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# INFLUENCE OF LABORATORY METHOD ON STUDENTS' MATHEMATICAL CREATIVI IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

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## ABSTRACT

*This study investigated the influence of laboratory method on students' mathematical creativity in junior secondary schools in Yenagoa, Bayelsa State. The study was guided by three research questions and three hypotheses. The Pretest- Postest non-randomise control group design was adopted for the study. A sample of 122 students from two intact classes selected randomly was used for the study. The instruments for data collection were the Mathematics Creativity Test (MCT) and Students Attitude towards Mathematics Questionnaire (SAMQ). The data collected were analysed using mean and standard deviation, and the Analysis of Covariance (ANCOVA). The result indicated that Laboratory method of teaching significantly enhance students' creativity in mathematics. The method equally enhanced mathematical creativity of both male and female students. Students' attitude towards mathematics also influenced mathematical creativity significantly. Among others, it was recommended that mathematics teachers should explore the use of laboratory method in teaching various concepts in Junior Secondary School level.*

**Keywords:** Laboratory method, Gender, Attitude, Mathematical creativity.

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## 1. INTRODUCTION

The science and technology era we today require a lot for the individual to survive. The 21st century youths require many sets of special skills in order to succeed in work and life (Sabbagh, 2012). Sabbagh further stated that education has emphasized the importance of promoting favourable conditions for developing creative potential of students. Creativity is one of the educational concerns in mathematics education. It is a human activity which acts upon and generates new mathematic (Ervynck, 1991). Ervynck asserts that it plays a vital role in the full cycle of advance mathematical thinking and works towards possible conjectures made in developing mathematical theories. Creativity in mathematics has three important dimensions (Brunkalla, 2009). The dimension of abstraction which concerns the creation of models that reflect the real world and can be solved with mathematical tools know to individuals. The second is the creativity of connection which is the realization that known mathematical tools can be applied to new problems, allowing problems to be viewed in a new way. The third is the creativity of researching which is the discovery of new mathematical tools that fit unsolved problems and add to the available tools for other users of mathematics. Generally accepted definition of mathematical creativity does not exist rather it has been viewed in several ways. Gil *et al.* (2007) based their definition on the concepts of fluency, flexibility and originality in mathematics; Runco (1993) describes it as a multifaceted construct involving both divergent and convergent thinking, problem finding and solving, self-expression, intrinsic motivation, a questioning attitude and self-confidence; and Singh (1988) looked at it as a process of formulating hypothesis concerning cause and effect in a



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mathematical situation, testing and retesting this hypothesis and making modifications and finally communicating the result. There has being no consensus as to what creativity is, however, it has being recognized as an important skill universally (Craft, 2005). This is why mathematics educators deem it fit to think about creativity in teaching mathematics such that the rising demand for creative competence in the ever changing society can be met (Sabbagh, 2012).

The teaching and learning environment in which the child finds himself/herself can enhance the development of his /her creative potential. The enhancement of the teaching and learning environment to provoke creativity demands planning (Sabbagh, 2012). The teacher, therefore, needs to apply a method that would enhance creativity in the classroom. A creative classroom should allow more time for open-ended questioning, digression from text, curiosity and for better development of creative though (Behar-Horenstein *et al*., 2003). Renzulli *et al*. (2000) noted that teachers in order to enhance creativity among pupils should create authentic learning situation where pupils should think, feel and do what practicing professionals do. An authentic learning situation creates an environment in which students apply relevant knowledge and skills to solve real problems (Renzulli *et al*., 2004). The laboratory approach is one of the methods that provide these opportunities for the learner.

The laboratory approach to the teaching of mathematics provides for independent investigation and experimentation for both individuals and groups (Klutz, 1963). Klutz further stated that students discover mathematical facts and concepts through the manipulation of objects, through the designs and construction of models, through studious inquiry and testing of hypothesis, through the application of theory and through reading and discussion. Adenegan (2003) cited by Adenegan (n.d) itemized the function of laboratory approach which includes:

> "Permitting students to learn abstract concepts through concrete experiences and thus increase their understanding of those ideas. Enabling students to personally experience the joy of discovering principles and relationships. Encouraging and developing creative problems solving ability. Making students to see the origin of mathematical ideas and participating in "mathematics in the making". p16

The experts on gender differences in science and mathematics have completely ignored gender differences in creativity, no matter their awareness of the central role of creativity in science and mathematics (Hill and Rogers, 2012). Hills and Rogers contented to the consideration of creativity and certain closely associated factors offering several key explanatory and constructive ideas on gender gaps in the mathematically intensive subfields of science and technology. They stated that while results on gender differences in creativity are inconclusive, there is a broad consensus among experts and lay observers alike that men exhibit substantially more creative achievement than women. It is necessary, therefore, to ascertain the gender differences in mathematical creativity using laboratory teaching approach.

