



# RAISING MATHEMATICS STUDENTS' CREATIVE-THINKING-ORIGINALITY TENDENCIES IN SOLVING ACADEMIC CHALLENGES OF WRITING CREATIVE RESEARCH IN DELTA STATE TERTIARY INSTITUTIONS

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## Abstract

*Raising mathematics students' Creative-Thinking-Originality tendencies in solving their academic challenges of writing effective Creative-Research in Delta State tertiary institutions was studied using Pretest and Posttest Quasi-experimental design. Two research questions and two null hypotheses guided the study. Population was 274 and multistage sample was used to obtain 100 mathematics students in two tertiary institutions drawn from the nine Delta State government owned tertiary institutions. Data was collected using Torrance-Test-Creative-Thinking with reliability coefficient of 0.83 obtained by test-retest method with Pearson Product Moment Correlation Statistics. Data was analysed using mean and Analysis of Covariance. Findings from the study revealed that there is no significant difference in the among difference abilities of mathematics students in writing creative research within the teaching methods,  $F(2,93) = 0.123$ ,  $p(0.885) > 0.05$ . However, those mathematics students taught using creative-research (teaching) in writing research exhibited significantly higher than those in the Conventional method  $F(1,93) = 54.773$ ,  $p(0.000) < 0.05$ . Moreso, no significant difference existed in the mathematics students' CTO based on gender on how to write research  $F(2,93) = 0.252$ ,  $p(0.778) > 0.05$ . Thus, Creative-Research Teaching was recommended for the teaching of mathematics in tertiary institutions in Delta State.*

**Keywords:** Creative-Research (teaching), Creative-Thinking-Originality (CTO), Different-Ability and Gender.

## Introduction

In the global education, scholars, practitioners and other stakeholder have long recognized the necessity of creativity development in children and for functional and meaningful living in the 21<sup>st</sup> century. In light of the potential benefits of accessing and using creativity both in the learning process and in daily life, some efforts and findings have supported the incorporation of creativity into curricula, policies, and experimental learning projects, with the expectation that, it will reinforce educational reforms (Tsai, 2013; Handayani, Rahayu & Agustini, 2020). Creativity is the desire of the individual to find an original product or solution (Mustafa & Birsan, 2019). Moreso, Shaheen in

Ayua, Terhempa & Ikyernum, 2022) opined that policies on education of many countries, such as Australia, Canada, United Kingdom, China, Singapore and Nigeria have proven the need to nurture students' creativity through science education promoting their originality of ideas.

Mathematics being the study of numbers, symbols, sizes, patterns, generalizations, measurements, models, quantities, relationships, functions, and its relevance to real life situations, is compulsory as subject in schools and has become a versatile tool in the study of sciences, humanities and technology. It is vital to state that it is useful in human activities in promoting creativity because it is the precursor for scientific discoveries and inventions from originalities of mind. According Hong, Part & Rowell (2017), underdevelopment will destroy a nation that does not take great interest in mathematics creativity. There is no country that can achieve technological breakthrough without a functional mathematics education because the prosperity of any country depends on the quantity of mathematics offered in its educational institutions. Ayua (2019), mathematics education is an aspect of general education and a major instrument for national development through creativity to achieve creative research writing in our tertiary institutions mathematics students.

