goes (2013) define ex post research as an ideal design for conducting social research when it is not possible or acceptable to manipulate the characteristics of human participants. It is a substitute for true experimental research and can be used to test hypotheses about cause-and-effect or correlational relations. Ex post facto design was used in this study to guide the data collection process. This is because the researcher dealt with variables that had already occurred. Apart from the lesson observation by the researcher, the independent variables and dependent variables all took place before the study. The independent variables included the support of SMASSE pedagogy by the principals, attendance of principals/deputies at SMASSE workshops, mathematics teachers' adoption of SMASSE INSETs, girls' review of mathematics teachers' adoption of SMSSE pedagogy and girls' attitude towards the adoption of SMASSE pedagogy. The dependent variable is girls' mathematics achievement (KCSE mathematics mean score 2009 to 2013).

Johnson and Christensen (2012) define cross sectional research as a study where data are collected from research participants at a single point in time or during a single, relatively brief time period (i.e. a period long enough to collect data from all the participants selected to be in the study). The data are typically collected from multiple groups or types of people in cross- sectional research. This design, suits the study because the study cut across the nine districts of Nairobi. The researcher collected data at a particular point in time across the nine districts with the intention of assessing the effects of the independent variables on a dependent variable. The independent variables were principals' rating of their support for the adoption of the SMASSE pedagogy principals' and deputies attendance of SMASSE workshops, mathematics teachers rating of the adoption of SMASSE pedagogy, mathematics teachers' attendance of SMASSE INSETs, researcher's observation of mathematics teachers adoption of SMASSE pedagogy, girls' rating of the adoption of SMASSE pedagogy by their mathematics teachers and girls' attitude towards the adoption of SMASSE pedagogy. The dependent variable was girls' KCSE mathematics achievement (KCSE mathematics mean scores) in Nairobi county.

3.3 Target Population

Johnson and Christensen (2012) define target populations as the larger population to study. For this study, the target population constitutes 57 principals, 241 mathematics teachers and 21,547 girls in 57 public secondary schools in Nairobi County as shown in table 3.1.

Table 3.4: Public Girls' and Mixed Secondary Schools in Nairobi County

District	Girls'/mixed Schools	Number of principals	Number of deputies	Number of Maths teachers	Girls on roll
Kamukunji	3	3	3	15	3, 068
Embakasi	6	6	6	22	1, 768
Njiru	9	9	9	31	1, 360
Kasarani	8	8	8	24	1, 633
Dagoretti	7	7	7	37	3, 139
Langata	4	4	4	15	866
Westlands	6	6	6	33	3, 967
Madaraka	7	7	7	32	2, 678
Starehe	7	7	7	32	3, 068
Totals	57	57	57	241	21,547

3.4 Sample Size and Sampling Techniques

Best and Kahn (2006) define a sample as a small proportion of the population that is selected for observation and analysis. The sample for the study was 22 principals, 22 deputies, 109 mathematics teachers and 11,434 students. Probability and non-probability techniques were used in the study. The non-probability techniques included stratified, quota and purposeful sampling. To achieve a sample of schools, first the quota systems was used to ensure representation from each district and representation of population for girls in each district. Then stratified sampling was done for category of schools namely Mixed Day (MD), Girls Day (GD) or Girls Boarding (GB). The principals and mathematics teachers were purposefully sampled virtue of their role, and form 3 girls were selected for participation because they would have completed 75% of the syllabus unlike forms 1 and 2, and were not busy with KCSE preparations as form 4 girls were. For the focus group discussion (FGD) sample the researcher used lottery method which Crossman (date unknown) defines as the most common way of random sampling. Here, each member or item of the population at hand is assigned a unique number. The numbers are then thoroughly mixed, like if you put them in a bowl or jar and shook it. Then, without looking, the researcher selects *n* numbers. The population members or items that are assigned that number are then included in the sample.

3.5 Data Collection Instruments

Data for the study was collected using questionnaires and observation schedules. Three sets of questionnaires for head teachers, teachers and students were developed the researcher. Items in the questionnaires were designed based on the objectives of the study, and on the literature review. The questionnaires consisted of sections A and B. Section A sought respondents' background information while section B consisted of items in a Likert type addressing the objectives of the study. Lesson observation schedules were used by the researcher as she observed the teaching of mathematics in the classroom. The principals questionnaire was used to obtain the KCSE mathematics mean scores for the period 2009-2013. The researcher obtained this data from the school following exhaustive efforts to obtain it from the Kenya National Examinations Council (KNEC) failed.

3.5.1 Validity of the Instruments

According to Twycross and Shields (2004) validity means a tool measures what it sets out to measure. They refer to internal validity which relates to the overall study with regards to the extent to which the research design is a good test of the hypothesis or is appropriate for the research or objectives. External validity, meanwhile, relates to whether or not research findings can be generalized beyond the immediate study sample and setting. They list measures of validity that provide evidence of the quality of a study, namely content, criterion and construct validity. Twycross and Shield (2004) define content validity as whether a tool appears to others to be measuring what it says it does. Face validity is a form of content validity; it involves the researcher other people to check if the tool covers all the areas. Concurrent and predictive validity are measures of criterion validity and it is measured using correlation coefficient whereby if the correlation coefficient is high the tool is considered valid. Construct validity measures the correlation between tests measuring related areas. A reasonable correlation between tests indicates construct validity. Like criterion validity, construct validity is measured using correlation coefficient.

The researcher used content validity by piloting the instruments and discussing with participants, research assistants as well as peers to give their opinions following which the instruments were revised and used for data collection. Correlation coefficient was used to measure criterion and construct validity of the tools.

3.5.2 Reliability of the Instruments

Mugenda and Mugenda (2008) define reliability as a measure of the degree to which a research instrument yields consistent results or data after repeated trials. They advocate four different methods of assessing reliability namely: - Test-retest, equivalent-form, split-half and internal consistency. The study used test-retest which involved administering the same instruments twice to the same group of subjects with the lapse between the first and the second tests. The disadvantage of this method is that if the time lapse is too short, subjects could be sensitized by the first test and tended to remember their responses during the second testing, which could give rise to an artificially high coefficient. A long time lapse of a year or more could lead to a change of subjects or other extraneous factors that may interfere with variables being measured. The coefficient of stability in this case could be artificially high or low. To address these issues, the researcher used a four week period between the two tests and triangulated instruments to help neutralize artificially high or low coefficients.

To measure the association between variables the researcher used the Pearson's Product Moment Correlation, r (also called the Pearson's r) or the correlation coefficient. Johnson and Christensen (2012) define correlation coefficient as a numerical index that indicates the strength and direction of the relationship between two variables. They describe positive correlation as a situation when two variables tend to move in the same direction. That is when one variable goes up the other variable goes up too and vice versa. A negative correlation on the other hand is a situation when scores on variables tend to move in opposite directions, meaning that when one variable goes up the other goes down and vice versa. According to Healy (2012) the Pearson's r varies from 0.00 to ± 1.0, with 0.00 indicating no association– 1.00 and + 1.00indicating perfect negative and perfect positive relationships, respectively. The researcher established a correlation level of 0.8 for the study, and used this to accept or reject the Null hypothesis. Pearson correlation coefficient for sample data is denoted "r". The formula for Pearson correlation coefficient r is given:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{\left[n \sum x^2 - (\sum x)^2\right]\left[n \sum y^2 - (\sum y)^2\right]}}$$

Equation 3.1

Where

r = Pearson correlation coefficient

x = Values in first set of data

y = Values in second set of data

n = Total number of values or number of paired scores

3.6 Data Collection Procedures

Administration of the research instruments for data collection was done the researcher both at the pre-testing and during the main study. The researcher first obtained a research permit from the National Commission for Science, Technology and Innovation (NACOSTI); a copy was presented to the County Director of Education (Nairobi County) and thereafter to the principals of the sampled schools to request for data collection.

The instruments were piloted in four schools with similar characteristics as those selected for the field work as recommended by Mugenda and Mugenda (2008) for test re-test reliability. They were then revised and re-administered after a four week period for the actual field work in 25 selected schools. The researcher administered the instruments to the selected schools in person. In liaison with various teachers, the researcher collected the teachers' and students' questionnaires on the same day to ensure the highest return rate of questionnaires. This reduced cases of loss of questionnaires and ensured a high return rate. The principals' questionnaires were either collected the same day or by appointment within a few days. In each school questionnaires were administered to the principal, mathematics teachers and form three girls whose lesson was observed. As each school had one principal, he or she was automatically given the principal's questionnaire to complete. However, the number of mathematics teachers and form three girls completing the questionnaires varied according to the size of the school and whether the school was a mixed or single sex girls' school. The number of teachers ranged from 2-6 and that of girls from 10-25.

Focus group discussion (FGD) was used to collect in-depth data relating to the effect of the adoption of ASEI-PDSI on girls' KCSE mathematics achievement in their schools. Though not a research instrument, FGD is a qualitative data collection technique. Rabiee (2004) cites Lederman (in Thomas et al, 1995) who defines FGD as 'a technique involving the use of interviews in which participants are selected because they are purposive, although they may not necessarily be representative sample of a specific population, this group being 'focused' on a given topic. Richardson and Rabiee (2001) maintain that participants in this type of research are therefore selected on the criteria that they would have something to say about the topic, are within the socio-characteristics and would be comfortable talking to the interviewer and each other. Form three girls were selected for the focus group discussion because they have something to say about the adoption of ASEI-PDSI, girls' KCSE mathematics achievement, are within the socio-characteristics as girls who took KCSE mathematics from 2009 to 2013 and would be comfortable talking to the interviewer and each other.\

3.7 Data Analysis Techniques

Correlation coefficient provides an understanding of the relationship between the independent and dependent variables. The correlation coefficient is a numerical index that indicates the strength and direction of the relationship between the variables. Its value ranges from -1, 0 to +1. A positive correlation occurs when the dependent and independent variables move in the same direction, a zero value indicates there are no correlation and a negative correlation means the dependent and independent variables move in opposite directions. Using the design, the researcher collected data at one time and analyzed the findings taking participants as a single group. The researcher collected two scores; that of the adoption of the ASEI-PDSI practice (lesson observation data) and performance (KCSE Mathematics Mean Scores) and established how they relate to each other (Creswell, 2008). KCSE mathematics mean scores are used because they are the most accurate and impartial measure of achievement at the end of secondary education in Kenya. The Mathematics Achievement Tests (MAT) constructed by researchers including those from CEMASTEA, are subjective and do not undergo near enough scrutiny as the KCSE Mathematics papers.

The instruments were administered, collected, validated, edited and coded on daily basis during the field work period. This was to minimize the potential of losing, corrupting or missing information. After field work, quantitative data was analyzed using the Statistical Package for Social Sciences (SPSS) and excel software as follows. Variables were defined and labels created based on questionnaires and observation schedule items. Data were entered in to SPSS variable and data view windows, and output processed using descriptive and inferential statistics. Descriptive statistics was presented in charts, figures and tables as most appropriate and inferential statistics involved testing of hypotheses using a range of statistical tests. Hypotheses dealing with the rating of principals, mathematics teachers and girl learners of the adoption of the ASEI-PDSI pedagogical approaches were analyzed using Pearson's r or chi-square tests because the data is ordinal, continuous and involve naming and ranking. Principals' and mathematics teachers' attendance at SMASSE workshops and INSETs respectively involve ratio measurements, naming, ranking, equal intervals, continuous and has zero point. They are analyzed using Pearson's r, t-test or ANOVA. It is analyzed using Pearson's r, t-test or ANOVA. The outcomes are interpreted and discussed under themes to reflect the objectives of the study.