Students' attitude towards mathematics and their implications for mathematics instruction have been considered an important factor influencing participation and success in mathematics (Grainer *et al*., 2006). An investigation into students' mathematics attitude and perspective, not only informs teachers, parents and administrators about students' needs in Mathematics. It can also engender initial reform in mathematics education. Can students' attitude influence their mathematical creativity which is a factor that can enable students to confidently engage in complex mathematical task and draw knowledge from a wide variety of mathematical topics.

### 1.1. Statement of Problem

The use of methods that will arouse the creative potential of students in the classroom had been very low, possibly, not in use at all. Limiting the use of these methods have affected the creativity of students, thereby reducing mathematics to a set of skills to master and rules to memorize (Mann, 2005). This has killed the natural curiosity and enthusiasm of children towards mathematics as they grew up and created the tremendous poor performance in mathematics in Nigeria.

### 1.2. Purpose of the Study

The purpose of the study is to determine the influence of laboratory method on students' mathematical creativity. The study is intended to specifically attain the following objectives:

1. Determine the mathematical creativity of students taught using laboratory method and those taught using conventional method.
2. Examine the mathematical creativity of male and female students taught using laboratory method.
3. Determine the difference in mathematical creativity based on students' attitude taught using laboratory methods.

### 1.3. Research Questions

In order to guide the study, the following research questions were posed:

1. What is the difference between the mathematical creativity of students taught using laboratory method and those taught using conventional method?
2. What difference exists between the mathematical creativity of male and female students taught using laboratory method?
3. What is the difference in mathematical creativity based on students' attitude taught using laboratory method?

### 1.4. Research Hypothesis

The following research hypotheses were formulated to direct the study.

1. There is no significant difference between the mathematical creativity of students taught using laboratory method and those taught using conventional method.
2. There is no significant difference between the mathematical creativity of male and female students taught using laboratory method.
3. There is no significant difference in mathematical creativity based on the attitude of students taught using laboratory method.

## 2. METHOD

Pretest- Postest non-randomise control group design was used for the study. All Junior Secondary One (JS 1) students in Yenogoa LGA constituted the population. Two schools were randomly selected from the schools in the Local Government Area in the session 2013/2014. The JS 1 students in the classes (Intact class) selected took part in the study. This gave a total of 122 students (55 males and 67 females).

The instruments for data collection were the Mathematics Creativity Test (MCT) and Students Attitude towards Mathematics Questionnaire (SAMQ). The Balka (1974) Creativity Ability in Mathematics Test (CAMT) was adapted for the Mathematics Creativity Test (MCT). Balka (1974) instrument was developed as a measure of mathematical creativity based on mathematicians, mathematics educators, and classroom teachers' input. He considered mathematics creativity as a score obtained in the instrument. This study also considered the definition of mathematics, creativity as the score obtained in the adapted instrument. The adapted instrument contained items such as, in the given polygons with their dotted lines (diagonal), list what happens when you increase the number of circles; do you think there is a relationship between the sides and number of triangles etc. The instrument was only on the concept of geometry and measurement. It had two sections A and B. section A was on demography information while B consisted of twenty items. The students Attitude towards Mathematics Questionnaire also comprised of two parts, A and B. Part A was on demographic information while part B had ten items on a four point Likert-type scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Among the items were mathematics is boring, I preferred mathematics being a compulsory subject, etc.

The instrument was validated by two mathematics educators, and four mathematics teachers. They ascertained the content validity of the instrument. Their corrections were effected on the final print of the instrument. The instruments were trial tested on 20 students who were not part of the study, but had all qualities as those in the study. The Kuder Richardson formula 20 and 21 were used to ascertain the reliability coefficient. Mathematics Creativity Test had a reliability of .82 while Students Attitude towards Mathematics Questionnaire had .78.

The Mathematics Creativity Test was administered as a pre-test to account for possibly pre-existing differences between the two groups. The Students Attitude towards Mathematics Questionnaire was also administered to the students taught with laboratory method only for their responses. The regular class teachers taught the two groups. The experimental group was taught by the teacher using the lesson pack prepared by the researchers after being trained. In the experimental group, the students were allowed to discover relationships between sides and angles, sides and triangles among various polygons and more. This led to formulation of various formulas in geometry and measuration. The control group was taught using the conventional method. In the control group, formulas were stated and used. The two groups were taught geometry and measuration from JS1 mathematics syllabus (NERDC, 2007) for 5 weeks involving four contacts of 40 minutes and 2 contacts of 80 minutes each week.

