The effect of using Constructivist Approach in developing critical thinking skills of classification and identifying relationships in Mathematics among Secondary School students

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Abstract- Mathematics as a language is a mixture of Concepts and techniques developed to aid precise and logical thinking about the relationship between physical and abstract objects. The learning of Mathematics therefore involves learning of Mathematical concepts and learning of Mathematical techniques. Piaget had initially warned that efforts to introduce abstract concepts to students without the corresponding experience would not result in conceptual learning but would only lead to memorization (rote learning) or learning of techniques alone; although techniques cannot be mastered without rote memorization. The non-equivalent control group design was used for the study. A Traditional approach (Control treatment group) and a Constructivist approach (the Experimental treatment group), were used for the teaching of a Mathematics content (Statistics) and the students’ critical thinking skills (CTS) of Classifying and Identifying relationships were tested using researcher constructed and validated instrument. The result showed that the mean post-test CTS of Classification for the Control treatment group was $\overline{x} = 28.96; SD = 6.34$ while the mean post-test CTS for the Experimental treatment group was $\overline{x} = 73.08; SD = 13.50$; and the mean post-test CTS of Identifying relationships for the Control treatment group was $\overline{x} = 57.54; SD = 24.68$ while the mean post-test CTS for the Experimental treatment group was $\overline{x} = 73.81; SD = 12.99$. An ANCOVA test of between-subjects effects showed a significant difference for both groups in each skill with p=0.000>0.05 between the mean post-test scores for the Control and Experimental groups but not for gender. This showed that the Constructivist approach to the learning of Mathematics was effective and results into conceptual learning of Mathematics content and development of CTSs of Classification and Identifying relationships for both male and females. The Constructivist approach to the learning of Mathematics is therefore recommended for the learning of Mathematics to ensure its application in daily life and logical living.

Keywords: Increasing Critical thinking skills, reasoning, constructivist approach, constructivism in education, problem solving, developing critical thinking skills

INTRODUCTION
The aims of Mathematics syllabus in secondary schools among others are the understanding of mathematical concepts and their application to everyday living and development of precise, logical, and abstract thinking. Obviously, these aims are peculiar to cognitive agents who are capable of conscious mental activities such as thinking, reasoning and remembering. Mathematics has been conceived as a language developed to aid precise and logical thinking about the relationship between physical and abstract objects. Can any approach to the teaching Mathematics lead students into developing those abilities? In the past, the emphasis in classrooms has been on imparting information and content [1] Scholastic.com (2021). Now, the principal goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done. The second goal of education is to form minds which can be critical, can verify, and not accept everything they are offered [2] (Piaget in Cherry, 2019). With the shift of emphasis in the goal of education, comes the demand for teaching approaches that would result in the type of learning desired. Can the Constructivist approach to the teaching of Mathematics content create men who are capable of doing new things, not simply repeating what they have been taught, and form minds which can be critical, can verify, and not accept everything they are offered?

Meaning, nature, and learning of Mathematics
Mathematics as a body of knowledge, is a language developed to aid precise and logical thinking about the relationships between physical and abstract objects [3](Marshall Cavendish Limited, 1989). It is a mixture of Concepts and Techniques [4] (World Book Encyclopedia, 1996). While robots, and lower animals are capable of acquiring techniques; Concepts, however, are abilities that are peculiar to cognitive agents. [5] Mosovich (2006), strengthened this act of thinking about the relationship between objects when he argued that the human talent for pattern recognition is simply the understanding that there is a systematic relationship between the elements in nature. For him, when this relationship is sought out, found and expressed, that is the language of Mathematics. He summarized mathematics when he said that whenever there is relationship and pattern, there is mathematics. Concepts are ideas, People learn or understand them by thinking, discussing, reading, listening and/or writing about them.
Critical Thinking skills of Classifying and Identifying Relationship

Critical thinking can be seen as having two components: 1) a set of information and belief generating and processing skills; and 2) the habit, based on intellectual commitment, of using those skills to guide behavior. It is thus contrasted with: 1) the mere acquisition and retention of information alone. 2) the mere possession of a set of skills because it involves a continual use of them, and 3) the mere use of those skills (“as an exercise”) without acceptance of their results (Elder, September, 2007). People who think critically are keenly aware of the inherently flawed nature of human thinking when left unchecked. SkillsYouNeed.com (2023) contend that Critical thinking is the ability to think clearly and rationally, understanding the logical connection between ideas. In essence, critical thinking requires one to use one’s ability to reason. It is about being an active learner rather than a passive recipient of information. In the past, the emphasis in classrooms has been on imparting information and content, however, there's been a shift toward teaching critical thinking, a skill that elevates thinking beyond memorization into the realm of analysis and logic [9](Scholastic Parents Staff, 2021). There are elements that experts agree are essential for critical thinking, such as being able to think independently, clearly and rationally. It involves the ability to reflect on an idea or problem, apply reason, and make logical connections between ideas [10] (Australian Christian College, 2023).

