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Effects of Experiential Learning Approach on Students' Achievement in Secondary School Mathematics in Kericho East Sub-County, Kenya

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Abstract: ***The knowledge of mathematics as a tool for use in everyday life is important for individual and societal development. Students' achievement in mathematics is important in Science and Technology which is important for industrial advancement of a country. However, students' performance in Kenya Certificate of Secondary Education mathematics examination has been relatively poor. This has been attributed to teacher centred teaching and learning approaches among other factors that have impacted negatively on achievement in mathematics. This study investigated the Effects of Experiential Learning Approach on students' achievement in mathematics inKericho East Sub-County. The topic Statistics I was taught to Form Two since it is one of the topics that is poorly performed according to KNEC reports on KCSE. Solomon Four Non Equivalent Control Group Design under the quasi-experimental research was used. A random sample of four co-educational district secondary schools was drawn from schools in Kericho East Sub-County. Each school provided one Form Two class. This translated to a total of 168 students. In the experimental groups Experiential Learning Approach (ELA) was used while Conventional Teaching Methods (CTM) was used in the control groups. One experimental and one control group was pre tested. At the end of the treatment all the four groups were post tested using Mathematics Achievement Test (MAT). The instruments were validated with the help of experts in the Department of Curriculum Instruction and Education Management of Egerton University and mathematics teachers from selected secondary schools. The MAT was pilot tested to estimate its reliability coefficient using Kuder Richardson 21 method. The reliability coefficient was 0.978 for the MAT. Descriptive as well as inferential statistics were used in data analysis. These included mean score, t-test and ANOVA. All statistical tests were subjected to test of significance at alpha (α) level of 0.05. The results revealed that ELA had a significant effect on students' achievement in mathematics. The findings of the study are expected to assist mathematics teachers to adjust their instructional strategies and also teacher trainers may use the information from the study to sensitise in-service and pre-service mathematics teachers on the importance of Experiential Learning strategies in enhancing achievement in Mathematics. The findings may also be used as a basis for future research in Mathematics Education.***

I. BACKGROUND TO THE STUDY

Mathematics is a product of the human mind and also an attempt to describe the outside world. It is much more than algebra, geometry, statistics and calculus. Primarily mathematics is a way of thinking and a way of organising a logical proof. As a way of thinking, it gives insight into the power of the human mind and forms a crucial discipline of learning programmes in school subjects everywhere in the world (Johnson & Rising, 1972). Mathematics introduces learners to concepts, skills and ways of thinking that are important in their everyday lives. It helps them understand the

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sense of numbers, patterns and shapes they see around them. As their mathematical confidence grows they look for patterns, use logical thinking and discover new connections, new solutions and different approaches to problems. According to Breakel and Mutunga (1992) mathematics is a way of thinking in which a person determines the validity of an idea or information.

Learners' performance in mathematics at the national examinations in many countries has remained low (Colwell, 2000). According to Colwell (2000) performance of American students in International Mathematical Tests was low in comparison to other countries. However some countries like Singapore, Taiwan, South Korea and Japan were doing better in mathematics. In Kenya mathematics is a compulsory subject at the primary and secondary school level and it is a basic requirement for many careers and trainings (Aguele & Agwagah, 2007; Githua, 2002). However students' examination results in mathematics in Kenya Certificate of Secondary Education (KCSE) have been relatively low. The trend of performance of candidates in paper I and II of mathematics between the years 2010 and 2014 are shown in Table 1.

YEAR	PAPER	CANDIDATURE	MAX. SCORE	MEAN SCORE
2010	1	356072	100	26.21
	2		100	19.92
	Overall		200	46.07
2011	1	409887	100	21.36
	2		100	28.22
	Overall		200	49.57
2012	1	433017	100	29.46
	2		100	27.86
	Overall		200	57.31
2013	1		100	28.12
	2		100	27.03
	Overall		200	55.15
2014	1		100	24.54
	2		100	23.50
	Overall		200	48.04

Source: Kenya National Examinations Council (KNEC) Report, 2015

Table 1: Candidates National Performance in Mathematics at KCSE Level from 2010 - 2014

Table 1 indicates that the overall performance has a decreasing trend. The mean score is below average of 50% for each paper. From the table it can be noted that the mathematics candidature has continually increased over the years. It is evident that the overall performance has been quite low, perhaps due to the students' lack of motivation to learn the subject, inadequate coverage of syllabus or the teacher centred methods used by most teachers (Miheso, 2012; Amadalo, Shikuku & Wasike, 2012). The topics that have been noted to give learners difficulties to solve problems hence achieve low marks at KCSE include Calculus, Three Dimensional Geometry, Vectors, Statistics, Probability, Loci and Navigation (KNEC, 2015).

