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# EFFECTS OF EXPERIENTIAL LEARNING APPROACH ON STUDENTS' PERFORMANCE IN MATHEMATICAL CREATIVITY DIMENSIONS IN KERICHO EAST SUB COUNTY, KENYA

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**ABSTRACT**: *This study focused on the effect of experiential learning approach on students' performance in the Mathematical Creativity Dimensions. 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 subcounty secondary schools was drawn from schools in Kericho East Sub-County, Kenya. 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 Mathematical Creativity Test (MCT). The results indicated that the students in the experimental groups performed significantly higher than those in the control groups. The experimental groups performed higher in the four dimensions (Fluency, Flexibility, Originality and Elaboration) than the control group. The findings showed that experiential learning approach is effective in developing mathematical creativity skills among learners. This information can be used by teachers and curriculum developers in planning for instruction and designing mathematics curriculum.*

**KEY WORDS**: mathematical creativity, creativity dimensions, fluency, flexibility, originality elaboration and experiential.

## INTRODUCTION

Education is aimed at developing an all-round creative person capable of reaching full potential in a dynamic socio-economic scene. It is supposed to develop an adaptive person in a changing environment capable of finding solutions for new problems, processing available information to get only vital things necessary for productive work, unconventional thinking and acting (Gorev, & Khuziakhmetor, 2017). This kind of an individual cannot be found if mathematics is taught using approaches that limit the use of creativity in the classroom and reduces mathematics to a set of skills to master and a set of rules to memorise. Mathematics teaching and learning has shifted to focus on skills such has revealing patterns in life, producing solutions to problems, critical and analytical thinking hence creative individuals. Creativity is a skill or way of thinking that needs to be developed in an individual (Sternberg, Kaufman & Grigorenko 2008). Sriraman (2004) has defined creativity as the ability to produce novel and original work. He further defines mathematical creativity as the process that results in unusual and insightful solutions to a problem

irrespective of the levels of complexity. To develop mathematical creativity among learners, require that teachers themselves have to be creative and be able to apply the 21st century skills and the fourth Industrial Revolution skills (4IR)**.** According to the World Economic Forum (WEF), 'Future Jobs' report that the top ten skills needed by employers in 2020 are Complex problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgement and decision making, service orientation, negotiation and cognitive flexibility (Gleason 2018). Berstron (1984) reports that creativity is performance where the individual is producing something new and unpredictable. Measuring mathematical creativity helps to recognize and affirm the strength and talent of individuals and helps instructors and counsellors or individuals discover unrecognized and untapped talents (Mann 2005). This is an indication that teachers should be well prepared to guide students gain conceptual knowledge which will lead to transferable skills required in the market today and in future. This can be attained if interactive teaching approaches are effectively used. This approaches include activity based teaching, experiential learning, cooperative learning among others.

Ervynck (1991) described creativity in three stages. Stage 0 is the preliminary technical stage which mainly involves technical and practical application of mathematical rules and procedures; Stage 1 which entails algorithmic activity such as performing mathematical techniques by applying algorithms repeatedly. Stage 2 consist of creative (Conceptual/Constructive) activity, this is the stage where true mathematical creativity occurs and consists of non-algorithmic decision making. Mathematics teachers should strive to make learners attain the third level, where they can solve problems creatively in the classroom and also in their day to day life. Siswono (2011) describes five levels of creative thinking which are derived from on a combination of mathematical fluency, flexibility and originality. A learner who attains the highest level of creative thinking in mathematics demonstrates all the three of these characteristic. Livne and Milgram (2006) also describes three aspects of creativity which include fluency, flexibility and novelty/originality. Imai (2010) describes elaboration as another dimension of creativity which is a learners' ability to give in-depth reasoning behind a solution path and provide a sound explanation as to why it is an appropriate solution. Boesen (2006) clearly explains that creativity is learning that goes beyond following strict algorithmic path or recalling ideas provided by others. From the above description it is clear that learning of mathematics should go beyond procedures and rules to decision making for students to be able to solve problems creatively.