At the end of the five weeks, the Mathematical Creativity Test was administered as posttest. The pre-test and post-test were scored 1 mark each for any answer and analysed using mean and standard deviation for answering research question and analysis of covariance (ANCOVA) for testing the hypothesis at .05 level of significant. The Students Attitude towards Mathematics Questionnaire was scored SA 4points, A 3points, D 2points while SD 1point and analysed for each student using the weighed mean. Any student who had a weighed mean below 2.5 was considered to have a negative attitude towards mathematics due to his/her disagreement to the items while those who had 2.5 and above were considered to have positive attitude due to their agreement to the items.

## 3. RESULTS

### 3.1. Research Question One

What is the difference between the mathematical creativity of students' taught using laboratory method and those taught using conventional method?

**Table-1.** adjusted Mean and Stand Deviation of Student Taught Using Laboratory and Conventional Method Using Pre-test as Covariate

| Method | N | X | SD |
|---|---|---|---|
| Laboratory | 62 | 12.01 | 2.71 |
| Conventional | 60 | 10.75 | 3.33 |

**Source:** Result from analysis of collected data using SPSS version20

As shown in table 1, the mean score (12.01) of students taught using laboratory method was greater than the mean score (10.75) of students taught using the conventional method. This implies that those taught using laboratory method achieved greater mathematical creativity potential than their counter parts taught using the convectional method. In order to ascertain if this difference was significant, the pre-test and post-test scores were further subjected to the Analysis of Covariance (ANOVA).

### 3.2. Research Question Two

What difference exists between the mathematical creativity of male and female students taught using laboratory method?

**Table-2.** Adjusted Mean and Standard Deviation of Male and Female Students Taught Using Laboratory Method Using Pretest as Covariate.

| Gender | N | X | SD |
|---|---|---|---|
| Male | 29 | 12.15 | 2.25 |
| Female | 23 | 11.84 | 3.09 |

**Source:** Result from analysis of collected data using SPSS version20

Table 2 revealed that the mean score (12.15) of male students was greater than the mean score (11.84) of female students. This implies that male students achieved greater mathematical creativity potentials than their female counterparts. In order to ascertain if this difference was significant, the pre-test and post-test scores were further subjected to the Analysis of Covariance (ANOVA).

### 3.3. Research Question Three

What is the influence of attitude of students taught using laboratory method on their mathematical creativity?

**Table-3.** Adjust Mean and Standard Deviation of Students with Positive and Negative Attitude Using Pretest as Covariate.

| Attitude | N | X | SD |
|---|---|---|---|
| Positive | 28 | 12.79 | 2.46 |
| Negative | 34 | 11.32 | 2.77 |

**Source:** Result from analysis of collected data using SPSS version20

Table 3 showed that the mean score (12.39) of students who had positive attitude was greater than the mean score (11.32) of those who had negative attitude. This implies that those who had positive attitude towards mathematics achieved greater mathematical creativity potentials than those who had negative attitude. In order to ascertain if this difference was significant, the pre-test and post-test scores were further subjected to the Analysis of Covariance (ANOVA).

### 3.4. Hypothesis One

$H_{O1:}$ There is no significant difference between the mathematical creativity of students taught using laboratory method and those taught using the conventional method.

**Table-4.** Covariance Analysis of Mathematical Creativity Scores of Students Taught Using Laboratory and Conventional Method Using Pretest as Covariate

| Source | Sum of Squares(SS) | Df | Mean Square(MS) | F | Sign @ p<.05 |
|---|---|---|---|---|---|
| Corrected Model | 54.28 | 2 | 27.14 | 2.96 | .056 |
| Method | 1025.20 | 1 | 1025.20 | 131.24 | .000 |
| Pretest | 10.33 | 1 | 10.33 | 1.13 | .291 |
| Method | 47.88 | 1 | 47.88 | 5.21 | .024 |
| Error | 1092.84 | 119 | 9.18 | | |
| Total | 16984.00 | 122 | | | |
| Corrected Total | 1147.12 | 121 | | | |

**Source:** Result from analysis of collected data using SPSS version20

As shown in table 4, the calculated probability value of method (P-value) .024 is less than the declared probability value (alpha level) .05. Therefore, the null hypothesis is rejected. It implies that there exist significant difference between the mathematical creativity of student taught using laboratory method and those taught using conventional method.