The performance of students in mathematics in KCSE in Kericho East Sub County has also been low. Table 2 shows the students' performance in mathematics Kericho East by their mean scores.

YEAR	CANDIDATURE	MEANSCORE	MEANGRADE	DEVIATION
2010	1966	3.9514	D+	+0.5014
2011	2035	4.1540	D+	+0.2026
2012	1978	4.3464	D+	+1.0705
2013	2315	5.4586	C-	+1.1122
2014	2221	5.3336	C-	- 0.1250

Source: Kericho District Education Office, 2015

Table 2: Candidates' Performance in Mathematics in Kericho East Sub County for the Years 2010-2014

Although the deviation in the mean scores is positive over the selected period except in 2014 the mean score for all the years is still low. The maximum grade that can be attained is A which has a meanscore of 12 points.

Learning in mathematics is not solely a cognitive affair. A better understanding of the relationship between teaching and learning strategy and outcomes in the cognitive and affective domains is imperative. There is need therefore, to improve upon the instructional strategies and develop curriculum that will produce better learners and creative thinkers (Ajogbeje&Omirin, 2013). Karega (2008) argues that one way of addressing the difficulties students experience in Kenyan classrooms is through appropriate teaching interventions that can be realised through professional development of teachers. It is with this in mind that the Ministry of Education in Kenya with assistance from the Government of Japan hoped to strengthen the teaching and learning of mathematics and science education in public schools through a project known as Strengthening Mathematics and Science in Secondary Education (SMASSE) (Kibe, Odhiambo & Ogwel, 2008). SMASSE project has made mathematics and science subjects to become more relevant to learners, more practical and therefore more interesting and less expensive. According to Wambugu (2006) the teaching approach that a teacher adopts is a factor that may affect students' achievement. The Conventional Teaching Methods (CTM), which are often used to teach mathematics are expository in nature. These methods leave little room for the students to think and be creative (Ndekei, 2011). There is a possibility that less low achievement in mathematics could be due to students' lack of hands on activities in learning mathematics.

Research has shown that learners of all ages tend to learn much more effectively if they are actively involved in the learning process rather than simply being receivers of instruction. Thus in recent years there has been a progressive move away from traditional teacher centred expository instruction towards student centred approaches. Experiential Learning Approach (ELA) is one of the student focused approach to teaching and learning.

This study addressed the effects of ELA on students' mathematical creativity and achievement in mathematics. According to Kolb (1984) Experiential Learning involves four stages as illustrated in figure 1

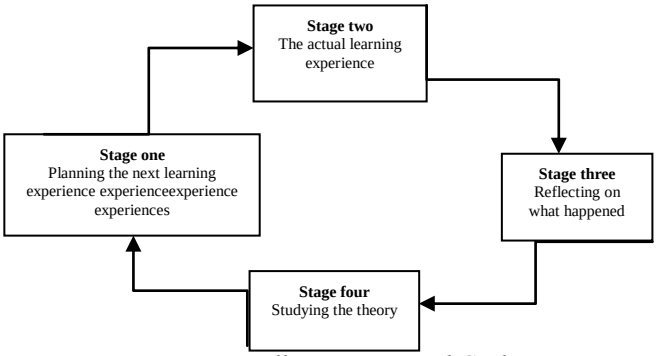

Figure 1: Kolb's Experiential Cycle

Figure 1 illustrates the stages of ELA. Stage one is the planning phase whereby the teacher and learners set the learning activities and objectives. The learner must be involved in the planning of the learning experience if ELA is to be fully effective. This can be done through action planning or preparing a learning contract. Action planning may involve nothing more than putting down a set of things to do, or discussing the proposed procedure with the teacher. It's useful for individual learners to set their own objectives for inclusion in the action plan (Kolb, 1984)

Stage two is where the actual learning occurs and students are actively involved in the learning activities and exploration of the learning experience. This stage involves drawing up a checklist of things that the learner should try to do, for example active observation of what is going on, and producing a log or record of some sort and formulating appropriate questions (Kolb, 1984)

Stage three is where the teacher and learner reflect on the effectiveness of the learning experience. This stage is probably the most crucial of all in the cycle though it may seem the most difficult. The teacher and the students should reflect on what the learners learnt, how they learned it, whether the learning experience could have been more effective and so on. Discussions of these reflections with the teacher can prove extremely helpful as can discussions with one's peers – either informally or at a formal debriefing session of some sort (Zilbert&Leske, 1989)

Stage four is where the teacher and learners link the actual learning experiences and the theories of learning it was meant to illustrate. Discussions with the instructor can prove extremely helpful during this stage of the Kolb cycle as can discussion with ones fellow learners. In this study form II secondary school students were taught the mathematics topic "Statistics" which has been found challenging at the KCSE (KNEC, 2012) using ELA.

II. METHODOLOGY

The study involved Quasi-experimental research in which the researcher used the Solomon Four Non-Equivalent Control Group Design. The design is considered rigorous enough for experimental and quasi-experimental studies. The secondary school classes once constituted exist as intact groups and school authorities do not normally allow such classes to be broken up and reconstituted for research purposes (Borg & Gall, 1989; Fraenkel & Wallen, 2000). This design has an advantage over others since it controls the major threats to internal validity except those associated with interaction and history, maturity and instrumentation (Cook & Campbell, 1979). Figure 6 presents Solomon Four Non-Equivalent Group Design.

Group 1	O_1	X	O_2
Group 2	O_3	-	O_4
Group 3	-	X	O_5
Group 4	-	-	O_6

(Source: Cohen & Manion, 1994; Gall, Borg & Gall, 2007)

Figure 2: Solomon Four Non-Equivalent Control Group Research Design

Key

Pre-tests: O_1 and O_3 Treatment: X

Post-tests: O_2, O_4, O_5 and O_6 No pre-test or no treatment: ___

Experimental groups: Group 1 and group 3

Control groups: Group 2 and Group 4

Non-equivalent control groups: - - - - - - - - - - - - -

In this design, to control for interaction between selection and interactions the schools were randomly assigned to control and treatment groups while that of interaction between selection and instrumentation was controlled by ensuring that the conditions under which the instruments were administered were kept as similar as possible in all the schools (Borg & Gall, 1989; Zechmesh & Shanghnessy, 1994). The effect of maturation was taken care of by the short time the study took. Solomon Four Non Equivalent Control Group Design has been used successfully in studies to determine the effect of teaching approaches on student achievement in Kenya (Wambugu & Changeiywo, 2008; Wachanga & Mwangi, 2004; Keraro, Wachanga & Orora, 2007). This design is designed to deal with a potential testing threat which occurs when the act of taking a test affects how people score on a pre-test or post-tests. According to Gall, Borg and Gall (2007), this design help achieve four main purposes;

- ✓ To assess the effects of the experimental treatment relative to the control condition.
- ✓ To assess the interaction between pre-test and experimental conditions.
- ✓ To assess the effects of the pre-test relative to no pre-test.
- ✓ To assess the homogeneity of the groups before administration of the treatment

RESEARCH OBJECTIVE

To establish the effects of Experiential Learning Approach on achievement in Mathematics.

RESEARCH HYPOTHESIS

H_o: There is no statistically significant difference in students' mathematics achievement between those taught through Experiential Learning Approach and those taught through conventional methods

III. RESULTS

To determine the effect of ELA on students' achievement in Mathematics, an analysis of the students' post-test MAT

scores was carried out. Hypothesis H_o1 of the research study stated that there is no statistically significant difference in students' mathematics achievement between those taught through experiential learning and those taught through conventional methods. To test this hypothesis an analysis involving ANOVA and Post Hoc tests was carried out. Table 3 shows the MAT post-test mean scores obtained by the students when the four groups were compared.

	N	Mean	SD
E1	45	26.1333	6.36967
C1	41	19.5122	5.99634
E2	42	23.6667	5.46236
C2	40	19.1000	4.53363
Total	168	22.2262	6.34129

Table 3: MAT Post-test Mean Scores Obtained by the Students in Four Groups

The means of the four groups were different. Experimental groups E_1 and E_2 achieved higher mean scores than control groups C_1 and C_2. The students in the Experimental groups were exposed to ELA and their mean scores were higher than those in the control groups. This shows that ELA had an effect of improving performance as compared to the conventional teaching methods. Table 3 shows higher mean score for E_2 compared to C_2, both groups were not pre-tested though E2 received treatment. It can be deduced that the treatment had a positive effect on the achievement of students in E_2. The control groups which did not receive treatment obtained lower mean scores than the experimental groups. If there was any pre-test effect on the pretested groups then the post test means of E1 and C1 would be much higher than E2 and C2. A comparison of the posttest mean scores does not indicate any effect caused by the pre-test. ANOVA was also carried out to establish whether the difference in the groups mean scores on the MAT were statistically significantly as shown in Table 4.