Crawford in Krippendorf (2019) viewed research as systematic and refined techniques of creative thinking, employing specialized tools, instruments and procedures in order to obtain a more adequate solution to a problem. According to Gomez (2007), educators have viewed creative thinking as a process that could only be pursued on an individual basis. Recognizing inmate developmental quality of creativity in students, they must be motivated when choosing their own tasks of research topic (Zeynalova, 2023). According to him, this would make the task more meaningful to them; when educators devote more time to problem-finding creative skills to communicate to their abilities during research writing transposing extrinsic motivations to foster students' intrinsic motivation. To be innovative with ideas and concepts, mathematics students need to have some basic concepts and knowledge of creative thinking. Dumas and Dunbar (2014) confirmed that, creative-thinking has been truly showed in literature as having important capacity of the human's mind. Zeynalova (2023) opined that creative thinking enable students to use their imagination to generate ideas, questions and hypotheses, experiment with alternatives and evaluating their own compared with their peers' ideas to obtain final products. Osman (2018) viewed creative thinkers need inquiry, examination, research, and discovery, critical thinking to depart from monotony to scrutinizing events. Osman (2018) and Turan, Koc & Karaoglu (2017) pointed out that people who have developed critical thinking and creativity skills can also reflect successful identity status features to become stable after a period of high-quality research in relation to their education level, age, educational department and gender. Pehkonen in Agus (2023), creative thinking is a logical and divergent high-level thinking skill to build new ideas to solve challenging problems in mathematics researches. This involved logical thinking. Logical thinking involves systematic and rational processes of verifying and making valid conclusion (Siswono, 2010 in Agus, 2023).

Creative-Thinking-Originality is one's cognitive process to generate effective ideas in solving problems mathematics under certain aims and conditions (Young and Balli in Handayani, Rahayu & Agustini, 2021). It had shown to have positive action in stimulating the mathematics students' brain functioning that can create proper

learning style (Lince, 2016). This learning style is generated from original ideas of the student's mind. The valuable characteristics of creative-thinking-originality skills include imagination description, independence, experimentation, holism, expression, self-transcendence, surprise, and creativity (McGregor in Handayani, Rahayu & Agustini, 2021). Creative-Thinking-Originality is an interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is novel, useful and original as defined within a social context. Creative-thinking-originality breeds creativity.

Originality is often highlighted as one of the most widely recognized facets of creativity (Fontenot, 2021). Originalities are solutions, methods or questions that are unique and show insight; and ability to produce common and clever ideas. Originality can be seen as a unique idea produced in everyday life to produce something big in an unconventional scientific progress. According to Scholastic Testing Service in Terhempa (2022), originality is viewed as thoughts that are unlikely to be formed by other individuals. Originality is the statistical infrequency and unusualness of the response to ideas Torrance, Ball & Safter in Schnapp (2018). Original thinking helps mathematics students with difference abilities (high, average and low) to combine existing ideas and create new and unusual ideas if taught with effective teaching method that can harness creative-thinking-originality. Although, many teaching pedagogies impacted creative-thinking-originality having collaboration with various theorists to our originality output based within sensorimotor experiences and comes to possess real novelty through creative teaching research Hostetter & Alibali in Fontenot (2021). Thus, the study of creative and original works would benefits from the examinations of the cognitive approach of creative teaching in producing skills to write effective mathematics research from original thoughts and ideas to yield original, unique and novelty products for future visions of research usages.

This study was necessitated by the low creativity level of tertiary institutions mathematics students orchestrated by usage of inappropriate teaching methods as enshrined in the National Policy on Education (Federal Republic of Nigeria, 2014). Moreso, the government educational policies emphasized laying of a sound basis for critical, reflective and independent thinking as well as manipulative skills as components of creativity instructions in tertiary institutions. Hence, this goal cannot be achieved when teaching methods are not hands and minds oriented. No wonder, Naz & Murad(2017), Avwiri (2017) and Peng (2019) studied confirmed that tertiary institutions science students are rendered passive and lacking creativity as a result of poor teaching methods having no impact on students creative research writing. Therefore, creative-thinking-originality which is an aspect of creativity can be achieved when taught with innovative teaching method making the mathematics students to write creative researches. It is against this background that the study seeks to investigate the Creative-Teaching (CT) Research on Creative-Thinking-Originality (CTO) among mathematics students in Delta State Tertiary Institutions.

### **Statement of the Problem**

Over the last three decades creative research writing in most Delta State tertiary institutions, had been difficult despite the unprecedented development that has come at the wake of internet and good library services. These had

not given birth to new ideas in students' creative thinking with the standardized modern ways of scientific, mathematics and technological research activities involving creativity. So, creative mathematics students with good research tendencies are needed in our tertiary institutions becoming creative citizens in the future to enhance mathematics development.

Creativity is the desire of the individual to find an original product or solution (Mustafa & Birsen, 2019). Originality alone in creativity is inadequate. The sense of desire and imagination are the key words of creativity. Torrance (1988); Bartscher, Lawler, Ramirez & Schinault, (2001), Lubert & Sternberg, (1998) in Mustafa & Birsen (2019) defined creativity as the process of sensing difficulties, problems, gaps in information, missing elements to achieve something new by making guesses and formulating hypotheses about these deficiencies; whereby, evaluating and testing these guesses and hypotheses; possibly revising and retesting them and finally communicate the results. This is creative research writing.

To exhibit creative tendencies (skills) in their scholastic endeavors and putting in enough efforts towards effective studies of the research processes enumerated in this study. The school environment is one of the most suitable areas for students creative-thinking-originality development designed with a lot of cultures of thinking under the mentorship of a determined teacher. The importance of ensuring positive environment that mathematics teacher can establish with the students making them safe independently to express themselves originally in ideas without being judged. According to Florida (2004) creative-thinking-originality mathematics students need a more tolerant classroom environment. Honeck (2016) recommended that students' creative-thinking-originalities are developed when they are constructively criticized, errors corrected, tolerances and humorous classroom environments to support their interests. With this, they can learn how to think and do something developmentally and progressively forever. To meet the challenges of creative research writing in mathematics in Delta State Tertiary Institutions; there is urgent need for students to be creative in thinking bringing product from their original ideas.

### **Purpose of the Study**

The purpose of this study is to investigate the Creative-Teaching (CT) Research on Creative-Thinking-Originality (CTO) among mathematics students in Delta State tertiary institutions. Specifically, the study seeks to:

1. Examine the mean Creative-Thinking-Originality scores of the mathematics students with different ability levels in writing mathematics research using creative teaching and conventional method.
2. Find out the mean Creative-Thinking-Originality scores between male and female mathematics students with different ability levels in writing mathematics research using creative teaching.

### **Research Questions**

The following two research questions were raised to guide the study:

1. What are the mean Creative-Thinking-Originality scores of mathematics students with different ability levels in writing mathematics research using Creative teaching and conventional method?

2. What are the mean Creative-Thinking-Originality scores between male and female mathematics students with different ability levels in writing mathematics research using creative teaching?

### Hypotheses

The following two null hypotheses were formulated and tested at  $p < 0.05$  alpha-level of significant.

1. There is no significant difference in the creative-thinking-originality scores of mathematics students with different ability levels in writing mathematics research using creative teaching and conventional methods.
2. There is no significant difference in the Creative-Thinking-Originality between male and female mathematics students with different ability levels in writing mathematics research using creative teaching?

### Methodology

A pre-test post-test Quasi-experimental design was used for the study. After pre-test, the experimental group was taught how to write mathematics research using Creative Teaching (CT); while, the control group was taught the same concept using conventional method (CM) for at least six weeks before post-test. This was to harness Creative-Thinking-Originality (CTO) by producing unimaginable, novel, and unique product. A multistage (stratified, purposive and random) sample of 100 tertiary institutions mathematics students in two institutions (University of Delta, Agbor and Delta State College of Education, Mosogar) were drawn from the population of mathematics students in Delta State. Firstly, the tertiary institutions were stratified into two (4 Universities with 84 mathematics students and 3 Colleges of Education (97), and 3 Polytechnics (83) respectively. Secondly, the two tertiary institutions were purposively selected because they were from the north and central senatorial districts of Delta State. Creativity equivalence test was administered to the mathematics students' in the two institutions and Analysis of Variance (ANOVA) was used to determine mathematics students' Creative-Thinking-Originality (CTO) homogeneity and equivalence. The research casted a lot A=Experimental Group, B=Control Group, C=Not involved in any group and D= None of the above for the four schools. Thirdly, the two institutions that were drawn from the lot had their mathematics students randomly assigned into 50 in experimental and 50 in control groups, respectively. This was for the purpose of honesty, objectivity, ensuring a bias-free sampling and assignment of subjects into groups. Torrance Test of Creative-Thinking (TTCT) Originality was used for data collection. Section A collected mathematics students' bio-data; while, section B had three activities each lasting for 10 minutes with opportunity for multiple responses of ideas, to test students' creative-thinking-originality in mathematics. Mathematics Students' Abilities levels were based on previous terms performance grades thus: high=A/B; Average =C/D; low= E/F. TTCT was validated by two experts; a senior lecturer in Mathematics Education and a professor of mathematics both from the Department of Science Education, College of Education, Mosogar and University of Delta, Agbor. The instrument was pilot tested on 25 mathematics students in Delta State University Abraka other than the sample for the main study. A reliability coefficient of 0.83 was determined by a test –retest method with Pearson Product Moment Correlation. The research questions were answered using mean and standard deviation; while, hypotheses were tested at 0.05 p-level using two-way Analysis of Covariance due to normality of the

distribution, homogeneity of variance, randomness of selection, measured based on interval scale and independence of samples.

## Results

**RQ1:** What are the mean Creative–Thinking–Originality (CTO) scores of the students with different ability levels in writing Mathematics using Creative Teaching (CT) and Convention Method (CM)?

**Table 1:** Mean and Standard Deviation of Creative-Thinking-Originality scores of mathematics students' Creative-Teaching (CT) and Conventional Method (CM)

| Abilities Levels | Sample (n) | Teaching Method | Pretest Mean; SD | Posttest Mean; SD | Mean Gain |
|------------------|------------|-----------------|------------------|-------------------|-----------|
| High             | 14         | CM              | 4.30; 2.09       | 2.67; 1.42        | 1.63      |
|                  | 14         | CT              | 3.34; 1.50       | 2.71; 1.86        | 0.92      |
| Average          | 19         | CM              | 3.32; 1.53       | 2.14; 1.28        | 1.18      |
|                  | 22         | CT              | 3.20; 1.03       | 2.07; 1.05        | 1.13      |
| Low              | 20         | CM              | 3.64; 2.09       | 2.23; 0.94        | 1.41      |
|                  | 11         | CT              | 3.12; 1.78       | 4.70; 1.40        | 1.58      |
| Cluster          |            | CM              | 3.58             | 2.36              | 1.22      |
|                  |            | CT              | 3.39             | 4.16              | 0.71      |

The result in Table 1 shows homogeneity in the pretest creative-thinking-originality mean scores among difference abilities of students, between; CM and CT with cluster means of 3.58 and 3.59. The Table also shows that all the creative–thinking–originality mean scores among different abilities of student in the CT were higher than those in the CM with cluster mean gain difference of 0.54.

**RQ2:** What are the mean Creative–Thinking–Originality scores between male and female students with different ability levels of writing Mathematics research using creative teaching?

**Table 2:** Mean and standard deviation of creative –Thinking –Originality scores of male and female students in writing mathematics research using creative teaching.

| Abilities levels | Sample (n) | Gender | Pretest Mean; SD | Posttest Mean; SD | Mean Gain |
|------------------|------------|--------|------------------|-------------------|-----------|
| High             | 10         | M      | 3.40;1.28        | 2.67;1.42         | 1.63      |
|                  | 18         | F      | 3.98;2.08        | 2.71;1.86         | 0.92      |
| Average          | 15         | M      | 3.62;1.73        | 2.14;1.28         | 1.18      |
|                  | 26         | F      | 3.50;1.63        | 2.07;1.05         | 1.13      |
| Low              | 23         | M      | 3.24;1.27        | 2.23;0.94         | 1.41      |
|                  | 08         | F      | 2.61;0.78        | 4.70;1.40         | 1.58      |
| Cluster          |            | M      | 3.70             | 2.70              | 1.00      |
|                  |            | F      | 3.15             | 3.88              | 0.73      |

The result in Table 2 shows homogeneity in the pretest mean scores among difference abilities levels between male and female mathematics students with cluster means of 3.70 and 3.15. The table also showed that the creative-thinking-originality mean scores in the post test of writing mathematics research were homogenous between male and female test with a cluster mean gain of 1.00 and 0.73.

**HO1:** There is significant difference in the creative-thinking-originality scores of mathematics students with different ability levels in writing mathematics research using creative teaching and conventional methods.

**Table 3:** Summary of two–way ANCOVA analysis on Creative–Thinking–Originality scores among different ability levels of writing mathematics research on teaching methods

| Source | Type sum of squares | Df | Mean Square | F | P | Partial Eta Squared | Noncent. Parameter | Observed Power |
|--------|---------------------|----|-------------|---|---|---------------------|--------------------|----------------|
|        | 3                   |    |             |   |   |                     |                    |                |

|                     |          |     |         |        |       |       |        |       |
|---------------------|----------|-----|---------|--------|-------|-------|--------|-------|
| Corrected Model     | 150.951  | 6   | 25.158  | 10.421 | 0.00  | 0.498 | 62.529 | 1.000 |
| Intercept           | 205.135  | 1   | 205.135 | 89.526 | 0.587 | 0.587 | 89.526 | 1.000 |
| Originality Pretest | 2.360    | 1   | 2.360   | 0.895  | 0.014 | 0.014 | 0.895  | 0.154 |
| Teaching Method     | 126.226  | 1   | 126.226 | 54.773 | 0.465 | 0.465 | 54.774 | 1.000 |
| Abilities levels    | 7.89     | 2   | 4.198   | 1.739  | 0.052 | 0.052 | 3.478  | 0.352 |
| Teaching Method     | 0.654    | 2   | 0.297   | 0.123  | 0.004 | 0.004 | 0.246  | 0.068 |
| Error               | 148.132  | 93  | 2.415   |        |       |       |        |       |
| Total               | 1325.430 | 100 |         |        |       |       |        |       |
| Corrected Total     | 312.045  | 99  |         |        |       |       |        |       |

**R-squared=0.498 (Adjusted R-squared=0.450)**

The result in Table 3 showed no significant difference in the Creative-Thinking-Originality among difference abilities students' levels of writing mathematics using CT and CM,  $F(2,93)=0.123$ ,  $p(0.885) > 0.05$ . Therefore, the null hypothesis was not rejected. However, the Table showed that students' creative-thinking-originality in the CT of writing mathematical researches were better than those in the CM,  $F(1,93)= 54.773$ ,  $p(0.000) < 0.05$ . The implication of this result is that, although, creative teaching enhances creative-thinking-originality in mathematics creative research writing. This is not dependent on students' academic abilities coupled with their difference abilities levels of writing mathematics research using creative teaching and conventional method.

**HO<sub>2</sub>:** There is no significant difference in the Creative-Thinking-Originality between male and female mathematics students with different ability levels in writing mathematics research using creative teaching?

**Table 4:** Summary of two-way ANCOVA Analysis on Creative-Thinking-Originality scores among male and female Mathematics students' of writing mathematics research based on creative method.

| Source              | Type 3 sum of squares | Df  | Mean Square | F     | P     | Partial Eta Squared | Noncent. Parameter | Observed Power |
|---------------------|-----------------------|-----|-------------|-------|-------|---------------------|--------------------|----------------|
| Corrected Model     | 18.354                | 6   | 18.354      | 0.638 | 0.057 | 0.498               | 3.825              | 1.000          |
| Intercept           | 289.128               | 1   | 289.128     | 52.76 | 0.456 | 0.587               | 52.760             | 1.000          |
| Originality Pretest | 5.061                 | 1   | 5.061       | 1.116 | 0.017 | 0.014               | 1.116              | 0.150          |
| Gender              | 0.130                 | 1   | 0.130       | 0.029 | 0.000 | 0.465               | 0.029              | 0.053          |
| Abilities levels    | 10.724                | 2   | 5.362       | 1.182 | 0.036 | 0.052               | 2.365              | 0.250          |
| Gender Ability      | 2.283                 | 2   | 1.142       | 0.008 | 0.504 | 0.004               | 0.504              | 0.088          |
| Error               | 285.694               | 93  | 4.535       |       |       |                     |                    |                |
| Total               | 1325.430              | 100 |             |       |       |                     |                    |                |
| Corrected Total     | 312.045               | 99  |             |       |       |                     |                    |                |

**R Squared= 0.057 (Adjusted R Squared= 0.033)**

The result in Table 4 revealed that significant difference does not exist in the creative–Thinking–Originality among different ability levels of male and female Mathematics students for writing research using CT,  $F(2,63) = 0.252$ ,  $p(0.778) > 0.05$ . The null hypothesis was therefore, not rejected.

## Discussion

Creative-thinking-originality on conventional method and creative teaching showed no significant differences in the creative-thinking-originality scores among different ability levels of Mathematics students. The study agrees with Fontenot (2021) who found no significant difference in originality-thinking task though with different strategy used. However, Mathematics students' creative-thinking-originality for writing Mathematics research using creative teaching was higher than those in the conventional method. The study finding disagreed with Peng (2018) and Lince (2016) who found significant differences in the combined creative-thinking scores (fluency, flexibility, and originality) for the three TIPS items. This may due to variations in curriculum content, teaching strategies, locations, probably time and the combined TIP. With respect to field experience, the finding is not odd because Mathematics students in the creative teaching were engaged through heightening anticipation, deepening expectation and keeping it going to: tickle their imaginations, acquire and create ideas, look beyond the information on the surface to find what is beneath it all, construct their knowledge, and use resources for future visions in writing effective mathematics research. This is in collaboration with Zeynalova (2023) research studied finding that qualities of creativity in students develop when allowed to choose their own tasks of research topic. These tasks become meaningful and motivated to them; when educators devote more time to problem-finding creative-skills to communicate to their abilities during research writing.

Regarding students Creative-thinking-originality based on gender, no significant difference existed in the creative-thinking-originality between male and female students with different-ability level in writing Mathematics research using creative teaching. This implies that, creative teaching on creative-thinking-originality is without gender disparity among different ability levels in Mathematics students. This disagreed with Chua (2015) findings that male out-performed the female students on originality, fluency and elaboration components of creative thinking ability. It means the male students were better in elaborating creative ideas than the female students. The present research study finding does not collaborated with Zalizan, Khadijah, Hazadiah & Ma'rof (2003) that difference exists between male and female students on learning styles. Zalizan, Khadijah, Hazadiah & Ma'rof (2002) in Chau (2015) claimed that male and female students who possessed different thinking and learning styles have different perspectives on the teaching style of teachers. Following field experience, the finding is not strange because both boys and girls explored their ideas, construct and use it for future research writing through active involvement in creative teaching and learning processes. Thus, the finding disagreed with Ode, Ayua and Alabi (2019) who found significant differences in creativity (fluency and originality) scores based on gender. This may also be due to variations in Mathematics curriculum content, teaching strategies, locations and probably time in writing researches.

## Conclusion and Recommendations

Based on the findings, it was concluded that: creative-thinking-originality among different ability of mathematics students will certainly be enhanced without gender disparity when they were taught on how to write effective research using creative teaching. Doing this effectively, the following were recommended:

- Mathematics teachers at the tertiary institutions levels should be trained by the Federal, State Ministries of Education and other stakeholders through seminars, workshops on how to effectively utilize creative teaching in writing mathematics researches.
- Government through the Ministries of Education, and teacher training institutions in Nigeria (Colleges of Education and Universities) should ensure in-service training and retraining of their mathematics teachers to maximize creative teaching lesson delivery.
- Teacher training institutions in Nigeria should include constructive teaching strategies such as creative teaching in the teacher training programmes to enable mathematics students effectively write creative researches.
- Tertiary institutions Heads should provide creative materials and funds needed by the mathematics teachers for creative teaching of mathematical contents.

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