CONSTRUCTIVISM AND CONSTRUCTIVIST APPROACH

Teachers of Mathematics have often taken for granted that given the logical nature of their subject that once a student is taught Mathematics that the student is bound to develop the skills and habit of being critical, logical, and precise in his thinking. [13]Wejr (2010) summarized that “How you teach becomes what you teach”, He further emphasized that “We cannot teach democracy by running our classes like a dictator. How something is taught becomes what you teach”, He further emphasized that “We cannot teach democracy by running our classes like a dictator. How something is taught becomes just as important as what is taught [14] (Werner and Bower, 1988).

Constructivism is a recent theory of learning and cognition which holds that people actively construct their own knowledge and that reality is determined by the experiences of the knower, rather than existing as an objective truth that is passively absorbed, distinct from the individual [15]Johassen, in Elliott, Kratochwill, Cook, & Travers, 2000; [16] University at Buffalo, 2023.

In the statement of the objectives of mathematics at the secondary schools, there are objectives that focus at acquisition of information, and there are those focused on the application and use of concepts in mathematics. The goal of teaching is learning; the different forms of learning articulated by [17] TeachThought (2023) include Memorization, Acquiring facts or procedures, Understanding reality, and Making sense of the world. But Piaget had initially warned that efforts to introduce abstract concepts to students without the corresponding experience would not result in conceptual learning but would only lead to memorization (rote learning). The point is to see that the more adequate our grasp of what we understand as “Knowledge”, the more we can consciously, and morally play the educator in mathematics education, the term “concept” repeatedly surfaces, often in contrast to the term “skill” or “techniques”. Yet the teaching of mathematics as skills still predominates in our schools, particularly because advocates of conceptual learning often assume the value of concepts without explicitly defending it by defining precisely what they are. Until an adequate response to this question is given, the question of how to teach concepts will remain unanswered and the method of skill teaching will continue to dominate mathematics teaching [18] (Confrey, July, 1981).

In essence, critical thinking requires you to use your ability to reason. It is about being an active learner rather than a passive recipient of information.

Can Critical Thinking Ability Be Tested Or Developed?

Efforts to show that Critical thinking skills can be increased or developed by carefully planned intervention was established by Prat-Sala, (Sept. 17, 2020); [20]Lapuz and Fulgenico, (2020); and [21]Narmaditya, Wulandari, & Sakarji, (2018)

There are various well-validated tests that quantify critical thinking. Here’s some examples:

**Problem of the study**

Given that Mathematics is composed of Concepts and Techniques, and given also, that the new emphasis in the goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done. Except the effect of various approaches to the teaching of Mathematics is scientifically established, It will remain unknown why mathematical concepts cannot be taught in the same way as mathematical techniques to attain these new goals. This research sets itself the problem of investigating the effect of using Constructivist Approach over the Traditional method of Mathematics teaching for the development of Critical thinking skills of Classifying and Identifying relationship in Mathematics among Secondary School Students.

**Purpose of the study**

The research will reveal the effect of using constructivist approach in teaching statistics in students’ critical thinking skills of classifying, and Identifying relationships over the traditional approach of teaching statistics.

**Research Questions**

The following research questions were constructed to guide the study:

1. What are the mean achievements of students taught statistics using constructivist teaching approach (Experimental) and those taught using traditional approach (Control) in the Critical Thinking skill of classification?
2. What are the mean achievements of male and female students taught statistics using constructivist teaching approach and those taught using traditional approach in the Critical Thinking skill of classification?
3. What are the mean achievements of students taught statistics using constructivist teaching approach and those taught using traditional approach in the Critical Thinking skill of Identifying relationships?
4. What are the mean achievements of male and female students taught statistics using constructivist teaching approach and those taught using traditional approach in the Critical Thinking skill of Identifying relationships?

