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Effect of ASEI-PDSI SMASSE Approach to Teaching on Mathematics Learning Outcomes in Secondary Schools in Kenya

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Abstract: ***Mathematics being one of the subjects given a lot of emphasis in the Kenyan school curriculum; it is deemed a determinant subject when it comes to helping Kenya as a developing country to achieve its dream of being a better economy by the year 2030. Performance and attainment in this subject is deemed crucial for students' admission to scientific and technological professions in higher institutions of learning. Every single learner is encouraged to work really hard in order to obtain good grades in mathematics, as a surety to entry into the most competitive professions in our society. However, performance in this subject has remained low despite deliberate efforts made by the government through the Strengthening of Mathematics and Science in Secondary Education (SMASSE) in-service training programmes. The purpose of this study was to investigate the effectiveness of the SMASSE approaches to teaching on the students' learning outcomes in secondary mathematics in Mt. Elgon Sub-county of Bungoma County in Kenya, in an effort to improve performance in the subject.A Quasi-Experimental research design was adopted. The study sample consisted of 10 teachers ofmathematics and 450 form three students drawn from 10 secondary schools and one Quality Assurance and Standards Officer. Both qualitative and quantitative data were collected and analyzed through both descriptive and inferential statistics. The findings of this study showed that the SMASSE approaches to teaching had a positive effect on mathematics learning outcomes. The study provides a basis for repackaging the pre-service teacher training programmes and encourages increased attendance of in-service courses to enlighten teachers on better teaching techniques for better learning outcomes in secondary mathematics in Kenya.***

Keywords: ASEI-PDSI SMASSE Approach, Mathematics Learning Outcomes, Students' Attainment

1. Introduction

Mathematical skills are an essential component to any child's education in the world today. In Kenya, parents, teachers and many stakeholders in education have put a lot of emphasis on children learning mathematics, and this implies that the subject is deemed crucial in achieving the general objectives of education. It is a compulsory subject in both the primary and secondary curricula. The Kenya Institute of Curriculum Development (KICD) has outlined the objectives of teaching this subject at secondary level as; enabling learners to acquire knowledge and skills for further education and training, to appreciate the role, value and use of mathematics in the society, to identify, concretize, symbolize, and use mathematical relationships in everyday life (KICD, 2014). Such thinking has led to a widespread interest to ensure good performance in the subject at all levels of learning. One principle that facilitates good teaching and learning of mathematics is effective classroom interaction, which can be achieved through involvement of both the teacher and the learners in a variety of learning activities. This calls for good lesson planning and presentation of the content in the classroom.

However, many countries, Kenya included,face a major problem of poor performance in mathematics at all levels of learning, yet it is a crucial subject component in many professions that the youth would like to engage with. There has been a wide spread interest to improve the level of mathematics performance across many countries in the African continent. Even the world wide drive for "Education for All" lays a lot of emphasis on basic education and literacy in science, mathematics and technology as a necessity (UNESCO 2005).

The Kenyan government has been making great effort to ensure better performance in the subject at both basic and tertiary levels; for instance through the Strengthening of Mathematics and Science in Secondary Education (SMASSE) programs and also through encouraging a lot of research in the subject aimed at finding strategies to improve the learning and performance in mathematics. Establishing factors that may improve performance has been an area of interest.Consequently, the research done on secondary mathematics in Kenya has revealed that the poor performance is largely due to factors like; students' poor attitude towards the subject, poor teaching skills, lack of and ineffective use of teaching and learning resources, gender disparities and problems of access (JICA, 2013; Bunyi, 2004; Wambui 2005). Such research findings continue to be disseminated to the teachers through the SMASSE training sessions to sensitize teachers on better ways of teaching and learning mathematics in schools for improved performance in the subject. However, some counties still post dismal performance in the subject as compared to others as evidenced by the Kenya National Examination Council (KNEC) yearly reports (KNEC 2014, 2015, 2016 and 2017).

2. Literature Review

The major aim of the SMASSE project has been to capacity built the teachers of science and mathematics, with the hope of improving understanding of concepts and performance in these subjects through In-Service Education and Training (INSET) sessions for teachers with an innovative approach (JICA 2013).The INSET Curriculum was developed to strengthen teacher competence by addressing such areas of concern as: teacher and learner attitudes, appropriate

pedagogy, good mastery of content, developing teaching / learning materials as well as effective administration and management strategies. Specifically, the project was aimed at improving the trainee's ability and skills in resource management, teaching approaches and strategies as well as brings about positive change towards mathematics and science among the teachers and the students.

