EFFECT OF CONCEPT MAPPING APPROACH ON STUDENTS ACHIEVEMENT IN MATHEMATICS IN SECONDARY SCHOOLS

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Abstract

The study was carried out to determine the effect of concept mapping approach on students’ achievement in Mathematics in Secondary School in NgorOkpala Local Government Area of Imo State. Based on the objective of the study, three hypotheses guided the study. The quasi-experimental research design was used in carrying out the study adopting the pre-test – post-test control type. The sample consists of 180 Senior Secondary One (SS1) Students comprising of 88 males and 92 females. In each of the schools selected two intact classes were assigned experimental and control groups. The experimental group was taught mathematical concepts using concept mapping approach while the control group was taught using traditional method. The data required for the study was collected using researcher made questions titled Mathematics Achievement Test (MAT). It had reliability coefficient of 0.79 determined using kuder-Richardson formula 20 (KR20). Mean, standard deviation, analysis of covariance (ANCOVA) and t-test statistical tools were used to analyse the data at 0.05 level of significance. The result of the study showed that, concept mapping approach improved students achievement in mathematics, the method removed gender inequality. Based on the result of the study it was recommended that, concept mapping approach should be used by teachers in teaching mathematics in secondary schools to improve students’ achievement.

Keywords: Achievement, mathematics, concept, mapping

Introduction

Mathematics is one of the core subjects to be offered by all students up to tertiary levels of education among science and technology courses. The compulsory nature of mathematics carries with it an assumption that all members of our society should have the knowledge of the subject.

Irrespective of the great importance of mathematics in nation building, scientific and technological development, its still notable that the students performance in mathematics at internal and external examinations has remained considerably poor (Ale, 1989). Ekwueme and Ali (2003) stated that, despite the important position mathematics occupies, it still remains one of the subjects that students persistently perform poorly in. Mathematics remains the most dreaded subject for many students in primary and secondary schools. Accordingly, the observed poor performance in mathematics has been a matter of serious concern to all well-meaning educators. Students’ poor performance over the years has been attributed to teachers’ use of inappropriate teaching methods which make students become passive and have less interaction with each other in doing task (zakaria, solfitri, Daud & Abidin, 2012).

The need for improved achievement in Mathematics has driven teachers and researchers to seek appropriate instructional strategies. These instructional strategies are the ones that will allow students to control their learning process as well as develop the required interest in mathematics. According to Jegede, Ala iyimola and Okebukola (1990), the increasing awareness of the importance of learner centeredness in the
teaching-learning situation has generated a lot of attention in relation to understanding how learners learn and how to help them learn about concepts. These efforts in assisting learners to learn more effectively has led to the development of meta-cognitive strategies to enhance meaningful learning (Biggs; 1988; Cliburn; 1990). According to Novak (1987) metacognitive strategies are strategies that empower the learner to take charge of his/her own learning in a highly meaningful fashion. Borich (2004) noted that metacognition which is a strategy used in self directed learning are mental processes that assist learners to reflect on their thinking by internalizing, understanding, and recalling the content to be learned. Concept mapping as a metacognitive instructional strategy is based on Ausubel-Novak-Godwin theory of meaningful learning, it relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognition bridging and integrative reconciliation (Ausubel, Novak &Hanesian 1978; Gowin, 1981, Novak &Gowin 1984).

Concept mapping is a technique used to represent the relationships among concept in two dimensional graph (Riu&Huichey 1996). According to Kinchin (2005) concept mapping serves as a strategy to help learners organize their cognitive frameworks into more powerful integrated patterns. Concept mapping is a systematic device for presenting a set of concept meanings embedded in a framework of propositions (Novak &Gowin, 1984). Concept mapping is a procedure that is used to measure the structure and organization of an individuals’ knowledge. It is also a strategy that can be used to develop students’ capacity to learn independently. According to Ajaja (2009), concept mapping is a learning strategy that students find useful in understanding complex ideas and clarifying ambiguous relationships. It is a two-dimensional representation of the relationship between key ideas in a topic. A concept map is a graph structure containing nodes that are interlinked by labelled directed areas. The nodes, which are linked together into propositions, show how students connect or link concepts.

The propositions are represented by arrows to connect individuals conceptstogther, the directionality of the link is indicated by arrow. The conceptualization of the materials by the students is indicated by the directionality and the connecting proposition. The proposition, thus illustrates the contextual relationship of the concepts to each other (Adeneye&Adel; 2011).

Concept maps are based on the premise that concepts do not exist in isolation but depend upon others for meaning. Concept maps represent knowledge in a hierarchical form. The hierarchical structure as supported by Novak (1998) has been questioned as the only means of linking concepts together (Ruiz - Primo &Shavelon; 1996) and one suggestion has been that the structure of the map should allow the structure of the knowledge and not the other way around (Derbentseva&Safayeni, 2004). The proponents of the concept mapping strategy posit that meaningful learning ensues when a learner is aware of and can control, the cognitive processes associated with learning.