	Sum of Squares	Df	Mean Square	F	p-value
Between Groups	1467.028	3	489.009	15.280	.000
Within Groups	5248.377	164	32.002		
Total	6715.405	167			

Table 2: ANOVA of the Post-test Mean Scores on the MAT

Table 4 ANOVA results show that that F(3,164) =15.280, p< 0.05 indicating that the differences in post-test scores of MAT for the four groups were statistically significant. Hence H_o which stated that there is no statistically significant difference in students' mathematics achievement between those taught through Experiential Learning Approach and those taught through conventional methods was thus rejected. Since there was a significant difference between the means of the groups, it was necessary to carry out post hoc comparisons test of MAT mean scores to establish where the differences occurred. The tests were carried out using Tukeys procedure at p<0.05 level because the group sizes were unequal. Table 5 shows the results of the Tukeys post-hoc test of MAT mean scores.

		Mean Difference (I-J)	SD	p-value
E1	C1	6.62114*	1.22135	.000
	E2	2.46667	1.21372	.180
	C2	7.03333*	1.22932	.000
C1	E1	-6.62114*	1.22135	.000
	E2	-4.15447*	1.24198	.006
	C2	.41220	1.25722	.988
E2	E1	-2.46667	1.21372	.180
	C1	4.15447*	1.24198	.006
	C2	4.56667*	1.24981	.002
C2	E1	-7.03333*	1.22932	.000
	C1	-.41220	1.25722	.988
	E2	-4.56667*	1.24981	.002

*. The mean difference is significant at the 0.05 level.

Table 3: TukeysPost Hoc Comparisons of the Post-test of MAT means for the Four Groups

The post-hoc comparisons showed that the mean differences between E1and C1(6.62), E1 and C2(7.03), E2 and C1(4.15) and E2 and C2(4.6) groups were statistically significant at p<0.05 level. However there was no statistically significant difference in the means between groups E1and E2(2.47) and groups C1 and C2(0.41). The results of the post hoc comparisons confirmed that ELA had a positive effect on students' achievement in Mathematics.

The study found that students who were taught using ELA achieved significantly higher scores in MAT than those who were taught through the conventional methods. This is an indication that the use of ELA was more effective in improving students' mathematics achievement as compared to the conventional teaching/learning methods. These findings are in agreement with findings of similar studies carried out earlier. Otaala (1999) in the study on improving academic teaching and learning stressed the use of Kolb's learning cycle to ensure that students reflect on their own experiences. The cycle should be followed by a consolidation which draws students into active work to explore the information and relate it to previous knowledge before moving to a new topic. This helps the students to maintain intrinsic motivation by application of learnt knowledge to real life situations (Zoldosava&Prokop, 2006).

Pascul and Uribe (2005) found that when experiential learning was used in an engineering course, there was consistent student participation. They found that experiential learning as an active instructional strategy improved academic performance and was stimulating for the teachers as the approach attained the stated outcomes. Studies on Experiential learning in Kenya show that students in Agriculture performed better than those taught using regular teaching methods (Ngesa, 2002). Other findings include those of Wambugu (2011) on experiential learning in physics education classrooms. The study findings showed that use of experiential

learning improved achievement and motivation to learn physics in secondary schools. Arnold, Warner and Osborne (2006) in their study on Experiential Learning in Agricultural Education classroom, found out that use of this approach increased subject matter retention among students.

IV. CONCLUSION AND RECOMMENDATION

The results of the analysis of post test scores on MAT for the four groups were significantly different. Group E1 and E2 had means of 26.13 and 23.66 respectively while C1 and C2 had means of 19.51 and 19.10 respectively. ANOVA results show that the difference in the mean scores between the four groups were significant. Tukeys post hoc analysis results on pairwise comparison revealed that there was a significant difference in favour of the experimental groups. This implies that ELA improved achievement in mathematics. Teacher education programmes should focus on preparing teachers to acquire appropriate skills in instructional methods which are problem solving and student centred such as ELA hence enhance achievement.

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