An Activity, Student-centered, Experiment and Improvisation- Plan, Do, See and Improve (ASEI-PDSI) approach to teaching was therefore proposed and adopted in nine piloting districts but later this was extended to all districts in Kenya.The ASEI approach is anchored on five basic tenets and endeavor's to shift teaching and learning from, namely; knowledge-based teaching to activity-focused teaching (Talk and chalk to hands-on), teacher-centered teaching to student-centered learning, lecture method or theoretical approach to experiments or research-based approach to learning, recipe type large scale experiments to scaled-down experiments and involving use of improvisations, even with locally available materials. This innovative approach essentially demands well planned learning activities and also calls for a high level of creativity (CEMESTEA, 2011).See Figure 1 below:

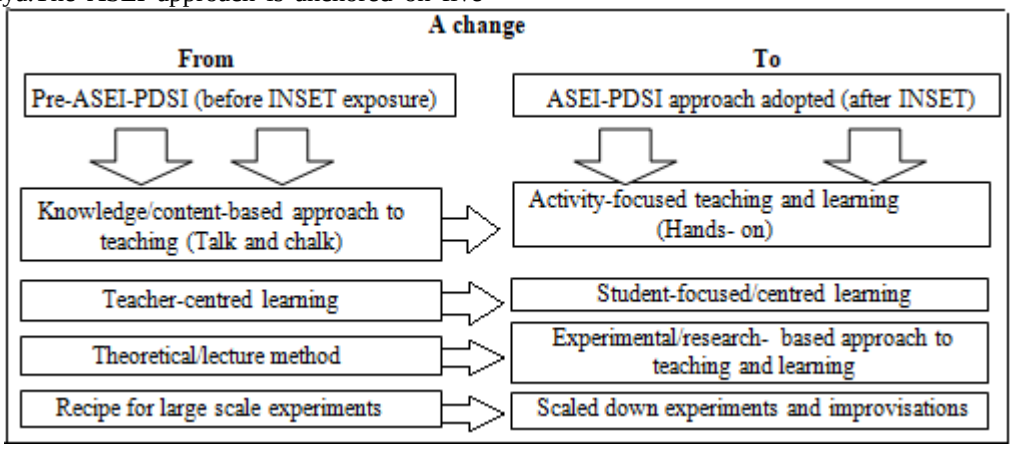

Figure 1: ASEI-PDSI paradigm shift
Source: Adopted from JICA report (2013)

The PDSI strategy aims at enabling the teachers of mathematics to effectively practice ASEI procedures at the classroom level, and as such, important aspects of effective lesson delivery such as work planning and evaluation are given due consideration. In Planning, the teacher is expected to prepare the teaching plans like schemes of work and lesson plans as well as lesson notes, and trying out the teaching-learning activities and materials before the lesson to ensure learners will be able to understand the concepts well.

To Do; the teacher is expected to present the lesson in the most innovative way ensuring active learner participation. Teachers are encouraged to; teach lessons in more captivating and innovative ways to arouse learners' interest e.g. through role play and storytelling, ensuring active learner participation, being able to facilitate the teaching-learning activities, dealing with students' questions and misconceptions, and also reinforcing learning at each step (Wambui, 2005). In Seeing; the teacher gets involved in evaluating the teaching-learning process during and after the lesson using various techniques and feedback from the learners in order to ensure learners understand concepts clearly before others are introduced. Teachers also invite their colleagues into their classrooms to observe their lessons and offer some reactions. This approach enables teachers to; understand the good practices in the lesson and strengthen them; and also see mistakes made in earlier lesson, and avoid earlier mistakes in future lessons.

Finally the teacher is expected to address aspects of Improving his/her teaching by reflecting on the self-evaluation reports and performance by learners in any exercises or tests given. The teacher reflects on the lesson performance, self-evaluation reports and his/her effectiveness in achieving the lesson objectives. The teacher makes use of such information in planning the next lesson to enhance good performance and student learning.The kind of reforms expected out of these attempts and practices include; a positive change in attitude towards mathematics by both teachers and students, teachers to be able to apply more effective teaching approaches, teachers to have a better mastery of content, teachers to develop effective teaching - learning resources and also lead to better administration and management in schools. In essence, the students should become active participants in the learning process while the teacher carefully guides the process of learning; thereby leading to more meaningful learning activities in the mathematics classrooms (JICA, 2013).The ASEI-PDSI approach is thus regarded a student-centred approach to learning, characterised by; active learner participation, emphasis on deep learning and understanding of concepts as well as the teacher valuing and supporting verbal and non-verbal interactions. It is hoped to equip teachers of mathematics and science with better teaching skills for effective classroom practices, believing that the battle against poor performance in mathematics and science must be won in the classroom. The approach is based on the premise that learners learn better when involved in the doing, through discussions, experiments and other activities, hence the emphasis on taking the learners as the central focus of learning. This is in recognition of the fact that for a long time teaching in schools has predominantly been traditional; where the teacher has been the centre of the learning process.

