The Influence of the ASEI-PDSI approach on Students' views and attitudes towards mathematics instruction

Jackson Khayati Mwelese[1], Joseph Ombofu Atwoto[2]
1. Science and Mathematics Education, Masinde Muliro University of Science and Technology. P.O. Box 190 – 50100 Kakamega, Kenya.
2. School of Education, Moi University, Eldoret, Kenya
*mwelesejackson@gmail.com

Abstract

This study examined the effect of the ASEI-PDSI approach in the teaching and learning of mathematics in selected secondary schools in Vihiga County, Kenya. Two research objectives the study sought to achieve were : (i) to determine the effects of the ASEI – PDSI approach on students' achievement in mathematics, and (ii) to determine the effect of ASEI-PDSI approach on students' views and attitudes towards the learning and teaching of mathematics. The study was based on the information processing theoretical construct. According to this theory, the learner during instruction is involved in active information processing that engages him/her to directly attend to the stimulus conditions and using his thought processes acts and reacts to the information. The approach embraces the three principles of active learning; hands-on activities, minds-on and mouths-on activities. Questionnaires, interview schedules and video recordings were used to collect information from the subjects. In the study, a total of 152 subjects were randomly assigned to four groups. The study was a true experimental research design based on Solomon Four-Fold design. The purpose of the study was to investigate the effect of using the ASEI-PDSI approach on form one secondary school students' views and attitudes in mathematics and their subsequent achievement. Students perform poorly in topics that require 'doing practical work' like constructions and drawing. As a result, this study used Basic Geometric Constructions to test students awareness and familiarity with the hands-on, minds-on and mouths-on activities. The control group was kept under a control condition by providing traditional competitive situation in class while the experimental group was provided with the ASEI-PDSI approach as treatment. The academic achievement of the control and experimental groups was examined through a post-test. In the experimental groups, one group was pretested, treated then post-tested while the other one was only treated then post-tested. In the control groups, one group was pretested then post-tested while the other one was only post-tested. The findings showed that the ASEI-PDSI had a significant effect on students' achievement. It was found out that students taught through the ASEI-PDSI approach had a better view and attitude towards mathematics than those taught through the traditional approaches. The study recommends that teachers should apply the ASEI-PDSI approach in their teaching to help students be actively involved in the lesson to have a better understanding and interest in the subject.

Keywords: ASEI-PDSI approach, Activity, Instruction, Attitude and Hands-on.

1.1 Introduction

What views do form one secondary school students hold regarding the teaching of mathematics when they join secondary school? In what ways are these affected by an instructional approach that involves the students into active participation? Are they sensitive to differences between teacher-centred and student-centred approaches? How does that influence their learning experiences? These were some of the questions that we regarded as potentially interesting to this study. Mathematics is one of the many subjects in the school curriculum. However, there is greater pressure for children to succeed in mathematics than in many other subjects in the school curriculum. The importance of mathematics is expressed in the Cockroft Report (1982, p1), which observes:

> There is no doubt that there is general agreement that every child should study Mathematics at school; indeed the study of Mathematics together with English is regarded by most people as being essential.

The importance of mathematics to the child and society can be viewed from many perspectives. For many it is seen in terms of arithmetic skills which are needed for use in everyday life situations e.g. at home, office and the workshop. Others view mathematics as the foundation for further studies and the basis of scientific and modern technology. Due to the overall importance in various aspects of life, mathematics is a basic requirement for the study of several other subjects in higher institutions of learning and even in several employment sectors. Therefore mathematics being a service subject has some influence in future courses or employment opportunities of students. Poor performance in the subject implies that a large number of students are being examined for purposes of selection for further studies and employment opportunities where they may not excel.

However, in-spite of its importance, performance in mathematics has not been impressive. This has led to a general perception in some quarters that the teaching of mathematics at secondary school level has not to date made sufficient effort to deal with the backgrounds and needs of present day students. Parents, teachers, politicians, educators, and the general public have expressed a lot of concern about the poor performance in mathematics. Kiragu (1986, p1) asserts that:

> Despite national efforts made in developing a curriculum that is appropriate to the needs of this country, coupled with teacher training efforts, performance in secondary school examinations has been relatively poor over the last ten or so years and particularly in mathematics.