### 3.5. Hypothesis Two

$H_{O2:}$ There is no significant difference between the mathematical creativity of male and female students taught with laboratory method.

**Table-5.** Covariance Analysis of Male and Female Students Mathematical Creativity Taught with Laboratory Method Using Pretest as Covariate.

| Source | SS | Df | MS | F | Sign @ p<.05 |
|---|---|---|---|---|---|
| Corrected Model | 1.46 | 2 | 0.73 | 0.10 | .908 |
| Method | 810.49 | 1 | 810.49 | 106.85 | .000 |
| Pretest | 0.17 | 1 | 0.17 | 0.02 | .888 |
| Method | 1.42 | 1 | 1.42 | 0.19 | .666 |
| Error | 447.52 | 59 | 7.59 | | |
| Total | 9353.00 | 62 | | | |
| Corrected Total | 448.98 | 61 | | | |

**Source:** Result from analysis of collected data using SPSS version20

Table 5 showed that the calculated p-value of gender (.666) is greater than the alpha level (.05). Therefore, the null hypothesis is retained. This implies that there is no significant difference between the mathematical creativity of male and female students taught using laboratory method

### 3.6. Hypothesis Three

$H_{O3:}$ There is no significant difference in mathematical creativity based on the attitude of students taught using laboratory method.

**Table-6.** Covariance Analysis of Mathematical Creativity Score of Students by Their Attitude Using Pretest as Covariate.

| Source | SS | Df | MS | F | Sign @ p<.05 |
|---|---|---|---|---|---|
| Corrected Model | 32.87 | 2 | 16.43 | 2.33 | .106 |
| Method | 814.74 | 1 | 814.74 | 111.52 | .000 |
| Pretest | 0.34 | 1 | 0.04 | 0.01 | .941 |
| Method | 32.83 | 1 | 32.83 | 4.65 | .035 |
| Error | 416.12 | 59 | 7.05 | | |
| Total | 9353.00 | 62 | | | |
| Corrected Total | 448.98 | 61 | | | |

**Source:** Result from analysis of collected data using SPSS version20

Table 6 revealed that the calculated p-value (0.35) of attitude is less than alpha level (.05). Therefore, the null hypothesis is rejected. This implies that attitude of student taught using laboratory method significantly influence their mathematical creativity.

## 4. DISCUSSION

The study investigated the influence of laboratory method on students' mathematical creativity. The findings from the result indicated a significant influence of laboratory method on students' mathematical creativity. This can be attributed to the laboratory method being able to provide a natural way of making discoveries, starting from concrete to abstract thereby helping in clarifying fundamental concepts. This supports Emaikwu (2012) who stated that activity based teaching involving students active participation in the learning process produces superior results than other methods because children learn best by doing not just by sitting and listening.

The study also found that there existed no significant difference in the mathematical creativity of male and female students, though male performed better than their female counterparts. This is in line with Baer and Kaufman (2008) who stated that while there are research results pointing in various and often contradictory

directions, the evidence does not support gender differences in creativity based on test results. They further stated that, there are studies that report that girls and women score higher than boys and men, and there are those that report the opposite.

The study also examined the influence of students' attitude on their mathematical creativity. The findings from the results revealed a significant influence of students' attitude on their mathematical creativity. This is in line with Mann (2005) who stated that student attitude were a significant predictor of mathematical creativity scores, after controlling for other independent variables.

## 5. CONCLUSION

The following conclusions were drawn based on the findings of the study:

1. Laboratory method of teaching significantly enhanced students' creativity in mathematics.
2. The laboratory method equally enhanced mathematical creativity of both male and female students.
3. Students' attitude towards mathematics significantly influenced mathematical creativity of students.

## 6. RECOMMENDATION

1. Mathematics teachers should ensure that their school have mathematics laboratory or share a corner of their office or classroom for such purposes.
2. Mathematics teachers should explore the use of laboratory method in teaching various concepts in Junior Secondary School level.
3. Workshops, Seminars and Conferences should be organized for mathematics teachers to appraise them with the use of laboratory method.
4. The government, heads of schools and parent-teachers association should ensure that mathematics laboratory is made available and equipped for the use of teachers and students
5. Teachers should possess a demeanor that should influence students towards the class and enlighten them on the importance of mathematics. This would boost the attitude of students.

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