Various researchers have examined the impact of using the SMASSE training program in Kenyan schools. Anyango (2012) found that the SMASSE training for teachers contributed to better teaching and understanding of mathematics topics and concepts by their learners and to a more significant extent, teachers of mathematics benefited from SMASSE training by sharing experiences amongst themselves. The study further found that teachers of mathematics conceptualized the child-centered approach as presented during SMASSE training. The study concluded that SMASSE training impacted positively on the teaching of mathematics and that the most effective teaching methods are the child-centered approaches using locally improvised teaching materials.Little is known about how teachers of mathematics in Mt. Elgon sub-county adapt to these approaches and whether they really attend these INSET sessions and utilize what they learn.

There seems to be aspects of the ASEI-PDSI approach to teaching that have not been well implemented resulting in its inefficiency. Situational findings by CEMESTEA (2009) also indicate a weak practice of ASEI-PDSI approach in the classroom, despite the MOE's heavy investment in the same. Use of appropriate classroom interaction patterns happens to be a fundamental factor in the success of any mathematics lesson activity and achievement of the lesson objectives, as they are likely to reflect aspects of the ASEI-PDSI approach to teaching that has been widely advocated in the SMASSE projects. Minimal study has been done to establish the extent to which teachers of mathematics effectively utilize aspects of the ASEI-PDSI approach in their teaching for better performance. It is against this background that this study was conducted to investigate into the adoption of the ASEI-PDSI strategies to teachingand its effect on secondary school mathematics learning outcomes.

The objective of this study therefore was to establish the effect of the ASEI-PDSI approach on mathematics learning outcomes between those exposed and those not exposed to these SMASSE approaches among selected secondary schools in Mt. Elgon sub-county.This was to help confirm true or otherwise a null hypothesis that; an exposure to the ASEI-PDSI approach to teaching hadno significant effect on secondary school mathematics learning outcomes.

3. Methodology

The study adopted a Quasi-experimental research design. The researcher randomly assigns subjects to the experimental and control groups then exposes both groups to a pre-test to establish if they differ significantly before being exposed to the study. The experimental group further undergoes treatment; the group was exposed to the ASEI-PDSI approach to teaching mathematics. The researcher then measured the differences between the two groups on the students' secondary school mathematics learning outcomes.The teachers of this group were encouraged to plan for their teaching and teach as planned as well as evaluate their learning to establish whether a change in behavior had occurred. They were also required to involve learners in many relevant activities as they also adopted improvisation where learning materials are limited. The control group was taught using the normal classroom practices that had been used before the onset of this study and the teachers of this group were not manipulated; they were not sensitized on the need to adopt the ASEI-PDSI approach in their teaching. All the groups were then given a post-test for comparison purposes among them. See Figure 2 below.

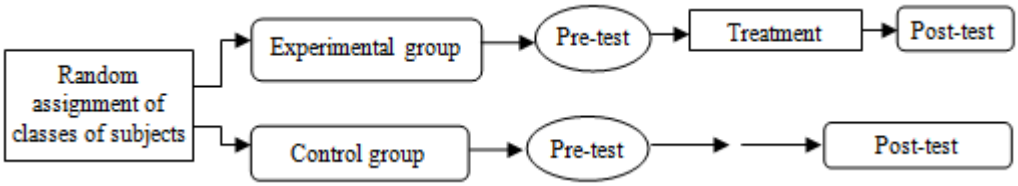

Figure 2: Procedure for a quasi-experimental research design
Source: Adopted from Patidar (2013)

A sample of 10 schools, 450 students, 10 teachers of mathematics and one Quality Assurance and Standards Officer participated in the study, giving a total of 461 respondents. Data was collected by use of Students' achievement tests, a Classroom Observation Schedule (COS) and questionnaires for teachers of mathematics. The Pearson product moment correlation coefficient (Pearson r) was applied on the instruments to help establish their reliability. Both qualitative and quantitative data were collected and therefore data analysis was done using descriptiveand inferential statistics. Means and standard deviations were calculated then a t-test applied on the quantitative data, while the qualitative data was analyzed thematically. All this was aimed at evaluating a null hypothesis (H_o) that:an exposure to the ASEI-PDSI approach to teaching has no significant effect on secondary school mathematics learning outcomes in Mt. Elgon sub-county.

4. Results and Discussion

Learners from both the experimental and control groups were exposed to a pre-test and a post-test. The post-test was administered after the experimental group was given some treatment. The preliminary findings from the pre-test revealed that the difference in mean performance (-0.0876) between the two cohorts was not statistically significant due to a lower t-value and a higher p-value, as shown in Table 1 below.