Prof. Christine Mango the Member of Parliament for Butula (1987) while addressing parliament in Kenya called for a probe into the teaching and learning of mathematics due to the poor performance of students in the national examinations. Despite the concerns raised and efforts made to improve results in mathematics, performance in the subject has continued to be poor over the years. Most students transit from primary schools to secondary schools with very good grades in mathematics. This continues never to be the case as they progress in their secondary school learning. The formidable problem currently facing mathematics education in Kenya is the need to improve the student's performance in mathematics. This study was concerned with a wide range of issues, including the nature of the innovation process and the perceptions of the participating teachers (see Ponte et al., 1991). In this paper we focus particularly on the views and attitudes held by the form one students about teaching and learning mathematics.

1.1.1 The ASEI-PDSI approach

The ASEI-PDSI Approach is home-grown strategy to promote learner-centred pedagogy among Kenyan teachers. We will explore in greater depth learner-centred pedagogy. ASEI, which stands for Activity, Student, Experiment and Improvisation embodies efforts to encourage a paradigm shift from teacher-centred to learner centred pedagogy. On the other hand PDSI which stands for Plan, Do, See and Improve encourages the culture of continuous improvement. ASEI-PDSI Approach therefore encourages learner-centred pedagogy whose essence is emhasis on the learner learning rather than the teacher teaching. As Shuell (1986) aptly put it: "Without taking away from the important role played by the teacher, it is helpful to remember that what the student does is actually more important in determining what is learnt than what the teacher does (p.429)".

The goal of teaching is to make students learn. The methods used in the instruction and the materials used should ensure the easy practice of learning. According to constructivism, learners construct their own knowledge. The teacher's role therefore is to create a conducive atmosphere of learning and facilitate this process to assist learners make the required progress. However, both research and anecdotal evidence show that in spite of its benefits majority of teachers rarelly do this.

1.2 The purpose of the study

One of the subjects that is performed well at the Kenya Certificate of Primary Education (KCPE) is mathematics. This is the most preferred subject by many students as they join form one for their secondary education. The same students do not perform equally well in the subject at the Kenya Certificate of Secondary Education (KCSE), after four years. The purpose of this study was therefore to investigate the effect of the ASEI-PDSI approach on form one secondary school students' views and attitudes towards mathematics teaching and learning.

1.3 Research hypotheses

HO_1 : There is no significant difference in students'view and attitude in mathematics teaching and learning when students are exposed to the ASEI-PDSI approach and when not exposed.

HO_2 : There is no significant difference in students' achievement in mathematics when form one students are exposed to the ASEI-PDSI approach of learning and when they are not.

2.0 Methodology and design

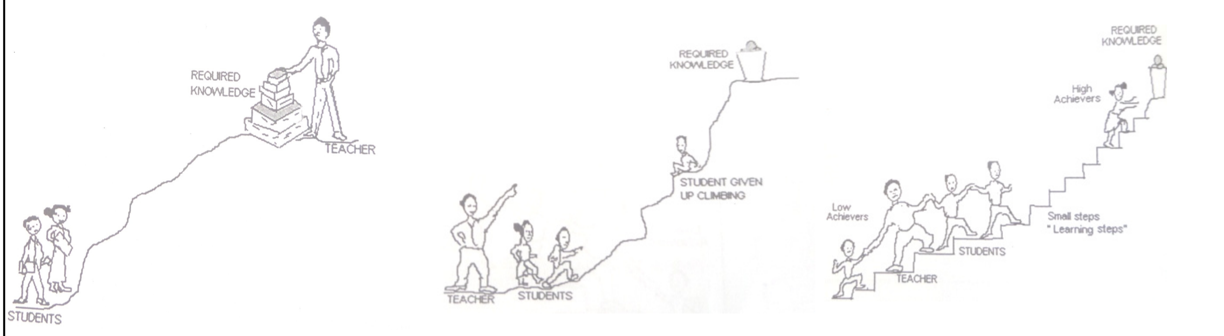
The study had three main phases. The first phase, preparation, included the formulation of research questions, the planning of field work (with the elaboration of interview and observation guides and of criteria for selection of informants), the outline of the final report, and a first contact with the field. The second phase included the conduction of field work and the third was devoted to writing the research report. The methodological approach and the field activities were strongly influenced by an interpretive conception of educational research, as described in Goetz and LeCompte (1984), Merriam (1988), and Patton (1987).