This study set out to establish the effect of experiential learning approach on students' performance in mathematical creativity. Experiential learning approach asserts that acquisition of skills and construction of knowledge by the learners is direct result of experience. Experiential learning can exist without a teacher and relates solely to the meaning making process of the individuals' direct experience. This is in agreement with Kolb (1984) who asserts that experiential learning is equivalent to personal gradual growth and change and that learning proceeds from concrete and progress towards the abstract. According to Newsome, Wardlow and Johnson (2005) experiential learning approach elevates students' cognition levels, increases use of critical thinking skills and therefore enhances students' ability to obtain, retain and retrieve knowledge hence increased achievement. Benson (2013) and Atherton (2009) contends that experiential learning is related to the autonomy of the learner to manipulate the learning environment. The study particularly studied

how students performed in the four dimensions of flexibility, fluency, elaboration and originality. Mann (2005) suggest that studies in mathematical creativity investigates situations of flexibility, fluency, elaboration and originality of students answers to a given problem. Feldhusen (2002) identified characteristics of mathematical thinking to include flexibility, innovation, fluency and originality, while Wallas (1926) explained creative process to include preparation, incubation, illumination and verification.

The study adopted Mann (2005) dimensions of creativity, which included fluency, flexibility, originality and elaboration. Fluency is an individual's ability to come up with a different/multiple responds and solution path to a problem (Leikin 2007, Sriraman, and Haavold 2017), flexibility on the other hand is the ability of an individual to change thinking paths when they encounter an impasse or thinking obstruction. Beghetto (2017) describes originality as an individual's ability to find a solution path that is especially unique and uncommon for that individual's level it is also referred to as novelty. Elaboration is an individual's ability to give in-depth reasoning behind a solution and provide sound explanation why it is an appropriate solution (Kim, Cho and Ahn2003).

**Purpose of the Study**

The purpose of the study was to establish the effect of Experiential Learning Approach on students' performance in the dimensions of mathematical creativity in Kericho East Subcounty, Kenya.

## METHODOLOGY

The study employed a quasi-experimental approach using a Solomon four non-equivalent control group design. The purpose was to compare the effect of experiential learning approach on students' performance in the four dimension of mathematical creativity. There were two experimental and two control groups. Four schools were purposively selected based on the students' entry behavior at form one, and two schools were randomly selected using simple random sampling to put them into experimental and control groups.

## FINDINGS

The study set out to find out the effect of experiential learning approach on students' performance in mathematical creativity dimensions. The null hypothesis stated that;

"*There is no statistically significant difference in students' performance in the mathematical creativity dimension between those taught using experiential approach and those taught using the conventional teaching approach".*

**Students' Performance in the dimensions of Mathematical Creativity**

Table 1 shows the descriptive results of students' performance in the different dimensions of mathematical creativity. The results are presented based on the study groups; two experimental and two control groups.

**Table 1**
Students Performance in the Dimensions of Creativity

| | | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|---|
| Learners Fluency | Experimental Group 1 | 45 | 11.7333 | 5.43725 | .81054 |
| | Control Group 1 | 41 | 8.3171 | 2.13821 | .33393 |
| | Experimental Group 2 | 42 | 10.5000 | 3.87141 | .59737 |
| | Control Group 2 | 40 | 7.3000 | 1.69766 | .26842 |
| | Total | 168 | 9.5357 | 4.04154 | .31181 |
| Learners Flexibility | Experimental Group 1 | 45 | 8.6889 | 2.08700 | .31111 |
| | Control Group 1 | 41 | 6.2439 | 1.15716 | .18072 |
| | Experimental Group 2 | 42 | 7.7857 | 1.78798 | .27589 |
| | Control Group 2 | 40 | 6.2000 | 1.11401 | .17614 |
| | Total | 168 | 7.2738 | 1.91965 | .14810 |
| Learners Elaboration | Experimental Group 1 | 45 | 7.4222 | 1.77724 | .26494 |
| | Control Group 1 | 41 | 5.6829 | .87861 | .13722 |
| | Experimental Group 2 | 42 | 7.2381 | 1.52715 | .23564 |
| | Control Group 2 | 40 | 5.7500 | .89872 | .14210 |
| | Total | 168 | 6.5536 | 1.56212 | .12052 |
| Learners Originality | Experimental Group 1 | 45 | 7.6889 | 2.23426 | .33306 |
| | Control Group 1 | 41 | 5.7805 | .88069 | .13754 |
| | Experimental Group 2 | 42 | 7.2619 | 1.53113 | .23626 |
| | Control Group 2 | 40 | 5.7250 | .84694 | .13391 |
| | Total | 168 | 6.6488 | 1.73771 | .13407 |