Quantitative data was organized in frequency counts and converted into percentages and was analyzed using descriptive and inferential statistics. Qualitative data from focus group discussions is discussed using the Miles and Huberman (1994) four step analyses of qualitative data namely, cleaning and coding, summarizing based on themes to make dense of the data. Unlike quantitative analysis, qualitative analysis, particularly focus group interviews, occurs concurrently with data collection. Rabiee (2004) cites Krueger (1994) who suggests that 'a helpful way of thinking about this role is to consider it as a continuum of analysis ranging from mere accumulation of raw data to the interpretation of data. The analysis continuum consists of raw data, descriptive statements, interpretation. Rabiee (2004) also cites Ritchie and Spencer (1994) who refer to a ‘Framework of Analysis’ which is ‘an analytical process which involves a number of distinct though highly interconnected stages. The five stages outlined are: familiarization, identifying a thematic framework, indexing charting and interpreting. The authors further maintain that the other distinctive aspect of framework analysis is that although it uses a thematic approach, it allows themes to develop both from the research questions or objectives and from the narratives of the participants.

The collection and analysis of the qualitative data from the focus group interviews for the study was ongoing with the researcher transcribing the interview notes on daily basis and continually trying to make sense of the data. The data is organized in broad themes to answer the research objectives. Tables, charts and graphs are used to present research findings. Rabiee (2004) points out that ‘analysis of qualitative data requires the development of news kills, but also imagination, patience, time and practice. Developing these skills is a good investment and the rewards are numerous!’

The quantitative and qualitative data are triangulated to give a comprehensive understanding of the research findings which is interpreted, discussed; conclusions drawn, recommendations made and gaps for further research are identified.

3.8 Ethical Considerations

The National Commission for Science, Technology and Innovation (NACOSTI) granted official research authorization upon approval of the research proposal the University of Nairobi. Informed consent was obtained from the principals and mathematics teachers for FGDs for students. Uninformed consent was obtained from the principals to enable the researcher to work with the students, given their legal incapability to grant permission. Anonymity of identity of the participants was upheld.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents an analysis and discussion of data from the field. The chapter presents the questionnaire return rate, demographic data of the respondents and the analysis on the 'Effect of Adoption of Strengthening Mathematics and Science Secondary Education (SMASSE) Pedagogy on Girls' Mathematics Achievement in Nairobi County'.

4.2 Questionnaire Return Rate

Questionnaire return rate is the proportion of the questionnaires returned after administration to the respondents. In this study, questionnaires issued to the sample population of respondents 95.5% principals, 100% of mathematics teachers and 100% girl learners successfully filled and returned the questionnaires. The response rate was high so there was no need for a follow up.

4.3 Demographic Data of the Participants for the Study

4.3.1 Demographic Information of the Principals and Mathematics Teachers

The demographic information of principals and mathematics teachers was based on gender, highest academic qualification and total years of experience.

Table 4.1: Summary of the Demographic Data of the Principals and Mathematics Teachers

		Principals %	Teachers %
Gender	M	20	58
	F	80	42
	Total	100	100
Highest Qualification	MEd	16.7	2.3
	BEd	54.2	48.8
	MSc	8.3	1.2
	PGDE	20.8	16.3
	Diploma	0	25.6
	*ATS	0	5.8
	Total	100	100
Experience in Years	0 – 4	20	29
	5 – 9	40	17
	10 - 14	35	12
	15 +	5	42
	Total	100	100

***ATS = Approved Teacher Status**

Table 4.1 shows that 80 per cent of principals were female while 20 per cent were male. Although this is in contravention of the two-thirds gender rule in the Kenya constitution of 2010 it is a motivating factor for girls who see their principals as role models. The high percentage of female principals means they are more likely to be sensitive to the needs of girls in their schools. Table 4.1 also shows mathematics teacher distribution of 58.0 per cent male and 42.0 per cent female which is in agreement with the two thirds gender rule of Kenya, although it points to a need for more female Mathematics teachers.

Table 4.1 further shows that principals and mathematics teachers are professionally qualified with principals having MEd (16.7%), BEd (54.2%), PGDE (20.8%), MSc (8.3%) and teachers having MEd (2.3%), MSc (1.2%), Diploma (25.6), Approved Teacher Status (ATS, 5.8%), BEd (48.8%) and PGDE (16.3%). This implies that the principals and mathematics teachers are qualified and capable of adopting the ASEI-PDSI approach. However, the high percentage (25.6%) of teachers' diplomas as the highest qualification teaching mathematics in secondary schools is a worrying situation.

Hypothesized distributions of adopter categories within a typical population (figure 2.3) discussed in chapter two can be used to suggest patterns of adoption of the ASEI – PDSI approach by principals and mathematics teachers based on their experience. The concept of adopter categories shows that an innovation goes through a natural predictable and lengthy process before becoming widely adopted within a population. The process involves (i) 'innovators' who readily adopt innovations such as SMASSE or ASEI – PDSI pedagogy, followed by (ii) early adopters, (iii) early majority, (iv)late majority and (v) laggards. The laggards are those who will resist and innovation until the bitter end; they are usually long serving teachers who have been involved with one innovation after another and have adopted their own set practices they think work for them. Table 4.2 presents the principals' and teachers' experience and hypothesized adopter categories.

Table 4.2: Principals', Teachers' Experience and Hypothesized Adopter Categories

Experience (Years)	Principals (%)	Mathematics Teachers (%)	Hypothesized Adopter Category (%)	category
0 - 4	20	29	16	Innovator and early adopters
5 - 9	40	16	34	Early majority adopters
10 - 14	35	10	34	Late majority adopters
15+	5	45	16	Laggards

Principals' experience patterns seem to follow the hypothesized pattern except that the percentage of laggards amongst principals is almost one third (5%) that of the hypothesized (16%). This implies that principals are less likely to resist the adoption of the ASEI –PDSI approach; that is the principals remain positive about ASEI –PDSI throughout the project period.

However, the adoption patterns of the mathematics teachers tell a different story. The teachers show a much higher innovator and early adopter percentage (29%) compared to the hypothesized (16%), very low early and late majority percentages of 16 % and 10 % respectively compared to the 34% hypothesized for both categories. Unfortunately there is a three and half fold increase in the percentage of mathematics teachers in the laggards category compared to the hypothesized value of 16%. This implies that the mathematics teachers who are the implementers of ASEI – PDSI start the adoption of the innovation with enthusiasm but lose stem within five years of practice. A high percentage (45%) of the most experienced of teachers (15+ years) resist the adoption of the innovation to the bitter end. This group of teachers would have been used to the traditional pedagogical approach the ASEI - PDSI approach is supposed to replace and as they say, ‘it is difficult to teach an old dog new tricks’.

For scoring the rating of the adoption, statements are rated high, medium or low based on the highest, medium and lowest score respectively in each row. The scoring is applied for the ratings of adoption by principals, mathematics teachers and the girls who completed questionnaires. For example, all the statements for principals in Table4.3 are rated high because they represent the highest scores for each statement in each row. The tables (4.4, 4.7, 4.8 and 4.10) rating adoptions by principals, mathematics teachers and girls respectively follow the same pattern.

4.4 Principals’ Rating of their Support for the Adoption of the ASEI-PDSI Approach

The purpose of the study was to investigate the effect of adoption of strengthening mathematics and science education (SMASSE) pedagogy or the ASEI-PDSI approach on girls’ mathematics achievement in Nairobi County. The study specifically sought to determine principals’ rating of their support for the adoption of the ASEI – PDSI approach in teaching Mathematics. Principals were asked to rate their support for the adoption of ASEI-PDSI. Their responses are presented in the tables 4.3 and 4.4.

Table 4.3: Principals' High Support for ASEI-PDSI Approach

Statements	Low %	Moderate %	High %
Ensuring adequacy of learning resources	5	20	75
Provision of mathematics teaching resources	25	5	70
Allowing teachers to attend SMASSE INSETs	10.0	20	70
Provision of resources needed	0.0	35	65
Acquisition of resources in advance	5	35	60
Students participate in teaching	5	35	60
Encourage teachers to apply ASEI-PDSI	20	20	60
Providing teachers time to plan lessons	15	35	50

Table 4.3 shows that 50–70 % of principals provided high level of support by ensuring adequacy of learning resources, providing mathematics teaching and learning resources, allowing teachers to attend SMASSE INSETs acquiring teaching and learning materials in advance, encouraging teachers to apply ASEI-PDSI approach and providing teachers time to plan lessons. Table 4.4 shows Principals' moderate and low support for ASEI-PDSI approach.

Table 4.4: Principals' Moderate and Low Support for ASEI-PDSI Approach

Statements	Low	Moderate	High
Holding conferences with teachers	10	50	40
Checking mathematics schemes of work	5	50	40
Checking of students' progress records	5	60	35
Checking of students' exercise books	30	40	30
Discuss implementation of ASEI-PDSI	35	40	25
Meetings to evaluate ASEI-PDSI techniques	50	25	25
Speakers to talk about ASEI-PDSI techniques	50	25	25
Apply ASEI-PDSI techniques	40	40	20
Monitoring the ASEI-PSDI techniques	45	35	20
Checking of ASE Lessons plans	50	40	10
Conducting classroom evaluations	40	55	5

Table 4.4 shows that 40-60% of principals gave moderate support for the ASEI-PDSI approach by holding conferences with teachers, checking mathematics schemes of work, checking students' progress records, checking students' exercise books and discussing the implementation of ASEI-PDSI. The principals show low support in areas of meetings to evaluate ASEI-PDSI, inviting speakers to talk about ASEI-PDSI, applying ASEI-PDSI, monitoring ASEI-PDSI, checking ASEI-PDSI lesson plans and conducting classroom evaluations.

The researcher is aware of the possibility of the principals and mathematics teachers rating themselves high. For this reason their responses will not be used in isolation; other instruments like the students' questionnaire and researcher's lesson observation schedule are used in addition to a focus group discussion with groups of girls. A triangulation of all the data will be used to inform the researcher.

4.5 Principals' and Deputies' Attendance of the SMASSE Workshops

To establish the extent to which principals and their deputies attend SMASSE workshops, they were posed with items that sought the same. Table 4.5 presents principals/deputy principals responses on whether they had attended SMASE workshop. Majority, 94.4% of principals indicated that they had attended SMASE workshop while 5.6% of principals had not yet attended SMASE workshop.

Majority, 83.3% of deputies attended SMASSE workshops while 16.7% were yet to attend the workshops.

Table 4.5: Principals/Deputies' Attendance of SMASE Workshops

	Principals	**Deputy Principals**
Response	**%**	**%**
Yes	94.4	83.3
No	5.6	16.7
Total	100	100

Table 4.6 shows data for schools which had entered candidates for the KCSE for ten years (2004 – 2013).

Table 4.6: KCSE Mathematics Mean Scores for Selected Schools (2004 - 2013)

School	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
01	3.22	2.61	2.11	1.93	1.96	1.62	1.20	1.43	1.54	1.75
02	4.01	3.96	3.69	3.41	3.78	3.11	3.96	3.36	3.41	3.72
03	2.70	3.02	2.83	2.40	2.74	2.51	3.51	2.67	3.15	2.73
04	6.20	5.70	5.50	5.7	5.00	5.00	7.20	6.24	5.72	5.29
05	3.48	3.44	3.96	4.00	3.82	3.91	3.93	4.63	3.42	3.06
06	2.94	2.79	2.91	2.71	2.43	2.09	2.74	2.64	2.50	2.90
07	8.27	8.5	7.74	7.83	7.95	7.96	7.69	8.31	7.70	8.15
08	11.07	10.48	10.41	11.02	10.38	10.96	10.89	10.3	10.24	9.96
09	10.68	10.32	9.45	9.01	8.79	9.71	8.03	7.91	7.89	6.32

The data in Table 4.6 points to poor performance across the schools as only one third of the schools (07, 08, 09) score above average considering a maximum mean score of 12 at the KCSE. Apart from one school, (04), the remaining schools persistently score well below average over the ten year period.