A detailed plan of activities was designed from the earlier beginning. It specified the actions to be carried out, the responsibilities of each of the members of the research team, and the approximate completion dates. In that respect, many of the suggestions regarding the design of a case study provided by Yin (1989) were taken into consideration. Data was collected for this study through interviews (which were audio-taped and later transcribed), observations, achievement tests and documental analysis. A number of people was interviewed, including teachers, administrators, Ministry officials and nineteen students, who were interviewed in groups. Each group had at least two boys and two girls and two high and two low achieving students. The selection, based in these criteria, was made jointly by the teachers and the researchers. Observations were also made of classes and of other school activities. Documental analysis was made of the text of the new curricula, the materials produced by the Ministry and by the teachers, the reports of the accompanying teachers, and other school documents.

3.1 Results

3.1.1 Student-centred pedagogy

Empowering learners to take control of their learning has been found to lead to improved retention and faster coverage of the syllubus (SMASSE Project, 2007). It is for this reason that this paper is intended to help teachers understand how to effectively put the learner at the centre of the learning process



(a) (b) (c)

Figure 1: Student-centred pedagogy
Source: SMASSE National Inset, CEMASTEA, Nairobi Kenya, 2014

Figure 1 shows the action taken by a variety of teachers of mathematics whenever they want to pass their content (knowledge) to their students during classroom instruction (Figure 1 (a)). Some teachers were identified forcing their information to the students. In such situations, some students without knowing the teacher's intentions would shy off and develop a negative attitude, thus impacting negatively on their understanding. In other instances, like in Figure 1 (b), the teacher would make reasonable attempt to help the students get the knowledge. However, the teacher only shows them the way to the knowledge but this does not guarantee the students the knowledge. In this case, it's only the bright students who struggle to get to the knowledge that appears to be very far from them. This approach does not encourage meaningful learning. In Figure 1 (c), this teacher realises that he has to walk the journey with students, helping them along the way. He is able to get the bright ones going as he encourages them on while at the same time moving with the low achievers towards acquiring the same knowledge. This approach left all the students feeling happy about learning.

3.1.2 The performance trend in mathematics at the KCPE level

The first objective of this study was to determine if there is any significant difference in students'views and attitudes in mathematics teaching and learning when students are exposed to the ASEI-PDSI approach and when not exposed. We did an analysis of their entry behaviour by giving them the KCPE mathematics paper to do as a pretest before subjecting them to any form of instruction. The table below shows the results of the pretest.

Table 1: Achievement on the Pretest (KCPE)

SCHOOL TYPE	GROUP	MEAN MARK (%) IN KCPE
A	Control 1 Experimental 1	48.38 45.34
B	Control 2 Experimental 2	45.33 48.49

The two groups' performance did not show any significant difference. Table 1 below shows the respective means scores in the pretest.

We compared the pretest and posttests of their arithmetic means and standard deviations of the Mathematics Achievement Tests (MAT) and then applied t-tests for independent samples to check whether the difference between the groups was meaningful. The comparisons of the means and standard deviations of the various groups were done. In each group, an average of the two post-tests was determined to reflect the students' overall ability and avoid any bias of the test. The second post-test was used to indicate the level of retention of the learnt information under the ASEI-PDSI approach over a period of time for both the control and experimental groups. There were 38 students in each group giving a total of 76 students.

Table 2: Achievement of control and experimental groups on pre-test

Group	N	Mean	SD	t-value
Experimental 1	38	45.34	11.79	
Control 2	38	45.33	12.03	*0.0178

*Not significant df = 74 t-value at 0.05 = 1.67

The results in Table 2 show the mean scores and standard deviations of the pre-tests of both the control and experimental groups of the two mixed schools. The calculated t-value of 0.0178 is less than the critical value of 1.67. therefore, the pre-test scores of the control group and the experimental group did not show any significant differences. This was assumed that the two groups started out with equivalent means. That is, they had the same ability and capability from the start.

Table 3: Mean, Standard Deviation and t-test scores.

Analysis	Control 1	Treatment 2	Critical t-value	Calculated t-value	Result
Mean(pre-test)	48.38	48.49			
Mean(post-test)	51.12	69.48			
SD	9.802	9.321	1.67	9.701	*9.701
Highest Score	68%	89%			

$n_1 = 38$, $n_2 = 38$, $\alpha = 0.05$, Tail: one – tail, critical t-value = 1.67. ***Significant**

The results in Table 3 above show the difference of means and standard deviation scores of the two groups on pre-test and posttest scores. The calculated t-value is 9.701 which is greater than the tabulated value that is 1.67. There was a significant difference in the achievement of the two groups on posttest implying a positive effect of the ASEI-PDSI on the experimental group. The post-test scores showed that the experimental group had higher scores than the control group. The t-test for independent samples was carried out to test whether the experimental and control groups differed significantly on the post-test. The experimental group scored a mean of 69.48% while the control group scored 51.12%. The calculated t-test value was 9.701 at a degree of freedom of 74 ($n_1 + n_2 - 2 = 74$) which is greater than the critical value of 1.67. The results showed that the scores of the experimental group were consistently higher than those of the control group while the standard deviation was lower. Hence the significant level above the critical t-value of 1.67. Therefore the hypothesis that there is no significant difference in students' achievement in mathematics when exposed to ASEI-PDSI approach and when only exposed to the traditional methods of instruction was rejected.

3.1.2 Students' views about the ASEI-PDSI approach towards mathematics and mathematics teaching and learning.

The conceptions, attitudes, and expectations of the students regarding mathematics and mathematics teaching and learning have been considered to be very significant factors underlying their school experience and achievement (Borasi, 1990; Shoenfeld, 1985). The general conceptions students exhibit determine the manner in which they approach mathematics tasks, in many cases leading them into nonproductive paths. Students have been found to hold a strong procedural and rule-oriented view of mathematics. Many students have the assumption that mathematics questions have a definite way of being solved and so they stick to the known algorithms without necessarily applying hands-on- activities. It was noted in this study that most students had learned the use of activities in their early years of upper primary school years and occasionally applied them in their class eight learning. However, 60% of the students admitted that teachers hardly used learning and teaching activities as they did in lower primary school classes. 55% of the teachers who were interviewed admitted that they preferred avoiding the use of activities in teaching because of the heavy syllabus workload against the stipulated time of completion. Such conceptions prevented the students and teachers from understanding that there are alternative strategies and approaches to many mathematical problems, different ways of defining concepts, and even different constructions due to different starting points.

In such difficult circumstances, students miss significant aspects of mathematical experience, including formulating their own questions, conjecturing relationships, and testing them. They may approch the tasks in the mathematical class with a very narrow frame of mind that keeps them from developing personal methods and building confidence in dealing with mathematical ideas. Associated with these conceptions are students' expectations of what is a mathematics classroom. In some instances where the teacher tried some innovative activities, some students with the a strong traditional orientation could struggle with the new approach. Some could complain of too much work being given to them as the teacher 'just lazies around'. This reaction of the students once developed, it would further inhibit the learning process.

However, the majority of both the teachers and students were full of praise for the ASEI-PDSI approach as one approach that breaks the 'ice' in their classroom, thus enhancing a healthy classroom interaction and allowing the student-centredness in the learning environment. When asked whether they would prefer the teacher to continue applying the approach, over 90% of them answered in affirmative.

With the use of diverse activities in the learning and teaching, students begin to appreciate their roles in active learning and their abilities to manipulate learning materials. As a result this helped the students to develop an impressive interest in the subject and contributed a lot in improving both their understanding and performance in mathematics. Their attitudes changed positively and had a much better view of the learning process. The concept of ASEI-PDSI ensured active student participation in the learning process, eased every classroom tension that would threaten active learning, and enhanced a learner-centred classroom environment. This environment boosts learning and ensures a better retention of learnt concepts and skills.

3.1.3 Students' views about mathematics and mathematics classes

This paper examined students' involvement in the ASEI-PDSI experience in comparison with previous approaches to learning mathematics. Students' activities, improving and improvising where the learning and teaching resources are insufficient or totally lacking plays the key role of the approach.

In general terms, the students were satisfied with their mathematics classes and with the new captivating approach that allowed them to learn collaboratively as they manipulated the learning materials. The students felt that classes were different from their usual traditional ones that were characterised by the teacher doing everything from talking to acting as they remained passive. In their view, there was much group work, reports and investigations. There was more discussion, less work on the blackboard, and more work in their notebooks and worksheets. Communication amongst the students and the teacher was cordial and mutual. Students were able to share and exchange their views as they checked their own learning. They felt that the new ASEI-PDSI approach implied more work and more thinking, which made them more competent and independent in the learning process.

For some of them, mathematics classes were sharply split in two groups: theoretical classes (mostly done through writing on the blackboard) and practical classes (exercises in their notebooks and worksheets), the latter being far more common than the former. The mathematics class was seen as practical and active. They were able to view mathematics as 'a doing and collaborative subject', where students are free to discuss their solutions as freely as possible. Both the students and teachers appreciated the fact that the weight of class participation and groupwork activity were increased and this saw more students developing a working spirit, inquisitive approach and interest in mathematics. This helped change their negative attitude to a positive one. The teachers who were interviewed confirmed that students could occasionally ask them when the next activity will be and what role each of them would play. This helped the students love the subject and it marked as their best entry into liking the subject and the mathematics teacher who for a long period is traditionally known to be unfriendly and official while in class.

4.0 Conclusion

The ASEI-PDSI experience implied quite significant changes in the lives of the students. They were presented with a different sort of mathematical activities which were perceived as requiring more thinking. Also, although that was not necessarily new for all of them, they were required to do much group work, made a significant use of their mathematical instruments, and engaged in multi-pronged class activities.

The students reacted in a very positive way towards the absence of the textbook. They took care in organizing their notebooks and worksheets and found them a useful study base. The challenge of different and more demanding mathematical activities was well taken care of by them. The students were positive about having problems requiring more effort and thinking. With the professional guidance of the skillful teachers, the students took themselves the initiative of asking the teacher more difficult problems. Occasionally, the teacher would develop their problem solving skills by allowing them to find solutions to such problems on their own through the group discussions.They were quite positive about the active nature of mathematics classes and their reactions to group work were also generally favourable.

The ASEI-PDSI approach does not restrict itself asking to simply asking questions to students and involving them in the lesson. It goes beyond that. It is concerned with the whole process of learning. It starts with preparing small steps (planning). During the lesson, the teacher is able to confirm their understanding at every step (seeing/evaluating). The teacher under this approach is able to diagnose learning difficulties and administer the appropriate mitigation. The teacher, in such difficulties is able to breakdown the steps into smaller steps of their level to ensure the learners understand them (improve).

Learner-centred pedagogy is the hallmark of the ASEI-PDSI approach. In practising it, the attitude of both the teacher and the learners is important. Learners are able to accustome to the process of learning by attempting positively to think and climb small steps by themselves. This action solidifies their understanding of mathematics concepts and skills. To change the students' attitude, the role of the teacher is important in such a way that he sets up an environment in which students can ask questions freely and collaborate mutually within their group discussions and activities. The study recommends that teachers should apply the ASEI-PDSI approach in their teaching to help students be actively involved in the lesson to have a better understanding and interest in the subject.

References

Borasi, R. (1990). The invisible hand operating on mathematics instruction: Students´ conceptions and expectations. In T. J. Cooney (Ed.), *Teaching and learning mathematics in the 1990s* (NCTM Yearbook), pp. 174-182. Reston: NCTM.

Cockroft, W.H. (1982). *Mathematics counts*. London: Her Majesty's Stationery Office.

Frank, M. (1988). Problem solving and mathematical beliefs. *Arithmetic Teacher*, 35 (1), 32-34.

Goetz, J. P. & LeCompte, M. (1984) *Ethnography and qualitative design in educational research*. San Diego: Academic Press.

Howson, G., Keitel, C., & Kilpatrick, J. (1981). *Curriculum development in mathematics*. Cambridge: Cambridge University Press.

Kiragu, F.W (1986). Achievement in Mathematics: An Investigation of the Factors that contribute to Mass Failure in KCE Mathematics. *BER, Seminar Paper No.20214, K.U,* Nairobi.

Merriam, S. (1988). *Case study research in education*. San Francisco: Jossey-Bass.

Patton, M. Q. (1987). *Qualitative evaluation methods*. Newbury Park: Sage.

Ponte, J. P., Matos, J. F., Guimarães, H. M., Leal, L. C., & Canavarro, A. P. (1991). *O processo de experimentação dos novos programas de Matemática: Um estudo de caso*. Lisboa: Instituto de Inovação Educacional.

Schoenfeld, A. (1985). *Mathematical problem solving*. Orlando, FL: Academic Press.

Yin, R. (1989). *Case study research: Design and methods*. Newbury Park: Sage