Concept map is visualized through a graphical representation, concepts are usually depicted by circles of bones, forming the nods of the new work by labelled links (Buzzetto-More 2007).

The importance of concept maps according to Ahmed (2010) includes

1. Concept maps can be used as advanced organizer to improve learners achievement (Kommers 2004).
2. Provide teachers with a meaningful and practical structured approach.
3. Aids the development of deep meaningful teaching moving towards critical thinking rather than surface approaches.
4. Concept maps also allow students to reflect their own misunderstanding and take ownership of their learning (Fitzgerald 2004).
5. Organize their thoughts and visualize the relationships between the key concepts in a semantic way (Pill 2005).

According to Novak (1998) the process of concept mapping can reduce the need for rote memory and make learning more meaningful.

Men-lei and Ming-Hsiung (2012) in a study to determine the effect of concept mapping on students cognitive load discovered that students
in the concept mapping class reduced cognitive load more than did students in the traditional teaching class. Kabaca (2002), and McLay and Brown (2003) compared concept mapping to the traditional method and concluded that former was more successful. Akeju, Simpson, Rotimi and Kenni (2011) in a study discovered a significant effect of concept mapping instructional strategy on students’ learning achievements. The strategy had a lingering effect that prompts recall of learned materials. Candan (2006) investigated the effect of concept mapping on primary school students understanding of the concepts of the force and motion. The result revealed that, there was a significant difference between the mean scores of experimental and control groups but gender had no significant influence on their understanding. Esiobu and Soyibo (2006) investigating the effects of concept and vee mappings on students cognitive achievement in ecology and genetics, discovered that, the experimental groups performed better than the control group. Adeneye and Adeleye (2011) in a similar study, discovered that concept mapping strategy enhanced students achievement in mathematics. It was also noted that concept mapping offers another means to create the necessary ‘mind-on’ environment that differentiates coherent mathematics instruction from a series of isolated activities. Johnston and Otis (2006) suggested that concept mapping should be treated as very personal learning tools.

**Statement of the problem**

Many students struggle to learn mathematics and often do not achieve success through their learning. This may stem from the fact that, they do not construct appropriate understanding of fundamental mathematics concepts through their learning strategies. This has left the students with poor performance in both public and internal examinations (Obodo 2004). Despite the high position offered to mathematics in Nigerian education system, it is disheartening that approaches and strategies for teaching and learning of this subject at both primary and secondary levels are not probably being put to use effectively that could promote learners activity and provide learners’ guided practice enabling them to retain concepts taught and solve problems (Achor, Imoko & Uloko 2009). It is against this backdrop that this study was carried out to answer the question, what is the effect of concept mapping approach on secondary school students’ achievement in mathematics?

This study aims at investigating the effect of concept mapping teaching approach on students’ achievement in mathematics. Specifically, this study will determine whether:

- Students taught mathematical concept using the concept mapping approach will perform better than those taught using the conventional approach.
- Male and female students in the experimental group will differ in their post test mean achievements scores.

**Methodology**

The quasi-experimental research design was employed in carrying out the study adopting the pre-test – post-test non equivalent control group design. This design was used to determine the effect of concept mapping approach on students’ achievement in mathematics at secondary school level since it was not possible to apply the true experimental design.

The population of the study consists of all the senior secondary one (SS1) students in the government owned secondary schools in Ngor Okpala Local Government Area of Imo State. A sample of 180 senior secondary one (SS1) students was used for the study as comprised of 3 secondary schools purposively selected for the study. The sample comprised of 88 male and 92 female students. In each of the schools selected for the study, two intact classes were assigned each of experimental and control groups. The experimental group had total of 102 students (48 males and 54 females) while the control group had 78 students (40 males and 38 females). The instrument used for data collection was a researcher made test instrument titled Geometry Achievement Test (GAT). It was a 40 item objective test question developed based on table of specification.

To ensure face and content validation, the instrument was given to three mathematics education experts and two measurement and Evaluation experts for validation. Their inputs were used for modification before it was administered. The instrument had reliability coefficient of 0.79 which was considered good.
enough for the study. This was determined through Kuder-Richardson formula 20 (KR20).

In each of the schools, two mathematics teachers were used for the study. The teacher for the experiment group was trained on concept mapping approach while the other was not. The trained teacher taught the experimental group using concept mapping approach while the control group was taught by the other teacher using the traditional approach. Before the lessons, both groups were pretested to ensure equal cognitive background.

The topic taught was a quadrilateral using the same lesson plan but different approaches. In the experimental group the students were guided through construction of concept maps showing relationships between different forms of quadrilateral using nodes. The relationship was based on area, perimeter, properties which nodes were used to link up similarities. After four weeks of lessons both groups were given a post-test using transposed version of the instrument.

The research questions were answered using mean and standard deviation while the hypotheses were tested using analysis of covariance (ANCOVA) and t-test statistical tools tested at 0.05 level of significance.

Results

RQ1: what is the difference between the mean achievement scores of students taught mathematical concepts using concept mapping approach and those taught using the traditional approach?

Table 1: Summary of students’ achievement

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Diff in mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expt</td>
<td>102</td>
<td>45.85</td>
<td>10.95</td>
<td>14.85</td>
</tr>
<tr>
<td>Contl</td>
<td>78</td>
<td>31.00</td>
<td>8.75</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 shows that, a mean achievement difference of 14.85 exist between students taught mathematical concepts using concept mapping approach and those taught using the traditional approach. This difference is in favour of those in the experiment group.

RQ2: what is the difference between the post test mean achievement scores of male and female students taught mathematical concept using concept mapping approach?

Table 2: Summary of post-test mean achievement of male and female students in experiment group

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Diff in mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>48</td>
<td>46.15</td>
<td>10.99</td>
<td>0.56</td>
</tr>
<tr>
<td>Females</td>
<td>54</td>
<td>45.59</td>
<td>11.01</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows that, a mean achievement difference 0.56 exists between male and female students achievement in the post test. This minor difference is in favour of the male students.

Ho1: There is no significant difference between the mean achievement scores of students taught mathematical concepts using concept mapping approach and those taught using the traditional approach.
Table 3: Summary of ANCOVA analysis of students’ achievement

<table>
<thead>
<tr>
<th>Source</th>
<th>SSS</th>
<th>df</th>
<th>MS</th>
<th>f-cal</th>
<th>Sig</th>
<th>Desn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected model</td>
<td>9928.680</td>
<td>2</td>
<td>4964.340</td>
<td>49.317</td>
<td>.000</td>
<td>Reject null</td>
</tr>
<tr>
<td>Intercept</td>
<td>26141.807</td>
<td>1</td>
<td>26141.807</td>
<td>259.700</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>177.724</td>
<td>1</td>
<td>177.724</td>
<td>1.766</td>
<td>.186</td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>8762.781</td>
<td>1</td>
<td>8762.781</td>
<td>87.052</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>17817.070</td>
<td>177</td>
<td>100.661</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>307407.000</td>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>27745.750</td>
<td>179</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a.R squared=.358(Adjusted R.squared=.351)

Table 3 above shows that, the computed F(87.052) is greater than the critical (3.84) also the sig (.000) is less than the sig (0.05). The result implies that, there is a significant difference between the mean achievement scores of students taught mathematical concepts using concept mapping approach and those taught using the traditional approach. The null hypothesis is rejected at 0.05 level of significance.

H0: There is no significant difference between the post-test mean achievement scores of male and female students taught mathematical concepts using concept mapping approach.

Table 4: Summary of t-test analysis of male and female students

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Df</th>
<th>t-cal</th>
<th>Sig</th>
<th>X</th>
<th>Desn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>48</td>
<td>46.146</td>
<td>10.986</td>
<td>100</td>
<td>.254</td>
<td>.800</td>
<td>0.05</td>
<td>Null</td>
</tr>
<tr>
<td>Females</td>
<td>54</td>
<td>45.593</td>
<td>11.005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 shows that the sig (.800) is greater than the significant level (0.05).

Also the computed t (.254) is less than the critical t(1.65). The result implies that there is no significant difference between the post-test mean achievement scores of male and female students taught mathematical concepts using concept mapping approach. The null hypothesis is upheld at 0.05 level of significance.

**Discussion of findings**

The result of the study revealed that students taught mathematical concepts using concept mapping approach had better achievement than those taught using the traditional approach as shown on table 1 above also, the result tested at 0.05 level of significance showed that, there was a significant difference between the mean achievement scores of students taught mathematical concepts using concept mapping approach than those taught using traditional method. This is subject to the fact that concept mapping approach is interactive, student centred in nature and allowed the students control their learning. This result is in agreement with the previous studies of Esiobu and Soyibo (2006), Ahmed (2010) Kabaca (2002), Mclay and Brown (2003).

Finally, the result of the study on table 11 revealed a minor difference in the post-test mean achievement scores of male and female students taught mathematical concepts using concept mapping approach, this was in favour of the male students. However, no statistical significant difference existed between their mean achievement scores when tested at 0.05 level of significance. This result agrees with the work of Ahmed (2010), Candan (2006) whose result revealed no statistically significant difference observed between genders due to concept mapping approach.

**Conclusion**

The study was carried out to determine the effect of concept mapping approach on student’s achievement in mathematics. The study revealed that concept mapping approach significantly enhanced the achievement of students in mathematics than the traditional methods, it had
no gender effects, it encouraged students’ classroom participation and interest.

**Recommendations**

Based on the findings of the study, the following recommendations are made:

1. Concept mapping approach should be used in teaching mathematical concepts in secondary schools as to improve students’ achievements, interest and participation in the subject.

2. Seminars, workshops and symposium should be organized to train mathematics teachers on how to use effective instructional approaches such as concept mapping in teaching mathematics.

3. Mathematics curriculum planners should integrate and lay emphasis on concept mapping approach in the restructuring of the curriculum as to help students develop better understanding of important concepts.

**References**


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