**Research Hypotheses**

The following research hypotheses were generated to guide the study:

1. There is no statistically significant difference in the mean Critical Thinking skill of classification at 0.05 level of significance between students taught statistics using Constructivist approach and those taught using traditional approach.
2. Male and female students do not statistically differ significantly at 0.05 level of significance in the mean critical thinking skill of classification.
3. There is no statistically significant difference in the mean Critical Thinking skill of Identifying relationship at 0.05 level of significance between students taught statistics using Constructivist approach and those taught using traditional approach.
4. Male and female students do not statistically differ significantly at 0.05 level of significance in the mean critical thinking skill of Identifying relationships.
5. There is no statistically significant interaction effect between constructivist teaching approach and gender of students at 0.05 level of significance.

**Research Design:**

The non-equivalent control group design; a type of quasi-experimental research experimental and control treatment groups was used. This research design is deemed appropriate as this experiment is basically to find out the effect of the use of Constructivist approach as an experimental treatment in developing critical thinking skills of mathematics among secondary school students using intact classes.

This design is also considered necessary as it was not possible to place students in groups by random assignment and the subjects in the different intact groups differ by number and gender. The Control group was included primarily to make it possible to measure the effect of extraneous factors upon the post test. [22] Kenny (1975) and [23] Jhangiani, R. S., Chiang, I. A., Cuttler, C., Leighton, D. C., & Metz, M. A, (nd) commended the adequacy of this design where random assignment of experimental and Control treatments has not been applied or where the equivalence of the groups is not assured.

**Treatments:**

The control group was taught using the traditional method whereby knowledge is transmitted to students through lecture method, memorization and passive reception of knowledge while the Constructivist approach emphasized student active participation and engagement in the gathering of data and creation of knowledge, conceptual teaching and utilization of student experiences, students were given group projects and assignments. More activity based, using questioning, explaining, demonstration and collaboration techniques.

**Instrumentation:**

The instruments for the study comprised of

(a) Pre-test
(b) Post-test
Thirty six (36) Critical Thinking Skills achievement tests otherwise called Mathematics usage tests (MUT) consisting of fifteen (15) CTS tests for the skill of Classification and twenty one (21) CTS tests for the skill of Identifying relationship as validated by the evaluators were used. Each is meant to test CT ability of students in Mathematics. The questions were spread over the four (4) content areas of Mathematics Curriculum in Statistics and two levels Blooms Taxonomy of educational objectives in the Cognitive domain as:

<table>
<thead>
<tr>
<th>Levels of Blooms Taxonomy</th>
<th>Content area</th>
<th>Organization of Data</th>
<th>Measures of typicality</th>
<th>Measures of dispersion</th>
<th>Positional measures</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Comprehension</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>21</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

**Reliability of Instrument**

The reliability of the two Mathematics usage tests (MUT) of the sampled Critical thinking skills tests namely Classification & Identifying relationships were established using split half method. The correlation coefficients were determined as $r_{12} = .71$ & .74 and the spearman-Brown formula correlation was used to determine the internal consistencies as; $r = .84$ and .90 respectively for Critical thinking skills of Classification and Identifying relationships

**Validation of Instrument**

Two (2) different Mathematics Usage tests (MUT) were constructed, each containing twenty five (25) questions. Five experts considered the questions for (1) the suitability of the items in testing for the particular CTS (2) the suitability of the language (3) the relevance of each item (4) other things deemed necessary in the wisdom of the experts and validated the tests

| Items accepted or modified under the above mentioned conditions are those approved by at least three of the five experts. At the end 36 of the 50 questions were finally used as indicated in the table of classification. The Concurrent validity were further established using Pearson Correlation coefficient with $r=0.81$ and 0.83 for the skills of Classifying and Identifying relationship respectively.

**Method of data Collection and Scoring of instruments**

The tests were administered to the respondents by the researcher at intervals. The students responded to the items on the question papers in an answer sheet attached to each CTS tests. These test questions and their answer sheets were retrieved from the students as soon as each subject finished with answering the questions. After the first set, the students were allowed 30 minutes for recreation before commencing the last set.

Each CTS tests had a total score of 100%. Each of the CTS test had 5%. Total score of each student in any CTS test was calculated using the formula

$$T = \frac{(5n \times 100)}{5}$$

From “Equation 1” T is the total score by a student subject, $n$ is the number of correct answers scored by each student on each CTS test, and N is the total number of questions in each CTS test.