Table 1: Difference in Mean gain between Pre-Test and Post-Test

	Control group (N=214)		Experimental group (N=216)		Difference in Means	T-value	P-value
	Mean	Standard Deviation	Mean	Standard Deviation			
Pre-test	1.5198	0.0866	1.6074	0.0972	0.0876	0.6747	0.2501
Post-test	2.1111	0.0914	3.1635	0.1186	1.0524	7.1293	0.0000
Mean Gain	0.5913		1.5561				

Table 1 above also shows the results of differences in the learning outcomes between the two groups after exposure to the ASEI-PSDI approach; as a treatment, in the classroom. Based on the results, the experimental group that had been exposed to the ASEI-PDSI approach had a higher mean in performance (3.1635) compared to the control group who were not exposed to the approach (2.1111). The difference in the mean performance between the two cohorts (-1.0524) was statistically significant at 1% ($p<0.001$). This is represented by a high t-value (7.1293) and lower p-value (0.000). The results reveal that those students exposed to the ASEI-PSDI approach performed better or had higher learning outcomes in Mathematics as compared to those who had not. The study therefore rejects the null hypothesis (H_o) that there is no statistical significant difference in mathematics learning outcomes between those students exposed to ASEI-PSDI approach and the control group and adopts the alternative hypothesis of significant difference.

The mean gain was quite high and significant for the experimental group (1.5561) than it was for the control group (0.5913) as seen in Table 1. The most probable reason for this occurrence is that adoption and utilization of the ASEI-PSDI strategies promotes learner involvement and participation in the lesson and in the learning of mathematics. These strategies encourage a lot of interaction between the teacher and the learners, and even among learners themselves.

The teachers in the experimental class involved learners in many learning activities including discussion in pairs, learners working out sums on the chalk board, making use of available learning resources, marking books and making corrections on the chalkboard, giving assignments, etc. Such teachers displayed improvement in their planning and lesson delivery activities, unlike those in the control group. Lesson introduction, development and conclusion activities were well coordinated. The lessons turned out to be as lively as these teachers adopted the learner-centred approaches to teaching. Learners in the experimental classes enjoyed the lessons. Some the reasons that these students gave for enjoying mathematics lessons included; the teacher explaining the content till they understood, the teacher being cheerful during the lesson, learners being given a chance to work out the sum on the chalkboard, learners being allowed to discuss and work out sums in groups and learners being congratulated by the teacher for getting the sums correct. This meant that their teachers encouraged participatory learning; doing, illustrating, discussing, sharing etc.

This result corroborates to other research findings. For instance, Nkwalume (2005) pointed out that the more 'real', alive' and 'accessible' lessons, will never be realized in our classrooms without adequate interaction in the classroom between the teacher and the students and among students themselves. The results are also in agreement with the survey results done by the SMASSEteam in 1998 that revealed that consistent failure in mathematics continue to characterize the secondary mathematics classrooms in Kenya due to factors like the teacher-centered, boring lessons and lack of effective use of the teaching-learning resources by teachers in their lesson presentations. The ASEI-PDSI approach essentially demands well planned learning activities well in advance and also calls for a high level of creativity (CEMESTEA 2011) and these teachers of mathematics must just therefore adopt and effectively implement such aspects in their teaching for better learning outcomes in secondary mathematics.The findings of this study revealed that adoption of the ASEI-PDSI strategies in teaching mathematics had a significant positive effect on the students' learning outcomes. The null hypothesis was therefore rejected

5. Conclusion

From the findings above, it is evident that effective adoption and implementation of aspects of the ASEI-PDSI approach to teaching mathematics leads to better learning outcomes in secondary mathematics. The experimental group that was sensitized inclusion of the ASEI-PDSI aspects in teaching produced higher learning outcomes in the post-test as compared to the control group classes that were taught using the usual approaches by their teachers. The SMASSE approach to teaching mathematics helps to yield better learning outcomes in secondary school mathematics in Mt. Elgon sub-county. Therefore teachers should embrace these ideas from SMASSE and use them in class for better learning outcomes.

6. Recommendations

This study recommends that;

1) The government to continue investing in more teachers to attend the SMASSE training sessions.
2) The subject quality assurance and standards officers, heads of subjects in mathematics and school managers to be more vigilant in monitoring implementation of the ASEI-PDSI aspects in teaching mathematics in the classroom by having regular sessions with the teachers of mathematics in the classroom.
3) Pre-service training programs to be enriched to include more aspects of the ASEI-PDSI approach to teaching mathematics so that our grandaunts are able to implement it easily in their teaching.

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