The findings of Table 1 indicate that students' performance was higher in both experimental groups than the control groups. This is an indication that the intervention was effective in improving students' mathematical creativity. Experimental group 1 performed better than the other groups in all the four dimensions followed by the experimental group 2. The control groups did not perform as well. This points to the fact experiential learning approach gives learners a chance to come up with original knowledge based on their experiences. Experiential learning approach had a positive effect in learners' fluency, flexibility, originality and elaboration in that order. The intervention seems to have made the students to perform well in fluency and flexibility. This can be explained by the fact that students are given a chance to experience learning by the being active in sharing, discussing and freely interacting. This approach makes learners to be active participants in knowledge creation as opposed to passive recipients of knowledge from the teachers. These findings are in agreement with the argument given by (Balka, 1974; Mann 2005; Argul & Kahveci, 2016) that the curriculum needs to be adapted to meet the needs of creative learners. Therefore, based on the findings above it is clear that if learners are given a chance to experience learning through collaborative hands-on activities then creativity can be enhanced. Experiential learning takes places when learners work together in an activity to achieve a common solution. Levenson (2011) calls this collective learning in which mathematical ideas and actions initially by individual students are built upon and reworked to produce a collective product.

Table 2 shows the ANOVA results of students' performance in the four dimensions of Mathematical creativity

**Table 2**
Differences in Students Performance in the Dimensions of Mathematical Creativity

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Learners Fluency | Between Groups | 517.208 | 3 | 172.403 | 12.790 | .000 |
| | Within Groups | 2210.578 | 164 | 13.479 | | |
| | Total | 2727.786 | 167 | | | |
| Learners Flexibility | Between Groups | 190.728 | 3 | 63.576 | 24.552 | .000 |
| | Within Groups | 424.677 | 164 | 2.589 | | |
| | Total | 615.405 | 167 | | | |
| Learners Elaboration | Between Groups | 110.543 | 3 | 36.848 | 20.349 | .000 |
| | Within Groups | 296.975 | 164 | 1.811 | | |
| | Total | 407.518 | 167 | | | |
| Learners Originality | Between Groups | 129.517 | 3 | 43.172 | 18.893 | .000 |
| | Within Groups | 374.763 | 164 | 2.285 | | |
| | Total | 504.280 | 167 | | | |

The results of Table 2 show that there was a significant difference in students' performance in the mathematics creativity dimensions between those taught using the experiential approach and those taught using conventional teaching approaches. This leads to the failure to accept of the null hypothesis that stated; "*There is no statistically significant difference in students' performance in the mathematical creativity dimension between those taught using experiential approach and those taught using the conventional teaching approach".* This leads us to accept the alternative hypothesis that there is a statistically significant difference in students' performance in mathematics creativity dimensions in favour of those taught using the experiential approach.
ANOVA Post Hoc analysis were run to establish exactly where the difference was between the four groups. This results are shown in Table 3.

**Table 3**
Post Hoc analysis, of Experimental and Control groups performance in the Dimensions of Mathematical Creativity

| Dependent Variable | (I) Study Groups | (J) Study Groups | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|---|
| Learners Fluency | Experimental Group 1 | Control Group 1 | 3.41626* | .79265 | .000 |
| | | Experimental Group 2 | 1.23333 | .78770 | .716 |
| | | Control Group 2 | 4.43333* | .79782 | .000 |
| | Control Group 1 | Experimental Group 1 | -3.41626* | .79265 | .000 |
| | | Experimental Group 2 | -2.18293* | .80603 | .045 |
| | | Control Group 2 | 1.01707 | .81593 | 1.000 |
| | Experimental Group 2 | Experimental Group 1 | -1.23333 | .78770 | .716 |
| | | Control Group 1 | 2.18293* | .80603 | .045 |
| | | Control Group 2 | 3.20000* | .81112 | .001 |
| | Control Group 2 | Experimental Group 1 | -4.43333* | .79782 | .000 |
| | | Control Group 1 | -1.01707 | .81593 | 1.000 |
| | | Experimental Group 2 | -3.20000* | .81112 | .001 |
| Learners Flexibility | Experimental Group 1 | Control Group 1 | 2.44499* | .34742 | .000 |
| | | Experimental Group 2 | .90317 | .34525 | .058 |
| | | Control Group 2 | 2.48889* | .34969 | .000 |
| | Control Group 1 | Experimental Group 1 | -2.44499* | .34742 | .000 |
| | | Experimental Group 2 | -1.54181* | .35329 | .000 |
| | | Control Group 2 | .04390 | .35763 | 1.000 |
| | Experimental Group 2 | Experimental Group 1 | -.90317 | .34525 | .058 |
| | | Control Group 1 | 1.54181* | .35329 | .000 |
| | | Control Group 2 | 1.58571* | .35552 | .000 |
| | Control Group 2 | Experimental Group 1 | -2.48889* | .34969 | .000 |
| | | Control Group 1 | -.04390 | .35763 | 1.000 |
| | | Experimental Group 2 | -1.58571* | .35552 | .000 |
| Learners Elaboration | Experimental Group 1 | Control Group 1 | 1.73930* | .29053 | .000 |
| | | Experimental Group 2 | .18413 | .28871 | 1.000 |
| | | Control Group 2 | 1.67222* | .29242 | .000 |
| | Control Group 1 | Experimental Group 1 | -1.73930* | .29053 | .000 |
| | | Experimental Group 2 | -1.55517* | .29543 | .000 |
| | | Control Group 2 | -.06707 | .29906 | 1.000 |
| | Experimental Group 2 | Experimental Group 1 | -.18413 | .28871 | 1.000 |
| | | Control Group 1 | 1.55517* | .29543 | .000 |
| | | Control Group 2 | 1.48810* | .29730 | .000 |
| | Control Group 2 | Experimental Group 1 | -1.67222* | .29242 | .000 |
| | | Control Group 1 | .06707 | .29906 | 1.000 |
| | | Experimental Group 2 | -1.48810* | .29730 | .000 |
| Learners Originality | Experimental Group 1 | Control Group 1 | 1.90840* | .32637 | .000 |
| | | Experimental Group 2 | .42698 | .32433 | 1.000 |
| | | Control Group 2 | 1.96389* | .32850 | .000 |
| | Control Group 1 | Experimental Group 1 | -1.90840* | .32637 | .000 |
| | | Experimental Group 2 | -1.48142* | .33188 | .000 |
| | | Control Group 2 | .05549 | .33595 | 1.000 |
| | Experimental Group 2 | Experimental Group 1 | -.42698 | .32433 | 1.000 |
| | | Control Group 1 | 1.48142* | .33188 | .000 |
| | | Control Group 2 | 1.53690* | .33397 | .000 |
| | Control Group 2 | Experimental Group 1 | -1.96389* | .32850 | .000 |
| | | Control Group 1 | -.05549 | .33595 | 1.000 |
| | | Experimental Group 2 | -1.53690* | .33397 | .000 |

The Post Hoc results indicate that there is a statistically significant difference in students' performance between the experimental groups and the control. Students' performance in fluency was found to be significantly different between experimental group1 and both control groups and experimental group 2 and both control groups in favor of the experimental groups. There were no statistically significant differences between the experimental groups. This is an indication that experiential learning approach is effective in increasing students' mathematical creativity particularly in the dimension of fluency in mathematics. Strozier, Flores, Shippen, and Hinton, (2012). defines mathematical fluency as the ability to solve problems automatically and with accuracy. They also that mathematical fluency is developed through instruction in the sequence of concrete-representation-abstract. This confirms that experiential learning develops mathematical fluency as shown in the performance of the experimental groups in this study. The same trend is repeated in learners' flexibility, elaboration and originality. Kiessewetter (1983) states that flexibility which is one of the components of creativity is one of the most important abilities of a successful problem solver. Kroesbergen and Kattou, (2018) notes that flexibility is the ability to have different types of categories of appropriate solutions. The findings of this study is that students taught using experiential approach performed better that those in the control group. This is an indication that experiential learning approach develop in learners' flexibility to solve mathematical problems. Flexibility in solving problems is a skill that is required in the world of work and employers are looking for employees with such critical skills. These findings show that experiential learning approach is effective in enhancing learners' mathematical creativity in all the four dimensions. McGregor (2007) and Martins (2009) notes that creativity is the result of thinking that leads to acquisition of new insights or new ideas in solving a problem that shows fluency, flexibility and originality in thinking. Zainudin, Subali and Jailani (2019) contends that students' creativity needs to be developed because this ability is a desired aspect employers are looking for. Jaersveld and Lachmann (2017) states that one of the indicators of creativity is the ability of solving problems through various alternatives. Zainudin, et al (2019) and Hana (2013) contends that creativity knowledge and skills can help individuals to have innovative ideas which can help nations achieve its goals. The findings of this study show that mathematical creativity can be developed in learners if experiential learning approaches are effectively used in schools.

## CONCLUSION AND RECOMMENDATION

The students in the experimental groups were found to perform significantly better than those in the control group. This shows that experiential learning approach is effective in developing the four dimensions of mathematical creativity in learners. It is the recommendation of this study that secondary school curricula should encourage the use of experiential learning approaches in mathematics classrooms. This is because experiential learning approach develop learners' creativity skills through hands-on and minds-on activities. It also recommends that pre-service teachers and in-service teachers should be prepared to be able to teach mathematics through experiences that make learners to be active participants in learning.

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