**Method of Data Analysis**

The main threat to the internal validity of non-equivalent Control group design as in the present study is the possibility that group differences on the post test are due to pre-existing group differences arising from non-randomization rather than to a treatment effect.

The data collected was analyzed using SPSS with particular focus on Mean, standard deviation, and ANCOVA was used for the hypotheses tests. ANCOVA is chosen to partition out the variation due to the extraneous variables and to increase the precision of the experiment.

**Results of Data Analysis**

**Research Question 1:** What are the mean achievements of students taught statistics using constructivist teaching approach (Experimental) and those taught using traditional approach (Control) in the Critical Thinking skill of classification?

<table>
<thead>
<tr>
<th>Dependent Variable: POST TEST SCORE OF SUBJECTS</th>
<th>Dependent Variable: POST TEST SCORE OF SUBJECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUPS IN THE EXPERIMENT</td>
<td>GROUPS IN THE EXPERIMENT</td>
</tr>
<tr>
<td>GENDER OF THE SUBJECT</td>
<td>GENDER OF THE SUBJECT</td>
</tr>
<tr>
<td>MEAN</td>
<td>STD. DEV.</td>
</tr>
<tr>
<td>MALE</td>
<td>73.333</td>
</tr>
<tr>
<td>FEMALE</td>
<td>72.857</td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>73.077</strong></td>
</tr>
<tr>
<td>MALE</td>
<td>29.667</td>
</tr>
<tr>
<td>FEMALE</td>
<td>28.400</td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>28.963</strong></td>
</tr>
</tbody>
</table>
Table 2 shows that the mean post achievements of students taught statistics using Constructivist approach (Experimental) is (\(\bar{x} = 73.08, S = 13.50\)) and those taught using the traditional approach (Control) is (\(\bar{x} = 28.96, SD = 6.34\)) in the critical thinking skill of classification.

**Research Question 2:** What are the mean achievements of students taught statistics using constructivist teaching approach and those taught using traditional approach in the Critical Thinking skill of Identifying relationships?

Table 2 shows that the mean achievements of students taught statistics using Constructivist approach (Experimental) is \(\bar{x} = 73.81, SD = 12.99\) and those taught using the traditional approach (Control) is \(\bar{x} = 33.33, SD = 10\) in the critical thinking skill of Identifying relationships.

**Research Question 3:** What are the mean achievements of male and female students taught statistics using Constructivist approach (Experimental) and those taught using traditional approach in the Critical Thinking skill of Identifying relationships?

**Research Question 4:** What are the mean achievements of male and female students taught statistics using Constructivist approach and those taught using traditional approach in the Critical Thinking skill of Identifying relationships?

**Research Hypotheses**

**Research Hypothesis 1:** There is no statistically significant difference in the mean Critical Thinking skill of classification, at 0.05 level of significance between students taught statistics using Constructivist approach (Experimental), and those taught using traditional approach (Control).

Table 3: Analysis of Covariance on Tests of Between-Subjects Effects on the Critical Thinking Skills of Identifying Relationship and Classification