Figure 4.1 shows a graph of the average yearly KCSE mathematics mean scores against the years (2003 -2013).

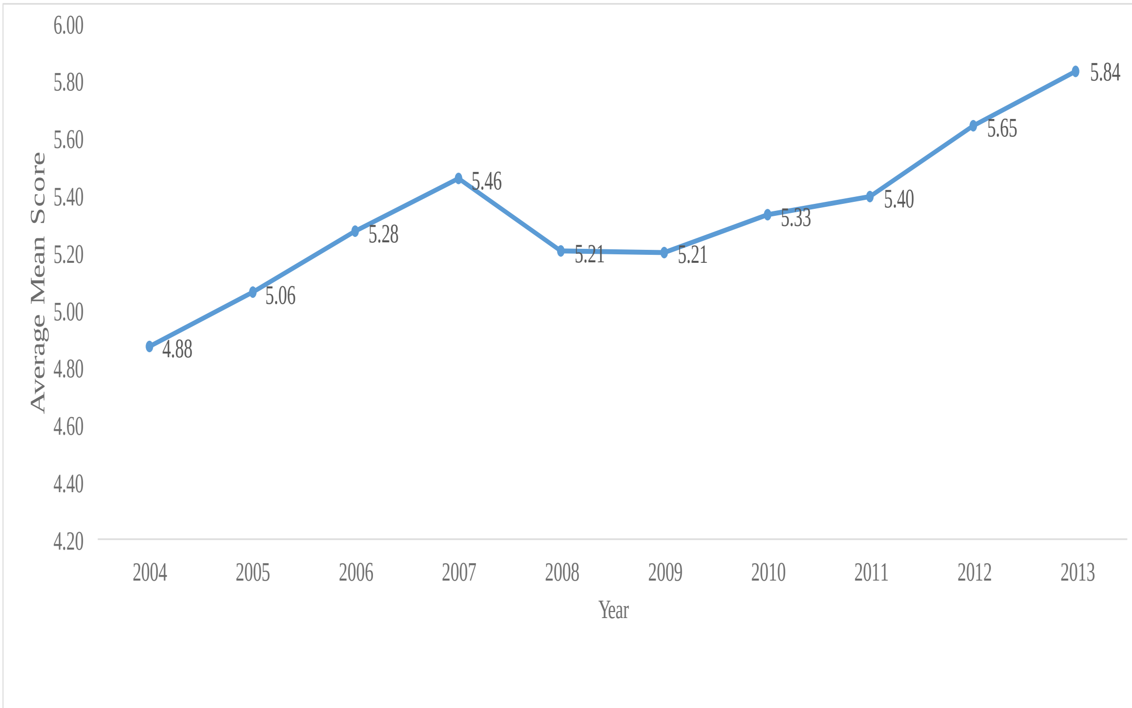

Figure 4.1: Schools KCSE Mathematics Average Mean Scores (2003 -2013)

Data presented in Figure 4.1 show there was increase in average KCSE mathematics mean scores from 4.88 in 2004 to 5.46 in 2007, implying that the ASEI–PDSI approach enhanced teaching and learning leading to the improvement in achievement. However, when the SMASSE project ended in 2008, there was a decline in the KCSE mean scores from 5.46 in 2007 to 5.21 in 2008 and 2009. This could be attributed to the post election violence of 2007 and 2008 which led to the displacement of communities thereby causing disruption to teaching and learning as well as the workshop and INSET attendance of principals/deputies and teachers respectively. Furthermore, the data do not indicate a significant impact of the ASEI –PDSI approach on learners' mathematics achievement over the 10 year period. Considering that the maximum mean score is 12, a maximum score of 5.84 is less than fifty percent (6.0) of the available score.

4.6 Mathematics Teachers' Rating of their Adoption of the ASEI-PDSI Approach

To determine mathematics teachers' rating of their adoption of the ASEI - PDSI approach teachers were asked to respond to items that sought the same. Data is presented in table 4.7.

The data in table 4.7 shows that majority of teachers rated as high their adoption of the ASEI-PDSI approach with regards to inviting questions from students, asking questions to check quality of understanding, keeping eye contact with students to monitor their feelings, ensuring active participation of all students in learning, teaching in a way to arouse the interest and curiosity of learners, giving further guidance to students on lesson activities, interjecting and calling to attention inattentive students, rephrasing questions or instructional statements as necessary, utilizing materials available in students' immediate environment, planning appropriately and realistically.

Table 4.7: Mathematics Teachers' High Adoption of the ASEI-PDSI Approach

Statements	Low %	Moderate %	High %
I invite questions from students	2.8	16.4	80.9
I question to check understanding	2.8	19.2	78.1
I keep eye contact to monitor feelings	5.5	19.2	75.4
Encourage all students to participate	4.1	19.2	76.7
I teach in a way to arouse the interest and curiosity of learners	9.6	27.4	63.0
I give further guidance to students on lesson activities.	5.4	32.9	61.6
I rightly interject and call to attention inattentive students.	6.8	31.5	61.7
I rephrase questions or instructional statements as necessary.	5.5	34.2	60.3
I utilize materials available in the students' immediate environment	8.2	39.7	52.1
My work plan is appropriate and realistic	8.2	41.1	50.7
I deal with students' misconceptions	4.1	46.6	49.3
I adjust lessons appropriately	9.6	43.8	46.6

Table 4.8 shows cases where the adoption of the ASEI-PDSI approach was only moderate or low.

Table 4.8: Mathematics Teachers' Moderate and Low Adoption of the ASEI – PDSI Approach (from Lesson Observation)

Statement	Low %	Moderate %	High %
Learners are given appropriate tasks for discussion	8.2	47.9	43.8
Students are encouraged to use improvised materials effectively	13.7	53.4	32.9
I encourage students to give their prior experiences	21.9	43.8	31.5
Lessons encourage learners to share their experiences	12.4	56.2	31.5
Lessons are activity-focused as practical work is given	6.8	63.0	30.1
I encourage students to give their own predictions	21.9	54.8	23.3
I encourage students to evaluate the lesson	42.5	35.6	1.9

The teachers moderately adopted encouraging students to use improvised materials effectively, encouraging students to give their prior experiences, making lessons activity-focused using practical activities and encouraging students to make their own predictions. However the teachers rated their adoption of the ASEI-PDSI approach as low with regards to encouraging students to evaluate their lessons.

4.7 Mathematics Teachers' Attendance of the SMASSE INSET

To assess the extent to which mathematics teachers attend SMASSE INSETs, they were asked to indicate whether they had attended SMASSE-INSET. Table 4.6 presents the finding.

Table 4.9: Mathematics Teachers' Attendance of the SMASSE INSETs

Response	%
Yes	89.7
No	10.3
Total	100.0

Majority 89.7% of mathematics teachers had attended SMASSE INSETs while 10.3% had not attended the INSET, at the time of the study (July 2014).

Table 4.10: Mathematics Teachers' Attendance per INSET Cycle

Cycles	%
1	17
2	17
3	11.3
4	54.7
Total	100.0

Table 4.10 shows 54.7% of the mathematics teachers had attended all four cycles of SMASSE INSETS, while 17% had attended it only once. Considering that mathematics teachers are keys in the adoption of the SMASSE pedagogy or ASEI-PDSI approach, the percentages attending all four cylces are low for effective or high rate of adoption.

4.8 Mathematics Teachers' Levels of Adoption of the ASEI-PDSI Approach (Based on Lesson Observations)

To assess the extent to which mathematics teachers adopt the ASEI-PDSI approach, the researcher carried out classroom observations of teachers in action. Table 4.8 presents the findings.

Table 4.11: Mathematics Teachers' Moderate Adoption of the ASEI-PDSI Approach

Statements	Low %	Moderate %	High %
Active participation of students	31.0	62.0	7.0
Appropriate tasks given for discussion	28.0	59.0	14.0
Lesson arouse the interest and curiosity of learners	41.0	52.0	7.0
Teacher kept eye contact with students	45.0	52.0	3.0
Students encouraged to give prior experience	48.0	45.0	7.0
Students encouraged to evaluate the lesson	97.0	3.0	0.0
Utilization of materials in the students' environment	79.0	17.0	3.0
Students used improvised materials effectively	83.0	10.0	7.0
Teacher used appropriate materials for students' use	66.0	24.0	10.0
Lesson used learners' prior experiences	55.0	41.0	3.0
Teacher dealt with students' misconception	76.0	21.0	3.0
Lesson encouraged learners to draw conclusions	72.0	21.0	7.0
Teacher summarized lesson and gave follow-up	59.0	31.0	10.0
Teacher checked accuracy and depth of content	59.0	31.0	10.0
Encouraged learners to view content	93.0	7.0	0.0
Teachers took account the individual differences	76.0	24.0	0.0
Teacher was attentive to needs of students	72.0	28.0	0.0
Teacher invited questions from students	72.0	24.0	3.0
Teacher asked questions to check understanding	79.0	21.0	0.0
Overall Average Percentage	63.0	31.0	6.0

The data in table 4.11 for the lessons observed in schools point to low adoption by most teachers in the majority of areas as indicated in table 4.11. There was no evidence of high adoption with regards to encouraging students to evaluate lessons or view content and teachers' attention to individual student needs or individual differences or asking questions to check understanding. The overall average adoption rate was low (63%), medium (31%) and high (6%) as shown in figure 4.2.

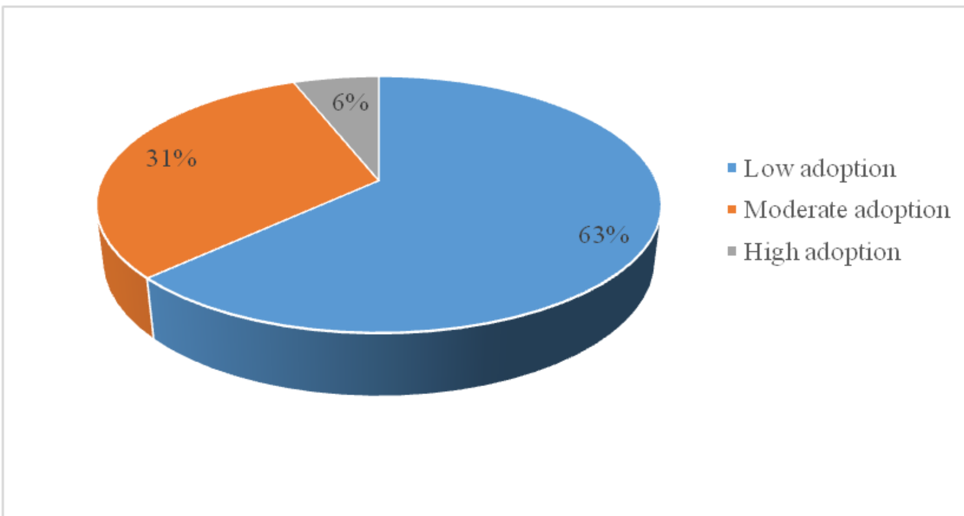

Figure 4.2: Levels of Adoption of the ASEI-PDSI Approach as per Lessons Observed

The findings in figure 4.2 do not support the assertion by principals, mathematics teachers and girls that the adoption of the ASEI-PDSI approach is high in the schools. A possible explanation could be the fact that the participants were reporting on practice over a period where as the researcher was reporting on a one-off lesson observation in each school.

4.9 Girls' Rating of their Mathematics Teachers' Adoption of the ASEI-PDSI Approach

To establish learners' rating of their teachers' adoption of the ASEI – PDSI approach, the researcher broke down the components of the ASEI-PDSI approach and asked students to rate the extent to which they were implemented by their mathematics teachers. The findings are presented in the following section:

Table 4.12: Students' Rating of the Adoption of ASEI-PDSI Approach

Statements	Low %	Moderate %	High %
Likes and Enjoy teaching	6.7	13.8	79.6
Practical/Activities	13.4	27.6	59.0
Marks Assignments	18.6	26.7	54.8
Allow us to present in class	21.9	23.3	54.6
Guidance during practical lessons	17.2	29.5	53.1
Summarizes lessons	21.5	27.6	51.0
Review the previous lesson	22.9	31.0	46.2
Locally Available Materials	26.2	31.9	41.9
Prepared Notes	44.3	17.6	38.1
Field Study	82.8	11.0	6.2

Table 4.12 shows that girl learners rate the adoption of the ASEI-PDSI approach as high with regards to liking and enjoying learning (79.6%), practical activities (59.0%)), marking of assignments (54.8%)), allowing them to make presentations

(54.6%)), guidance during practical lessons (53.1%)) and summarizing the lesson (51.0%)). The learners rate the adoption as low for field study (82.8%)) and prepared notes (44.3%)).

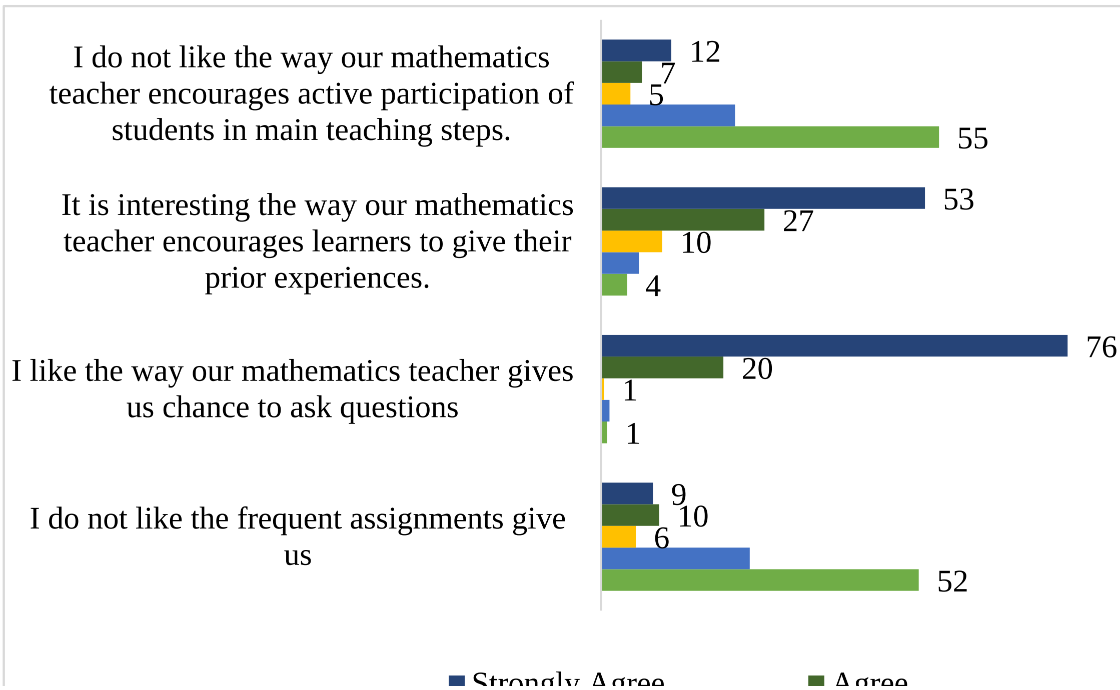

Figure 4.3: Students' Attitude Towards ASEI-PDSI Approach (%)

Data shows that girls strongly agree that they like the way mathematics teachers give them the chance to ask questions (76%) and they find it interesting the way mathematics teachers encourage learners to give their prior experiences (74%). The learners strongly disagree that the learners dislike the way mathematics encourage active participation of students in main teaching steps (55%) and the frequency of assignments teachers give them (52%).

4.10 Girl Learners' Attitude Towards the ASEI-PDSI Techniques used by their Mathematics Teachers in the Classroom

To determine girl learners' attitude towards the ASEI – PDSI approach used by their mathematics teachers, students were posed with items that sought the same.

Table 4.13 presents the results

Table 4.13: Girls' Attitude Towards the ASEI-PDSI Approach

Statements	Strongly disagree %	Dis-agree %	Un-decided %	Agree %	Strongly Agree %
Checking accuracy	6.2	7.6	6.2	17.6	62.4
Encourages us view content	5.2	8.1	6.7	22.9	7.1
Deals with misconceptions	6.2	6.7	10.5	24.8	51.9
Draws conclusions	9.2	7.6	13.3	31.0	39.0
Teacher facilitates skills	44.8	23.3	9.5	11.9	10.5
Doesn't summarizes lesson	46.7	20.5	7.1	18.5	7.1

Data in Table 4.13 show that 44.8% of students strongly disagreed that their teacher facilitates process skills, majority 51.9% of students strongly agreed that their students deals with students' misconception, 39.0% of students strongly agreed that their teachers encourages them to draw conclusions. Data further shows that 46.7% of students strongly disagreed that their teachers doesn't summarizes lesson. Majority, 62.4% of students strongly agreed that their teacher checked accuracy, corrections and depth of content while majority 57.1% of students strongly agreed that their teachers encouraged them to view content.

4.11 Focus Group Discussions (FGD)

In each school a focus group discussion was held with 6- 12 form three girls using a focus group discussion guide (appendix ix).

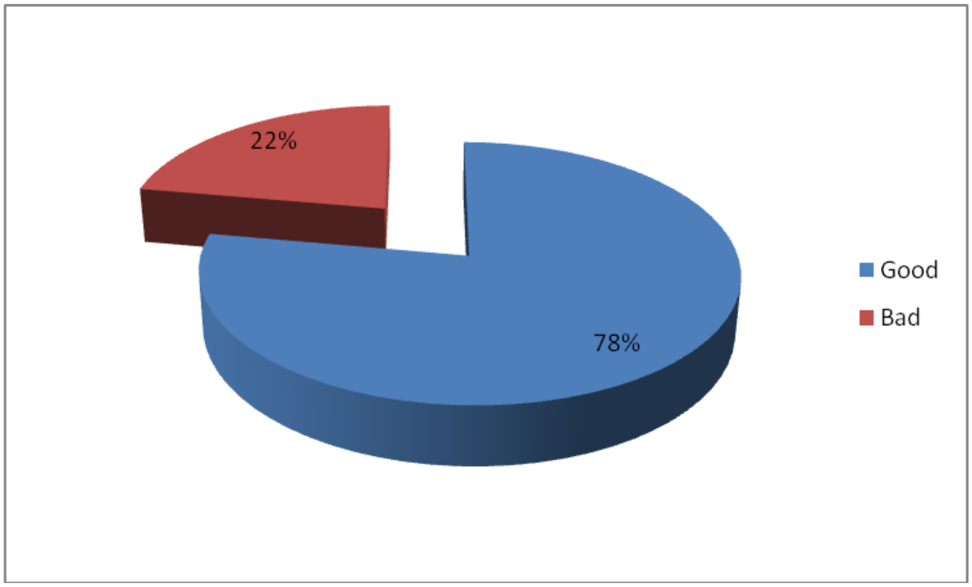

Figure 4.4: Students' Feelings about ASEI-PDSI Approach

Figure 4.4 shows that majority (78%) of girls feel that the ASEI-PDSI approach is good for teaching mathematics. This is supported by the fact that the girls have a positive attitude towards the approach. The girls have also indicated that their teachers' adoption of the approach in teaching them mathematics is high as shown in table 4.12. Only 22 % of the girls think that the approach is bad for teaching mathematics.

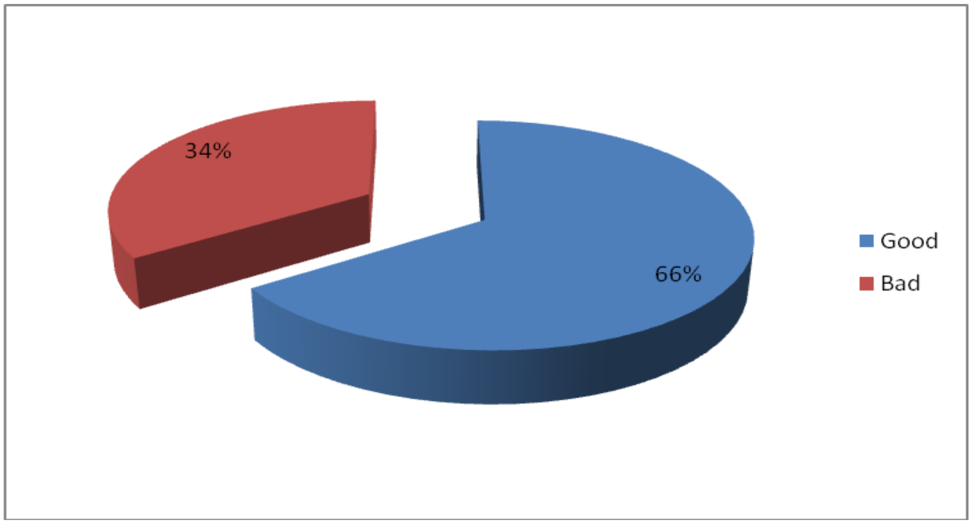

Figure 4.5: Students' Feelings about Learning Activities for Mathematics

According to figure 4.5, two thirds (66%) of the girls are satisfied with the mathematics learning activities provided by their mathematics teachers.

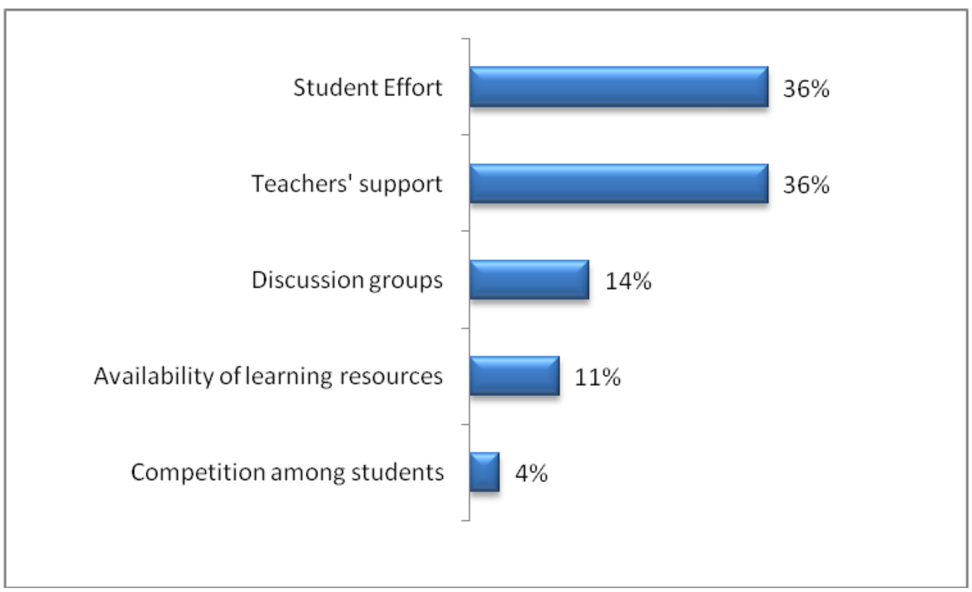

Figure 4.6: Factors that Help Girls do Well in Mathematics

Figure 4.6 shows that student effort and teachers support (36%) are the key contributors to good performance in mathematics for girls. The support is best shown by student centred approach, a key aspect of ASEI.

Figure 4.7 indicates that learner attitude, motivation and availability of resources are the three topmost contributors to hindering learning mathematics. If girls have a negative attitude to the teaching approach or to mathematics, lack motivation or there is shortage of resources, girls' learning is hindered and that leads low achievement in mathematics.

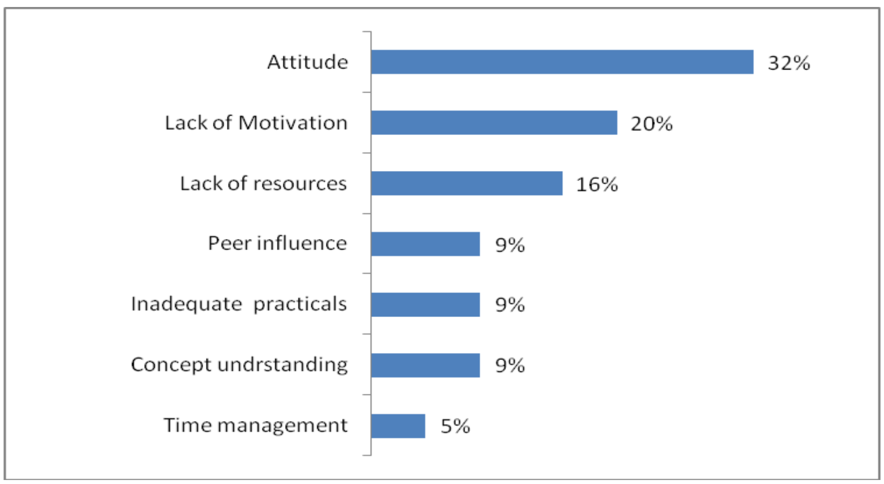

Figure 4.7: Factors that Hinder Girls' Learning in Mathematics

Figure 4.7 points to the fact that a disappointing quarter of girls improve their performance in mathematics in secondary school. The remainder of the girls either performs the same or less as they did in primary schools. This means that for a majority of girls there is no value added to their mathematics performance in secondary school. This is supported by the below average KCSE mathematics mean scores by two-thirds of the schools in table 4.6.

Figure 4.8: Performance in Mathematics since Starting Secondary School

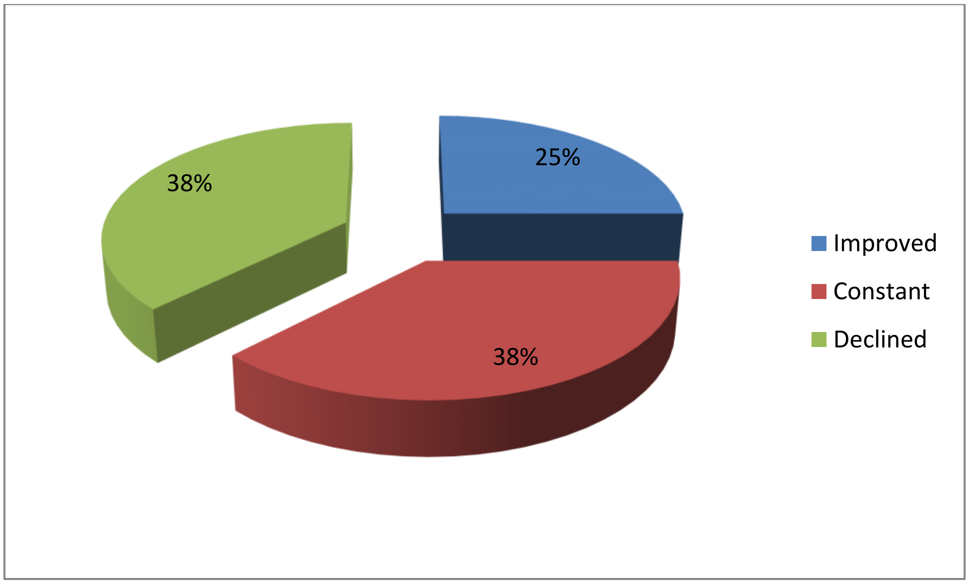

Table 4.14 How Mathematics Teachers Start and End Lessons

Start of lessons:	
Reviewing previous work	18%
Asking questions	18%
Check of assignment	27%
Motivation talk	36%
Total	100
Endings of lessons:	
Ask and allow questions	38%
Gives assignments	25%
Reviews or summarizes the lesson	38%
Total	100

Table 4.14 shows evidence that mathematics teachers make efforts to motivate girls and check their assignments at the start of lessons, as well as ask and allow questions, and summarize lessons at the end of each class. All these are good attributes of the ASEI-PDSI approach and therefore evidence of the adoption of the ASEI-PDSI approach.

4.12 Hypotheses Testing

Lapan, Quartaroli, and Riemer (2012) define hypothesis as a reasoned and research –supported guess about what might cause a result or outcome; a hypothesis can be pre- and post-tested to arrive at a conclusion either proving or disproving the hypothesized effect. According to Johnson and Christensen (2012) hypothesis testing is the branch of inferential statistics that is concerned with how well the sample data support a null hypothesis (Ho) and when the null hypothesis (Ho) can be rejected. The null hypothesis is the hypothesis tested in statistics and the test operates under the assumption that the null hypothesis is true.

There is an alternative hypothesis (H1) which Johnson and Christensen (2012) define as the population parameter which is some value other than the value stated by the null hypothesis (Ho). The alternative hypothesis (H1) asserts the opposite of Ho and usually represents a statement of a difference between means or a relationship between variables. Johnson and Christensen (2012) point out that Ho and H_1 are contradictory because they cannot both be true at the same time. If hypothesis testing allows the researcher to reject Ho, this means that the researcher can tentatively accept H_1.

To measure the association between variables the researcher used the Pearson's Product Moment Correlation, r (also called the Pearson's r) or the correlation coefficient. Johnson and Christensen (2012) define correlation coefficient as a numerical index that indicates the strength and direction of the relationship between two variables. They describe positive correlation as a situation when two variables tend to move in the same direction. That is when one variable goes up the other variable goes up too and vice versa. A negative correlation on the other hand is a situation when scores on variables tend to move in opposite directions, meaning that when one variable goes up the other goes down and vice versa. According to Healy (2012) the Pearson's r varies from -1 to 0 to +1 indicating negative, no and positive relationship respectively. That means a value closer to a -1 indicates a strong inverse relationship and a value closer to +1 indicates a strong direct relationship

Statistical significance is defined by Johnson and Christensen as a claim made when the evidence suggests an observed result was probably not due to chance. It is expressed in terms of probability, where the probability value (p value) is the probability of a research study or more extreme result if the null hypothesis were true. The p value is 0-1, where something happens: rarely if $p \leq 0$, never happens if $p=0$ and always happens if $p \leq 1$. For the study a p value of $p \leq 0.05$ is adopted. That means the researcher wants to be 95 per cent confident that the null hypothesis is wrong before rejecting it; otherwise taking no more than 5 per cent chance of being wrong when rejecting Ho. Significance test is based on 1- or 2-

tailed with the possibility of looking at an effect in one and two directions respectively. The study is looking at the relationships between the dependent variable, girls' KCSE Mathematics mean scores and independent variables namely: principals' rating of their support for the adoption of the SMASSE pedagogy, principals/deputies' attendance of SMASSE workshops, mathematics teachers' rating for the adoption of the SMASSE pedagogy, mathematics teachers' attendance of SMASSE INSETs, girls' rating of the adoption of the SMASSE pedagogy and girls' attitude towards the adoption of the SMASSE pedagogy. The relationship could be in one of two directions, direct or inverse; for this reason 2-tailed significance is used in the hypothesis testing in this study.

H_{01}: There is no significant relationship between principals' rating of support for ASEI- PDSI and girls' achievement in KCSE Mathematics

Table 4.15: Correlation Principals' Rating of Support for the ASEI - PDSI and Girls Achievement in KCSE Mathematics

Principals rating of support for adoption of ASEI-PDSI approach	Girls' KCSE mathematics mean score		
	Pearson Correlation	Sig. (2 tailed)	N
Conducting classroom evaluation	0.052	0.834	19
Holding conferences with teacher(s)	0.153	0.153	20
Provision of resources	0.237	0.029	19
Ensuring adequacy of resources	0.325	0.162	20
Acquisition of materials in advance	0.249	0.289	20
Checking schemes of work	0.096	0.696	19
Checking of ASEI lessons plans	0.521	0.034	18
Checking of students' progress records	0.077	0.754	19
Checking of students' exercise books	0.105	0.670	19
Allowing teachers to attend INSETs	0.002	0.994	20
Making sure that teachers adopt ASEI-PDSI	0.023	0.929	18
Discuss implementation of ASEI-PDSI	0.418	0.532	20
Ensuring students participation	0.137	0.564	20
Making mathematics teachers team teach	0.098	0.681	20
Providing teachers time to plan lessons	0.210	0.388	19
Encouraging teachers to apply ASEI-PDSI	0.795	0.039	20
Holding meeting to evaluate ASEI-PDSI	0.280	0.232	20
Inviting speakers to talk about ASEI-PDSI	0.771	0.004	19
Monitoring the adoption of ASEI-PDSI	0.658	0.022	20

From table 4.15, a Pearson product-moment correlation coefficient was computed to assess the relationship between principals' rating of support for ASEI- PDSI and girls' achievement in KCSE Mathematics. Principals' support for ASEI-PDSI was rated using twenty attributes as shown in the table above. Pearson correlation was conducted to establish if there is a relation between each attribute and girls achievement in KCSE Mathematics as shown in the table above. Most of the attributes had a positive correlation with girls' achievement in KCSE Mathematics. However, they had no statistically significant relationship. Provision of resources, checking of ASEI lessons plans , encouraging teachers to apply ASEI-PDSI, inviting speakers to talk about ASEI-PDSI and monitoring the adoption of ASEI-PDSI had not only positive correlation but had also statistically significant correlation. So, provision of resources, checking of ASEI lessons plans, encouraging teachers to apply ASEI-PDSI, inviting speakers to talk about ASEI-PDSI and monitoring the adoption of ASEI-PDSI increases girls' achievement in KCSE Mathematics. Since, most attributes had a positive correlation but not statistically significant, we fail to reject null hypothesis.

H_{02}: There is no relationship between the attendance of principals and their deputies at SMASSE workshops and girls achievement in KCSE mathematics.

Table 4.16: Correlation between Principals and their Deputies' Attendance to SMASSE Workshops and Girls' KCSE Mathematics Mean Score

		Math's average score
Deputy principal attendance of SMASSE workshop	Pearson Correlation	.522
	Sig. (2-tailed)	.651
	N	15
Principal s' of SMASSE workshop	Pearson Correlation	.598
	Sig. (2-tailed)	.592
	N	17

A Pearson product-moment correlation coefficient was computed to assess the relationship between the extent to which principals and their deputies attend SMASSE workshops and girls achievement in KCSE mathematics. There was a positive correlation between the two variables, r=0.522, n=15, p=0.651 and r=0.598, n=17, p=0.592 for deputy and principals respectively. However, there is not statistical significance correlation between the two variables. We therefore, fail to reject the null hypothesis.

H_{O3}: There is no relationship between mathematics teachers' rating of their adoption of the ASEI and Girls' KCSE mathematics mean scores

Table 4.17: Correlation between Teachers' Rating of their Adoption of the ASEI-PDSI Approach and Girls' KCSE Mathematics Mean Score

Mathematics teachers' rating of their adoption of ASEI-PDSI approach	Girls' KCSE mathematics mean score		
	Pearson Correlation	**Sig. (2 tailed)**	**N**
Lessons are activity focused as practical work is given	0.555	0.034	70
Learners are given appropriate tasks for discussion	0.653	0.013	70
Encourage students to give their prior experiences	0.237	0.029	70
Encourage students to give their own predictions	0.325	0.162	72
Encourage students to evaluate the lesson	0.249	0.029	70
Utilize materials available in the students' immediate environment	0.196	0.011	71
Students are encouraged to use improvised materials	0.521	0.034	72
Teach in a way to arouse the interest and curiosity of learners	0.777	0.004	70
Lessons encourage learners to share their experiences	0.95	0.000	70
Deal with the students' misconceptions and reinforce learning at every step	0.702	0.001	70
Ensure active participation of students in teaching	0.523	0.009	71
Work plan is appropriate and realistic in light of lesson content and students' abilities/interest/skills	0.418	0.532	70
Keep eye contact with students to monitor their feelings	0.137	0.564	70
Invite questions from students'	0.698	0.001	70
Ask questions to check quality of understanding	0.710	0.008	71
Rephrase questions or instructional statements as necessary	0.795	0.039	72
Rightly interject and call to attention inattentive students	0.280	0.232	70
Give further guidance to students on lesson activities	0.771	0.004	72
Make appropriate adjustments in the conduct of the lesson	0.658	0.022	71

The adoption of teachers on the ASEI PDSI was measured using nineteen attributes. From table 4.13, a Pearson product-moment correlation coefficient was computed to assess the relationship between mathematics teachers' adoption of the ASEI –PDSI approach and Girls' KCSE mathematics mean score. Pearson correlation was conducted to establish if there is a relationship between each attribute and girls' achievement in KCSE Mathematics as shown in the table above. Most of the attributes showed a positive correlation with girls' achievement in KCSE Mathematics, which were statistically significant at P=0.05 level of significance. However, encouragement of students to give their own predictions , work plan is appropriate and realistic in light of lesson content and students' abilities/interest/skills , keep eye contact with students to monitor their feelings and rightly interject and call to attention inattentive students had positive correlation with girls' achievement in KCSE Mathematics even though not statistically significantly related. Since, most attributes had a positive correlation with girls' achievement in KCSE Mathematics and are statistically significant relation, we reject null hypothesis.

H_{O4}: There is no relationship between mathematics teachers' attendance at SMASSE INSETs and Girls; KCSE mathematics mean score

Table 4.18: Correlation between Teachers' Attendance of SMASSE-INSETS and Girls' KCSE Mathematics Mean Score

		Math's average score
Teachers' attendance of SMASSE INSETS	Pearson Correlation	.809
	Sig. (2-tailed)	.012
	N	53

A Pearson product-moment correlation coefficient was computed to assess the relationship between the extent to which mathematics teachers attend SMASSE INSETs and girls' achievement in KCSE mathematics. There was a positive correlation between the two variables, r=0.809, n=53, p=0.012.Overall, there was a strong, positive correlation between mathematics teachers attend SMASSE INSETs and girls' achievement in KSCE mathematics. The sig (2-tailed) value is 0.012. This value is less than 0.05. Because of this, we can conclude that there is a statistically significant correlation between the two variables. Increases in the number of times mathematics teachers attend SMASSE INSETs were correlated with increases in girls' achievement in KCSE mathematics. Hence, we reject the null hypothesis.

H_{O5}: There is no relationship between mathematics teachers' adoption of the ASEI and Girls' KCSE mathematics means score.

Table 4.19: Correlation between Mathematics Teachers' Adoption of the ASEI and Girls' KCSE Mathematics Mean Score

Mathematics teachers' rating of their adoption of ASEI-PDSI approach	N =21 Girls' KCSE mathematics mean score Pearson Correlation	 Sig. (2 tailed)
Lessons are activity focused as practical work is given	0.546	0.044
Appropriate tasks for discussion	0.753	0.023
students encourage to give their prior experiences	0.737	0.019
students encourage to evaluate the lesson	0.525	0.002
Utilize materials available in the students' immediate environment	0.549	0.009
Students are encouraged to use improvised materials	0.396	0.011
Teacher prepared appropriate and adequate materials for student use	0.521	0.034
Lesson was stimulating enough to arouse the interest and curiosity of learners	0.977	0.014
Lessons encourage learners to share their experiences	0.85	0.000
Teacher deal with the students' misconceptions and reinforce learning at every step	0.102	0.001
Active participation of students in teaching steps	0.623	0.009
lesson encouraged learners to draw conclusion	0.518	0.032
Teacher summarized lesson and gave follow up activities	0.937	0.004
Teacher checked accuracy , correctness and depth of content through question and answer question and answer	0.898	0.001
lesson encouraged learners to view content in relation to what they come across in the society	0.910	0.000
Teacher conducted lesson taking into account the individual differences in student capability	0.595	0.001
teacher was attentive to needs of students of both low and high academic ability	0.980	0.000
teacher kept eye on students to monitor their feelings	0.671	0.004
teacher invited questions from students	0.558	0.002
teacher asked question to check quality of understanding		

The adoption of teachers on the ASEI PDSI was measured using twenty attributes. From table 4.15, a Pearson product-moment correlation coefficient was computed to assess the relationship between mathematics teachers' adoption of the ASEI –PDSI approach and Girls' KCSE mathematics mean score. Pearson correlation was conducted to establish if there is a relationship between each attribute and girls' achievement in KCSE Mathematics as shown in the table above. All of the attributes showed a positive correlation with girls' achievement in KCSE Mathematics, which were statistically significant at alpha=0.05 level of significance. Since, all attributes had a positive correlation with girls' achievement in KCSE Mathematics and are statistically significant relation, we reject null hypothesis.

H_{O6}: There is no relationship between students' rating of the adoption of the ASEI-PDSI approach and Girls' KCSE mathematics means score

Table 4.20: Correlation between Students' Rating of the Adoption of the ASEI-PDSI Approach and Girls' KCSE Mathematics Mean Score

Students' rating of the adoption of the ASEI-PDSI	N = 211 Girls' KCSE mathematics mean score	
	Pearson Correlation	**Sig. (2 tailed)**
Mathematics teacher starts a lesson by reviewing the previous lesson	0.871	0.014
Mathematics teacher gives us practical /activities to do	0.562	0.010
Mathematics teacher uses locally available materials to teach us mathematics	0.422	0.019
Mathematics teacher uses prepared notes to teach us instead of textbook alone	0.221	0.012
Mathematics teacher guides us during practical lessons	0.836	0.020
Mathematics teacher summarizes what she/he has taught at the end of the lesson	0.756	0.015
Mathematics teacher allows us to present in class activities	0.521	0.014
Mathematics teachers takes us for filed study	0.771	0.134
Mathematics teacher marks our assignments	0.97	0.000
Mathematics teacher likes and enjoys teaching the subject	0.78	0.001

The students' rating of the adoption of ASEI-PDSI was measured using ten attributes as shown in the table above. A Pearson product-moment correlation coefficient was computed to assess the relationship between students' rating of the adoption of the ASEI –PDSI approach and Girls' KCSE mathematics mean score. Pearson correlation was conducted to establish if there is a relationship between each attribute and girls' achievement in KCSE Mathematics. Nearly all of the attributes showed a positive correlation with girls' achievement in KCSE Mathematics, which were statistically significant at alpha=0.05 level of significance. This indicates that as they increase, there is an increase in the girls' achievement in KCSE Mathematics. However, Mathematics teachers' takes us for field study had a positive correlation with girls' achievement in KCSE Mathematics although not statistically significant. Hence, we reject the null hypothesis as almost all the attributes showed a positive statistical significance relationship with girls' achievement in KCSE Mathematics.

H_{O7}: There is no relationship between learners' attitude to the ASEI – PDSI approach and Girls' KCSE mathematics means score

Table 4.21: Correlation between Students' Attitude and Girls' KCSE Mathematics Mean Score

Learners' attitude to the ASEI – PDSI approach	N = 211 Girls' KCSE mathematics mean score	
	Pearson Correlation	Sig. (2 tailed)
Do not like the frequent assignments given to us	0.564	0.034
Like the way our mathematics teacher gives us a chance to ask questions	0.853	0.013
Interesting the way our mathematics teacher encourages learners to give their prior experiences	0.237	0.329
Do not like the way mathematics teacher encourages active participation of students in main teaching steps	0.325	0.002
Interesting the way our mathematics teacher encourages us to give our own observations	0.249	0.129
Not comfortable with the way our mathematics teacher facilitates process skills such as observing and measuring	0.96	0.001
Like the way our mathematics teacher deals with student misconception and reinforces at every step	0.365	0.121
Like the way our mathematics teacher encourages us to draw conclusions	0.521	0.034
Mathematics teacher does not summarize lessons	0.877	0.000
Happy with our mathematics teacher checking accuracy , correctness and depth of content through question and answer technique	0.85	0.001
Like the way our mathematics teacher encourages us to view content relation to what we come across the society	0.702	0.003

Learners' attitude to the ASEI-PDSI approach was measured using eleven attributes as shown in the table above. A Pearson product-moment correlation coefficient was computed to assess the relationship between learners' attitude of the ASEI –PDSI approach and Girls' KCSE mathematics mean score. Pearson correlation was conducted to establish if there is a relationship between each attribute and girls' achievement in KCSE Mathematics. More than two thirds of the attributes showed a positive correlation with girls' achievement in KCSE Mathematics, which were statistically significant at alpha=0.05 level of significance. This indicates that as they increase, there is an increase in the girls' achievement in KCSE Mathematics. However, interesting the way our mathematics teacher encourages learners to give their prior experiences , interesting the way our mathematics teacher encourages us to give our own observations and like the way our mathematics teacher deals with student misconception and reinforces at every step had a positive correlation with girls' achievement in KCSE Mathematics although not statistically significant. Hence, we reject the null hypothesis as almost all the attributes showed a positive statistical significance relationship with girls' achievement in KCSE Mathematics.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter is a summary of the research, stating the summary of the research and its findings, conclusions, recommendations and suggestions for further research into the influence of pedagogy and any other intervention in all secondary school subjects on boys' and girls' achievement if we are to achieve education equality and quality education for all learners.

5.2 Summary

The purpose of the study was to investigate the influence of the ASEI - PDSI pedagogical approaches on girls' achievement in KCSE Mathematics in public secondary schools in Nairobi County. The study was guided by seven research objectives. Research objective one sought to determine principals' rating of their support for the adoption of the ASEI – PDSI approach in teaching Mathematics, research objective two sought to establish the extent to which principals and their deputies attend SMASSE workshops. Research objective three sought to determine mathematics teachers' rating of their adoption of the ASEI - PDSI approaches, research objective four sought to assess the extent to which mathematics teachers attend SMASSE INSETs. Research objective five sought to establish the level of adoption of the ASEI – PDSI approach by mathematics teachers, research objective six sought to establish learners' rating of their teachers' adoption of the ASEI – PDSI approach while research objective seven sought to determine girl learners' attitude towards the ASEI – PDSI approach used their mathematics teachers.

Little research has been conducted in the South which examines the differing impact of classroom factors on learning outcomes for boys and girls. CEMASTEA (2013) did a SMASE Project Impact Survey (SPIAS) 2012, in Secondary Schools in Kenya in which the researchers looked at variables including students participation and achievement in mathematics and science but did not look at it from a gender perspective; an opportunity that was lost. So this study looking at the influence of the ASEI-PDSI approach on girls' achievement in mathematics in public secondary schools in Nairobi County was a step in the right direction.

The research design adopted was Ex post facto and descriptive survey design. This was because the variables were events that had already occurred (the training of mathematics teachers in SMASSE INSETs) and the examination processes for the form four students had occurred for five years from 2009 to 2013). The researcher used static groups because there was no chance to randomize the samples. The target population included 57 secondary schools, 57 principals and 11,084 girl learners. The instruments used for data collection questionnaires and observation schedules. Three sets of questionnaires for head teachers, teachers and students were developed by the researcher. Items in the questionnaires were designed based on the objectives of the study, and on the literature review. The questionnaires consisted of sections A and B. Section A sought for respondents' background information while section B consisted of items in a Likert type addressing the objectives of the study. The class observation schedules were used by the researcher as she observed teaching of mathematics in the classroom. The instruments were administered and collected on the same day, ensuring a high rate of return.

The instruments were administered, collected, validated, edited and coded on daily basis during the field work period. This was to minimize the potential of losing, corrupting or missing information. After field work, quantitative data was analyzed using the Statistical Package for Social Sciences (SPSS) and excel software as follows. Variables were defined and labels created based on questionnaires and observation schedule items. Data were entered in to SPSS variable and data view windows, and output processed using descriptive and inferential statistics. Descriptive statistics was presented in charts, figures and tables as most appropriate and inferential statistics involved testing of hypotheses using a range of statistical tests. Hypotheses dealing with the perceptions of principals, mathematics teachers and girl learners of the adoption of the ASEI-PDSI pedagogical approaches were analyzed using Pearson's r or chi-square tests because the data is ordinal, continuous and involve naming and ranking. Principals' and mathematics teachers' attendance at SMASSE workshops and INSETs respectively are analyzed using Pearson's r, t-test or ANOVA. It is analyzed using Pearson's r, t-test or ANOVA. The outcomes are interpreted and discussed under themes to reflect the objectives of the study. Qualitative data (FGD) is discussed using qualitative data analysis techniques namely, cleaning and coding, summarizing based on themes to make sense of the data. Quantitative and qualitative data is triangulated to draw conclusions from the mixed research methods. Tables, charts and graphs were used to present the research findings for interpretation.

5.3.1 Principals' Support for the ASEI-PDSI Approach

The study found that principals provided high level of support the adoption of ASEI-PDSI pedagogy. Their hypothesized adopter pattern indicates (table 4.2) that they are good adopters of innovation; they adopt the innovation, go along with it and sustain it with very few resisting it (laggards). They provide very good support for the adoption of ASEI-PDSI by making available teaching and learning resources as well as allowing mathematics teachers to attend INSETS. However, they show low levels of support for the approach in terms of monitoring and evaluating the implementation of the approach. The implications of this are that the principals are not able to manage the performance of mathematics teaching and learning to improve girls' KCSE mathematics achievement. They are also unable to ensure the sustainability of the approach and mathematics teachers will revert to their old teaching methods. Hypothesis testing confirms that although there is a positive relationship between principals' support for the adoption of

ASEI-PDSI pedagogy the relationship is not significant enough to influence girls' KCSE mathematics achievement. So there is no relationship between principals' support for the adoption and girls' KCSE mathematics achievement.

5.3.2 Principals'/Deputies' Attendance of SMASSE Workshops

Majority of principals and deputies show a good attendance record for the SMASSE workshops. This means they understand their roles and responsibilities for supporting the adoption of ASEI-PDSI pedagogy. However, having the knowledge does not necessarily translate into support for the approach and enhancement of girls' KCSE mathematics achievement. Specific targets would need to be set for principals to monitor learner achievement by gender, and ensure all learners, but particularly girls achieve well in mathematics. Hypothesis testing shows that although there is a positive relationship between principals' and deputies' attendance of workshops and girls' KCSE mathematics achievement, the relationship is not statistically significant. So principals' and deputies' attendance of SMASSE workshops has no influence on girls' KCSE mathematics achievement.

5.3.3 KCSE Mean Scores for Selected Schools (2009-2013)

KCSE mathematics mean scores for those selected schools which had entered candidates for mathematics for the ten year period (2009-2013) show general improvement in girls' KCSE mathematics achievement from year to year. However, considering that the maximum mean score is 12, less than half of these schools are achieving above average mean score (6) even after ten years of doing the examinations. One third of these schools are still achieving less than thirty percent of the maximum scores with another one third scoring more than seventy five percent of the maximum mean score available.

5.3.4 Mathematics Teachers' Rating of their Adoption of the ASEI-PDSI Approach

Overall, mathematics teachers show a high level of adoption of ASEI-PDSI pedagogy. This may or may not be the case as self –evaluation usually makes individuals rate themselves highly, knowingly or unknowingly. However, mathematics teachers rarely encourage girls to make their own predictions or allow their colleagues or girls to evaluate their lessons. There is a statistically significant relationship between mathematics teachers' rating of their adoption of ASEI-PDSI pedagogy; so their rating of their adoption of the pedagogy has a significant influence on girls' KCSE mathematics achievement.

5.3.5 Mathematics Teachers' Attendance of SMASSE INSETs

Mathematics teachers regularly attend SMASSE INSETs. There is a significant positive relationship between their attendance of the INSETs and girls' KCSE mathematics achievement. Mathematics teachers' attendance of SMASSE INSETs has a significant influence on girls' KCSE mathematics achievement.

5.3.6 Mathematics Teachers' Adoption of the ASEI-PDSI Approach

Data for the lesson observed per school points to low adoption by mathematics teachers. Hypothesis testing shows there is a statistically significant positive relationship between the adoption of ASEI-PDSI and girls' KCSE mathematics achievement. The low adoption does not support mathematics teachers' high rating of their adoption of ASEI-PDSI. A possible explanation for this could be due to the fact that the researcher was reporting on one lesson observation while mathematics teachers were reporting on their practice over a period of time.

5.3.7 Girl Learners' Rating of Teachers' Adoption of the ASEI-PDSI Approach

Girls rate their mathematics teachers' adoption of ASEI-PDSI pedagogy as high. One girl said this:

'I like the teaching of my teacher because he makes everyone understand; the maths teacher gives room for questions from students, teacher's explanation is systematic with emphasis on step by step approach, teacher gives evaluation test at the end of each topic'.

The girls point to active participation in lessons, use of learning materials and a mixture of group work, whole class discussions as their preferred teaching strategies. They like to see collaboration among the teachers, as one student put it, 'team work among the mathematics teachers helps me do well in mathematics, especially when the teachers teach different topics they are good in'.

Hypothesis testing shows a strong positive correlation between girls' rating of their mathematics teachers' adoption of AESI-PDSI and girls' KCSE mathematics achievement. Therefore we can say that girls' rating of their mathematics teachers' adoption of ASEI-PDSI pedagogy has an influence on girls' KCSE mathematics achievement.

5.3.8 Learners' Attitude to the ASEI-PDSI Approach

Girls have a positive attitude towards the ASEI-PDSI approach.

Some girls pointed out during the focus group discussion that positive attitude of the learners (and the teachers) towards the subject and the way it is taught helps them do well in mathematics. However, sometime negative attitude hinders them. One girl said:

'I want to improve in my maths performance but I face the challenge of negative attitude setting in. There is a tendency for one to give up when the subject becomes difficult'.

5.4 Conclusions

The results of the study shows that even though principals rate as high their support for the adoption of the pedagogy and they and the deputies regularly attend the SMASSE workshops their efforts are not producing the necessary effect on girls' KCSE mathematics achievement. This could be due to a host of factors. However, considering that principals rarely evaluate the adoption of the pedagogy, improving the monitoring, evaluation of teaching, learning and assessment as well as target setting will improve girls' KCSE mathematics achievement. CEMASTEA should emphasize this in the principals' workshop sessions. Mathematics teachers' high rating of their support for the adoption and their low adoption of the ASEI-PDSI Pedagogy as well as their good attendance of SMASSE INSETs all have an effect on effect on girls' KCSE mathematics achievement. The low adoption of the pedagogy observed by the researcher may explain why girls' KCSE mathematics mean scores in many schools continue to be below average (mean score 6) despite small improvements over a ten year period (2009-2013). Mathematics teachers need to consider adopting gender responsive pedagogy (GRP) to improve the achievement of all learners, particularly girls, in mathematics in secondary schools long term. Teachers should encourage their colleagues and learners to evaluate their lessons. Girls' rating of their mathematics teachers' adoption of ASEI-PDSI pedagogy and their attitude towards the adoption of the pedagogy have an effect on girls' KCSE mathematics achievement. Mathematics teachers need to help girls not switch off the subject when the subject becomes difficult for them. Teachers need to regularly remind girls about the usefulness of mathematics in their daily lives and its importance in high earning careers. Girls want to achieve well in mathematics but some need a supportive environment that motivates and gives the confidence to do so.

5.5 Recommendations

Based on the findings the following recommendations were made. The ministry of Education should work with FAWE to roll out Gender Responsive Pedagogy across the country. The Kenya Institute of Curriculum Development (KICD) should make decisions regarding how areas covered in the SMASSE INSET could be included in the pre-service teacher curriculum. CEMASTEA should contract external evaluators to independently evaluate the influence of the adoption of ASEI-PDSI pedagogy on boys' and girls' KCSE mathematics achievement in public secondary schools across the country. Teachers and principals should use research findings to improve the adoption of the ASEI-PDSI pedagogy. Mathematics teachers should improve the achievement of learners, particularly girls in KCSE Mathematics long term by adopting gender responsive pedagogy.

5.6 Further Research

The researcher suggests that since the study was conducted in area, similar study to be conducted in other areas and compare the results. The researcher also suggests a comparative analysis of factors, in the West and Africa that influence achievement in mathematics to be conducted.

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APPENDICES

APPENDIX I

LETTER OF INTRODUCTION

University of Nairobi, School of Education

P.O. BOX 30197, NAIROBI

Principal,

…….…………………….Secondary school

Dear Sir/Madam,

RE: RESEARCH ON INFLUENCE OF ASEI - PDSI PEDAGOGICAL TECHNIQUES ON GIRLS' KCSE MATHEMATICS PERFORMANCE IN NAIROBI COUNTY, KENYA

I am a post graduate student from the University of Nairobi pursuing a PhD Degree in Curriculum Studies. I am conducting research on "influence of ASEI - PDSI pedagogical techniques on girls' KCSE mathematics performance in Nairobi County, Kenya". Your school has been selected to participate in this study. I am kindly requesting your assistance in collection of data for the purpose of this study. The study is purely for academic purposes hence the anonymity of the respondents will highly be respected.

Thank you in advance

Yours faithfully

Aminata Sessay

APPENDIX II

QUESTIONNAIRE FOR SCHOOL PRINCIPALS

This is a study that seeks to assess the “influence of ASEI - PDSI pedagogical techniques on girls’ KCSE mathematics performance in Nairobi County, Kenya”. You have been selected to participate in this study. I will appreciate it if you could take your time to respond to this questionnaire. Your honest response to the questions will be highly appreciated. Thank you for taking your time.

Section A: Background Information

What is your gender? Male [ ] Female [ ]

What is your highest academic qualification? ------------------------------

What is your total headship experience? -------------------------------- (years)

Section B: Support for the adoption of the ASEI-PDSI Approaches

Please rate your frequency of doing the following to support the ASEI-PDSI approaches ticking the correct box.

Key: 1 =High 2 = Moderate 1= Low

SN	Statements	3	2	1
1	Conducting classroom evaluations of mathematics lessons			
2	Holding of individual conferences with mathematics teacher(s)			
3	Provision of mathematics teaching resources			

4	Ensuring adequacy of learning resources			
5	Acquisition of teaching and learning materials in advance			
6	Checking mathematics schemes of work			
7	Checking of ASEI lesson plans			
8	Checking of students' progress records			
9	Checking of students' exercise books			
10	Encouraging teachers to attend SMASSE INSETs			
11	Making sure that teachers adopt ASEI-PDSI techniques			
12	Discussing with teachers the adoption of ASEI-PDSI techniques			
13	Ensuring that students participate in the teaching and learning process			
14	Making mathematics teachers team teach regularly			
15	Providing teachers time to plan lessons			
16	Encouraging teachers to apply the ASEI-PDSI techniques			
17	Holding meetings to evaluate the ASEI-PDSI techniques			
18	Inviting speakers to talk about ASEI-PDSI techniques			
19	Monitoring the adoption of the ASEI-PDSI techniques			

20 a) Have you attended the SMASSE workshops for principals? Yes---/No -----

b) If yes, how many times have you attended? ----------

21a) has your deputy attended the SMASSE workshops for deputies? Yes --/No –

b) If yes, how many times have he / she attended? -----------

22) What is the NOR in your school? _______ Boys ________ girls

23 what has been the KCSE Mathematics mean score in your school in the last 10 years or since you started the exam?

Year	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
Mathematics KCSE Mean Scores										

APPENDIX III

QUESTIONNAIRE FOR THE MATHEMATICS TEACHERS

This is a study that seeks to assess the "influence of ASEI - PDSI pedagogical techniques on girls' KCSE mathematics performance in Nairobi County, Kenya". You have been selected to participate in this study. I will appreciate it if you could take your time to respond to this questionnaire. Your honest response to the questions will be appreciated. Thank you for taking your time.

Section A: Background Information

What is your gender? Male [ ] Female [ ]

What is your highest academic qualification? --------------------------

What is your total teaching experience? -------------------------- (years)

Section B: Adoption of the ASEI-PDSI Approaches

Please rate your frequency of doing the following in the teaching of mathematics

Key: 1 =High 2 = Moderate 1= Low

S/N	Statements	3	2	1
1	Lessons are activity-focused as practical work is given			
2	Learners are given appropriate tasks for discussion			
3	I encourage students to give their prior experiences			
4	I encourage students to give their own predictions			
5	I encourage students to evaluate the lesson			
6	I utilize materials available in the students' immediate environment			
7	Students are encouraged to use improvised materials effectively			

8	I teach in a way to arouse the interest and curiosity of learners			
9	Lessons encourage learners to share their experiences			
10	I deal with students' misconceptions and reinforce learning at every step			
11	I ensure active participation of students in teaching			
12	My work plan is appropriate and realistic in light of lesson content and students' abilities/interest/skills.			
13	I keep eye contact with students to monitor their feelings			
14	I invite questions from students.			
15	I ask questions to check quality of understanding.			
16	I rephrase questions or instructional statements as necessary.			
17	I rightly interject and call to attention inattentive students.			
18	I give further guidance to students on lesson activities.			
19	I make appropriate adjustments in the conduct of the lesson.			

20 a) Have you attended the SMASSE INSETs for Mathematics teachers?

Yes ---/ No ---

b) If yes, which cycles did you attend?

1) – 2) --- 3) --- 4) -----

APPENDIX IV

QUESTIONNAIRE FOR THE STUDENTS

This is a study that seeks to assess the “influence of ASEI - PDSI pedagogical techniques on girls’ KCSE mathematics performance in Nairobi County, Kenya”. You have been selected to participate in this study. I will appreciate it if you could take your time to respond to this questionnaire. Your honest response to this questionnaire will make this study a success. Thank you for taking your time.

Section A: Adoption of the ASEI-PDSI Approaches

Please rate the following on the frequency during teaching of mathematics

Key: 1 =High 2 = Moderate 1= Low

SN	Statements	3	2	1
1	Our mathematics teacher starts a lesson reviewing the previous lesson			
2	He/she gives us practical/ activities to do			
3	He/she uses locally available materials to teach us mathematics			
4	He/she uses prepared notes to teach us instead of textbook alone			
5	He/she guides us during practical lessons			
6	He/she summarizes what she or he has taught at the end of the lesson			
7	He/she allows us to present in class activities.			
8	He/she takes us for a field study			
9	He/she marks our assignments			
10	He/she likes and enjoy teaching the subject			

Section B: Attitude towards ASEI-PDSI techniques

In a scale of 1 to 5 where 5 is strongly agree and 1 is strongly disagree, indicate the extent to which you agree or disagree with the following statements

Key: 5=strongly agree; 4=Agree; 3=Undecided; 2=Disagree; 1=strongly disagree

	Attitude towards ASEI-PDSI techniques	5	4	3	2	1
11	I do not like the frequent assignments give us					
12	I like the way our mathematics teacher gives us chance to ask questions					
13	It is interesting the way our mathematics teacher encourages learners to give their prior experiences.					
14	I do not like the way our mathematics teacher encourages active participation of students in main teaching steps					
15	It is interesting the way our mathematics teacher encourages us to give our own observations					
16	I am not comfortable with the way our mathematics teacher facilitates process skills					
17	I like the way our mathematics teacher deals with students' misconceptions and reinforces learning					
18	I like the way our mathematics on encourages us to draw our own conclusions					
19	Our mathematics does not summarize lessons					
20	I am happy with our m checking accuracy, correctness and depth of content through question and answer technique					
21	I like the way our mathematics teacher encourages us to view content in relation to what we come across in the society.					

APPENDIX V

OBSERVATION SCHEDULE

School Code…………… Class………………….. Date of observation…………..

No of Students….. „„„ Duration of Lesson …………… (Mins)

Key: 1 =High 2 = Moderate 1= Low

S/N	**Activity**	**3**	**2**	**1**
1	Lesson was activity-focused as practical work was given			
2	Appropriate tasks were given for discussion			
3	Students were effectively encouraged to give their prior experiences.			
4	Students were effectively encouraged to evaluate the lesson.			
5	Utilization of materials available in the students' immediate environment.			
6	Students were able to use improvised materials effectively			
7	Teacher prepared appropriate and adequate materials for students' use.			
8	Lesson was stimulating enough to arouse the interest and curiosity of learners			
9	Lesson encouraged learners to give their prior experiences.			
10	Teacher dealt with students' misconceptions and reinforced learning at every step.			
11	Active participation of students in main teaching steps.			
12	Lesson encouraged learners to draw conclusions			

13	Teacher summarized lesson and gave follow-up activities.			
14	Teacher checked accuracy, correctness and depth of content through question and answer technique			
15	Lesson encouraged learners to view content in relation to what they come across in the society.			
16	Teacher conducted lesson taking into account the individual differences in student capability.			
17	Teacher was attentive to needs of students of both low and high academic ability.			
18	Teacher kept eye on students to monitor their feelings.			
19	Teacher invited questions from students.			
20	Teacher asked questions to check quality of understanding.			

APPENDIX VI

K.C.S.E Mathematics Mean Scores for selected Schools (2004 - 2013)

School	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
1001	3.22	2.61	2.11	1.93	1.96	1.62	1.20	1.43	1.54	1.75
1002	1.40	2.13	------	------	------	------	------	------	------	------
1003	4.01	3.96	3.69	3.41	3.78	3.11	3.96	3.36	3.41	3.72
1004	1.81	1.93	------	------	------	------	------	------	------	------
1005	2.70	3.02	2.83	2.40	2.74	2.51	3.51	2.67	3.15	2.73
1006	3.20	2.64	3.06	------	------	------	------	------	------	------
1007	7.60	7.80	7.60	7.40	7.40	6.80	------	------	------	------
1008	6.20	5.70	5.50	5.70	5.00	5.00	7.20	6.24	5.72	5.29
1009	3.48	3.44	3.96	4.00	3.82	3.91	3.93	4.63	3.42	3.06
1010	4.41	3.67	4.10	------	------	------	------	------	------	------
1011	3.71	3.40	2.74	1.84	2.08	2.10	------	------	------	------
1012	3.10	------	------	------	------	------	------	------	------	------
1013	4.78	4.33	4.18	------	------	------	------	------	------	------
1014	2.94	2.79	2.91	2.71	2.43	2.09	2.74	2.64	2.50	2.90
1014	3.85	3.87	4.10	3.90	3.75	------	------	------	------	------
1016	8.27	8.50	7.74	7.83	7.95	7.96	7.69	8.31	7.70	8.15
1017	11.07	10.48	10.41	11.02	10.38	10.96	10.89	10.30	10.24	9.96
1018	10.68	10.32	9.45	9.01	8.79	9.71	8.03	7.91	7.89	6.32
1019	3.82	3.31	4.24	4.64	------	------	------	------	------	------
1020	3.50	3.70	3.10	------	------	------	------	------	------	------

APPENDIX VII

List of Sample Schools

District / Schools	School Type	Girls on roll
Kamukunji District		
1001	MD	224
1002	GB	350
1003	GD	235
Embakasi District		
2001	GB	320
2002	MD	370
Njiru District		
3001	MD	353
Kasarani District		
4001	MD	1750
4002	GB	439
Dagoretti District		
5001	MD	175
5002	GB	581
5003	GB	1004
Langata District		
6001	MD	351
Westlands District		
7001	MD	155
7002	GB	596
7003	GB	978
7004	GB	1100
Makadara District		
8001	GB	790
8002	GD	357
8003	MD	146
Starehe District		
9001	MD	127
9002	GD	211
9003	GB	822
TOTAL	**22**	**11,434**

APPENDIX VIII

ASEI Lesson Plan Recommended by CEMASTEA

Topic: ....

Subtopic: ....

Class:..........Duration: .... Rationale:..

Objectives: ....

Prerequisite skills and knowledge: ....

Teaching/Learning Resources: ....

Stage/Time	Teaching /learning activities	Learning points	Remarks
Introduction			
Lesson Development			
Summary/Conclusion/ Evaluation			

References: ....

STUDENT WORKSHEET

APPENDIX IX

Focus Group DISCUSSION SCHEDULE FOR FORM THREE GIRLS

Welcome!

Greetings! My name is Aminata Sessay, a research student at the University of Nairobi. I am investigating the 'Effect of Adoption Strengthening of Mathematics and Science Secondary Education (SMASSE) Pedagogy on Girls' Mathematics Achievement in Nairobi County, Kenya'. The information I gather will be used for academic purposes only. I kindly ask you to give me 30 minutes of your time to answer some questions about the teaching and learning in your school.

I have already obtained permission from your principal for you to participate in the discussions. However, if you do not wish to participate, you will be allowed to leave. I would like each of you to talk; I may call on you if you have not spoken. There is no right or wrong answers to the questions I ask so feel free to express your views and let us allow one person to speak at a time.

Name of interviewer: ______________________Date of interview____________

School Code:____

How do you feel about the:

Teaching approach of mathematics in your school?

Learning activities for mathematics?

How many teachers have you had for mathematics since form 3?

Describe one of:-

(i) Your best mathematics lesson in form 2 or 3. ii) Why was it the best?

(i) Your worst mathematics lesson in form 2 or 3. (ii) Why was it the worst?

(a) What helps you do well in mathematics?

(b) What hinders you do well in mathematics?

(a) How has your performance in mathematics changed since you started secondary school? (b) What contributed the most to this change?

(a) Which gender of mathematics teachers do you prefer? (b) Why is that?

How do the resources used to teach mathematics help your understanding of mathematics?

How does your mathematics teacher;-

Start the lesson? b) End the lesson?

How often do you work;-i) on your own? ii) in small groups?

iii) as a whole class?

Which of these techniques (above) helps you most in learning mathematics?

Which of the above techniques does your teacher use the most?

Is there anything else about your learning of mathematics that you wish to share?