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected</td>
<td>23653.6</td>
<td>4</td>
<td>5913.4</td>
<td>58.37</td>
<td>0.00</td>
<td>Corrected</td>
<td>25939.4</td>
<td>4</td>
<td>6484.81</td>
<td>57.27</td>
<td>0.00</td>
</tr>
<tr>
<td>Model</td>
<td>46</td>
<td>6</td>
<td>7.05</td>
<td>0.14</td>
<td>0.70</td>
<td>Model</td>
<td>225</td>
<td>2</td>
<td>102.62</td>
<td>5.13</td>
<td>0.04</td>
</tr>
<tr>
<td>Intercept</td>
<td>4057.86</td>
<td>1</td>
<td>4057.86</td>
<td>40.05</td>
<td>0.00</td>
<td>Intercept</td>
<td>7327.0</td>
<td>1</td>
<td>7327.05</td>
<td>64.70</td>
<td>0.00</td>
</tr>
<tr>
<td>PRESCHOOL</td>
<td>1160.49</td>
<td>1</td>
<td>1160.49</td>
<td>11.45</td>
<td>0.00</td>
<td>PRESCHOOL</td>
<td>151.19</td>
<td>1</td>
<td>151.19</td>
<td>1.335</td>
<td>0.254</td>
</tr>
<tr>
<td>RE</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>RE</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>TREAT</td>
<td>21209.2</td>
<td>1</td>
<td>2120.92</td>
<td>21.03</td>
<td>0.00</td>
<td>TREAT</td>
<td>24278.0</td>
<td>1</td>
<td>24278.8</td>
<td>214.4</td>
<td>0.00</td>
</tr>
<tr>
<td>MENT</td>
<td>2</td>
<td>222</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>MENT</td>
<td>837</td>
<td>37</td>
<td>0.04</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>GROUPS</td>
<td>340.719</td>
<td>1</td>
<td>340.72</td>
<td>3.363</td>
<td>.073</td>
<td>GROUPS</td>
<td>2.141</td>
<td>1</td>
<td>2.141</td>
<td>.019</td>
<td>.891</td>
</tr>
<tr>
<td>GENDER</td>
<td>206.336</td>
<td>1</td>
<td>206.34</td>
<td>2.037</td>
<td>.160</td>
<td>GENDER</td>
<td>5.374</td>
<td>1</td>
<td>5.374</td>
<td>.047</td>
<td>.828</td>
</tr>
<tr>
<td>Error</td>
<td>4862.47</td>
<td>48</td>
<td>101.30</td>
<td>0.04</td>
<td>2</td>
<td>Error</td>
<td>5435.4</td>
<td>48</td>
<td>113.24</td>
<td>0.54</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>178455.0</td>
<td>53</td>
<td>3.4181</td>
<td>1.17</td>
<td>0.27</td>
<td>Total</td>
<td>16709</td>
<td>53</td>
<td>0.00</td>
<td>1.37</td>
<td>0.254</td>
</tr>
<tr>
<td>Corrected</td>
<td>28516.1</td>
<td>52</td>
<td>548.14</td>
<td>0.00</td>
<td>0</td>
<td>Corrected</td>
<td>31374</td>
<td>52</td>
<td>6.79</td>
<td>0.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

a. CRITICAL THINKING SKILL EMPHASIZED = IDENTIFYING RELATIONSHIP
b. R Squared = .829 (Adjusted R Squared = .815)
c. Computed using alpha = .05
Table 3 above shows that the mean score of the Experimental group (\(\bar{x} = 73.08, S = 13.50\)) differs significantly with the mean score of the Control group (\(\bar{x} = 28.96, SD = 6.34\)) in critical thinking skill of Classification with \(p = .000 < .05\). The experimental treatment was quite effective in developing critical thinking skill of classification among students. The table shows that more than 81% of the variability in the mean score on critical thinking skill of Identifying relationship is accounted for by the experimental treatment.

**Research Hypothesis 2**: Male and female students do not statistically differ significantly at 0.05 level of significance in the mean critical thinking skill of classification.

Table 3 shows that males with (\(\bar{x} = 73.33; SD = 14.97\)) and females with (\(\bar{x} = 72.86; SD = 12.67\)) do not differ in their mean score in Critical thinking skill of Classification with \(p = .891 > .05\).

**Research Hypothesis 3**: There is no statistically significant difference in the mean Critical Thinking skill of Identifying relationship at 0.05 level of significance between students taught statistics using Constructivist approach and those taught using traditional approach.

Table 3 above also shows that the mean score of the Experimental group (\(\bar{x} = 73.81, S = 12.99\)) differs significantly with the mean score of the Control group (\(\bar{x} = 33.33, SD = 10\)) in critical thinking skill of Classification with \(p = .000 < .05\). The table shows that more than 81% of the variability in the mean score on critical thinking skill of Identifying relationship is accounted for by the experimental treatment.

**Research Hypothesis 4**: Male and female students do not statistically differ significantly at 0.05 level of significance in the mean critical thinking skill of Identifying relationships.

Table 3 shows that males with (\(\bar{x} = 79.25; SD = 12.11\)) and females with (\(\bar{x} = 69.14; SD = 12.23\)) do not differ in their mean score in Critical thinking skill of Classification with \(p = .073 > .05\).

**Research Hypothesis 5**: There is no statistically significant interaction effect between constructivist teaching approach and gender of students at 0.05 level of significance for the critical thinking skill of Classification and Identifying relationships.

From tables 3, the interaction effect between treatment and gender for the Critical Thinking skill of Classification is \(p = .828 > .05\) shows that there is no significant interaction effect meaning that the treatment was equally effective for both male and female subjects. Similarly, the interaction effect between treatment and gender for the Critical thinking skill of Identifying relationships is \(p = .160 > .05\) again showing that there is no significant interaction effect between treatment and gender for the Critical thinking skill of Identifying relationship respectively.

Cognitive abilities like thinking, reasoning and problem-solving may be considered to be some of the chief characteristics which distinguish human beings from other species including the higher animals; it enables the individual to make sense of the world [24]; [25]; [18]. (Reshma, nd; Sharma, nd; Confrey, July 1981).

**Discussion:**

The use of constructivist approach in teaching students statistics resulted in very high mean achievement of 73.08% and 73.81% for the Critical thinking skills of Classification and Identifying relationship respectively as in Table 2, while those taught the same content using the traditional teaching approach had a mean achievement of 29% and 33.3% for the same skills of Classification and Identifying relationship respectively. The differences in the mean achievements between the Experimental and Control groups for the Critical thinking Skills were tested for significance in table 3 using ANCOVA and the result showed a statistically significant difference in the Experimental and control group means for the two Critical thinking skills with a \(p\)-value of .000 and .000<.05 indicating that the differences in the mean achievements of experimental and Control groups is a real difference resulting from the superiority of the Constructivist Approach over the Traditional approach to the teaching of Statistics content of Secondary School Mathematics Curriculum for SSS3 students. The interaction effect showed a \(p\)-values of \(p = .828\) and .160 respectively for Critical thinking skills of Classification and Identifying relationship respectively, revealing a non-significant interaction effect between the Experimental treatment and gender of subjects. Meaning that the experimental treatment was equally effective for both male and female subjects for the two skills. These findings synchronize with the findings of show that Critical thinking skills can be increased or developed by carefully planned intervention established by Prat-Sala, (Sept. 17, 2020); Lapuz and Fulgenico, (2020); and Narmaditya, Wulandari, & Sakarji, (2018).

**Conclusion**

Mathematics is composed of “Concepts” and “Techniques; the term “concept” repeatedly surfaces, often in contrast to the term “Techniques”. Yet the teaching of mathematics as techniques still predominates in our schools; the question of how to teach concepts will remain unanswered and the method of teaching “Techniques” will continue to dominate mathematics teaching (Confrey, July, 1981). To learn (think), the teacher will have to engage the student using the student’s own experience.

Today’s education system is seriously flawed – it focuses on teaching rather than learning thereby reconstructing the nature of Mathematics into content that can be acquired without thinking or experience. Critical thinking requires the teachers to engage students’ natural ability to reason, it is about being an active learner rather than a passive recipient of information. Constructivism is an approach that rigorously engages students to question ideas and assumptions rather than accepting them at face value. The use of constructivist approach showed a significant positive effect on students’ achievement on the test of critical thinking skills.
Recommendation:
Critical thinking has been aptly defined by Elder, (Sept. 2007) as the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing and/or evaluating information gathered from or generated by observation, experience, reflection, reasoning or communication as a guide to believe and action. It has been dubbed as a vital component of 21st century skills. This research has shown that teachers can more easily develop or increase this critical skills among Mathematics students, when teaching is done using constructivist approach. The following recommendations are therefore suggested:

1. Teachers should be made to focus on students’ learning rather than teaching; by concentrating on students’ own experiences as starting point for teaching. The Students should be led into planned experiences that contain the expected learning and be made to reflect upon those experiences.
2. Students should be made to think on their experiences by engaging the students natural ability to reason using constructivist approach; noting that Piaget had initially warned that efforts to introduce abstract concepts to students without the corresponding experience would not result in conceptual learning but would only lead to memorization (rote learning).
3. Teachers should rigorously engage students to question their ideas, and assumptions by being an active learner rather than being a passive recipient of information. Respecting children’s experiences and or stages of mental development, that is the way to get them involved.
4. Teachers need to realize that based on the nature of Mathematics, that not all teaching approach will result in learning Mathematics; while mathematical facts, skills and techniques could be learnt by memorization and drill, Mathematical concepts can mainly be learnt by Constructivist approach. To be able to meet with the new goals of Mathematics education, it is always better and productive when a student is made to know Mathematical concepts and techniques; i.e. teachers should be made to know that mathematical concepts cannot be taught in the same way as mathematical facts, skills, and techniques to attain the new goals of Mathematics education.

REFERENCES:


