Lagos State University, Ojo, Lagos State, Nigeria

From the Selected Works of Bolanle Danmole

Fall March, 2005

EFFECT OF CONCEPT MAPPING ON STUDENTS' ACADEMIC PERFORMANCE IN JUNIOR SECONDARY SCHOOL INTEGRATED SCIENCE IN ILORIN METROPOLIS

Bolanle Danmole, (Ph.D)
S.A. Adebayo, (M.Ed)

This work is licensed under a Creative Commons CC_BY-NC-SA International License.

Available at: https://works.bepress.com/bolanle-danmole/
EFFECT OF CONCEPT MAPPING ON STUDENTS' ACADEMIC PERFORMANCE IN JUNIOR SECONDARY SCHOOL INTEGRATED SCIENCE IN ILORIN METROPOLIS

By

DANMOLE, B. T. (Ph.D)

and

ADEBAYO, S. A. (M.Ed)

ABSTRACT

The study sought to determine the effect of concept mapping on students' performance in junior secondary school integrated science in Ilorin métopolis. Pretest and posttest control only research design was employed to determine if there was any significant difference in the performance of the experimental group taught with concept mapping comprising of 67 students (45 males and 22 females) and the control group of 61 students (38 males and 23 females). Four hypotheses were developed and tested in the study. The results revealed that the experimental group exposed to concept mapping performed significantly better than students in the control group who were not taught using concept mapping. There was no significant difference in the performance of male and female students taught with the concept mapping. The results suggest that concept mapping is a valid and potentially useful strategy for improving students' performance. It was recommended that concept mapping be used in teaching in addition to other appropriate instructional strategy or method to enhance effective and meaningful teaching/learning.
INTRODUCTION

Science educators have been criticized regarding the nature of science taught in our secondary schools due to the frequent poor performance of students in the science subjects (Daramola, 1983). Science advocates have attributed several factors to the poor performance of students, some of which are poor quality of instruction (Danmole, 1992); student inability to understand and apply science concept (Hallack, 1990). Several studies have also highlighted this: Novak Gowin (1984); Jegede, Alaiyemola and Okebukola (1990); Esiobu & Soyibo (1995).

The frequent poor performance of science students in the Senior Secondary School Certificate Examinations shows that there is the need to re-examine the way students are taught science in Nigerian secondary schools. This has become inevitable in order to bring about meaningful learning and understanding of concepts, laws and theories, since the three statements: What to teach, how to teach and how students learn are inextricably intertwined. If teachers are able to teach effectively, students will understand and perform better in science.

The advances made in learning in cognitive science and the new philosophy of science together with the epistemological ideas of the constructivists (i.e. learning as a human construction) and its intersection especially with the learner have influenced the way teaching and learning process is viewed. To the constructivists, learning is viewed as a process of conceptual change where a learner’s preconceptions are recognized through an interaction between experiences and new information. This means that learning involves the learner taking active role in building new knowledge by modifying their existing conceptions. Also, an increasing awareness of the importance of learner centredness in the teaching and learning process has directed a lot of attention to understanding how learners learn and how to help them learn concepts (Jegede et al 1990). These efforts have led to the development of metacognitive strategies to enhance meaningful learning. As explained by Novak (1987) metacognitive strategies are concerned with the learner taking charge of his/her learning in a meaningful way. These strategies also include learning about meaningful learning (metalearning) and learning about nature of knowledge (metaknowledge) which could be realized using concept mapping.

Concept mapping is one of such instructional strategies, which evolved from the work of Novak (1984) and his associates. It is based on Ausubel’s (1963, 1968; Ausubel, Novak and Hanesian, 1978) assimilation theory of cognitive learning. This theory asserts that concepts derive their meaning through connections or relationship with other concepts and meaningful learning occurs only when new knowledge is consciously linked with relevant concepts or propositions already possessed by the learner. The concept mapping detailed by Novak and Gowin (1984, p 34-44) is a procedure for assisting learners to recognize concepts and order information about the properties of objects, events or processes into a meaningful whole.

The use of concept mapping as an instructional strategy has provided positive effects: interesting and positive results in teaching and learning situations in science and science related subjects have been obtained. For example, Novak, Gowin and Johansen (1983), found that experimental eight-grade (S. S. II) classes which received instruction in mapping demonstrated superiority over control classes in problem solving skill. Okebukola and Jegede (1988), also found that concept mapping significantly improved pre-degree students’ achievement in genetics and ecology respectively, while Ahove (1998), showed that in-service integrated science trainee teachers who used concept mapping with lecture/discussion
method to teach, taught better than their counterparts who did not. The reasons was the fact that “the concept mapper (trainee teachers) achieved metacognition which facilitates learning and understanding of abstract concepts” by allowing the trainee teachers reconceptualise their subject matter knowledge as a conceptually rich tapestry of interrelated ideas and make science conceptually transparent.

Several studies have been carried out by educational researchers on concept mapping in the elementary school (Novak and Mosunda, 1991). The students were found to be capable of developing very thoughtful concept maps, which shows conceptual growth. In the senior secondary school, positive results have been obtained in biology (Okebukola and Jegede, 1988; Okebukola and Soyibo, 1995); chemistry (Novak, 1984; Cullen, 1990); and Mathematics (Malone and Deckers, 1984; Okonkwo, 1998). The efficacy of concept mapping in enhancing meaningful learning was expressed in the results of these preceding studies. However, the dearth of literature on the use of concepts mapping in the junior secondary school level provides the justification for this study.

The foundation for learning of science in the Nigerian secondary school starts from the junior secondary school in the form of integrated science. This level of the educational system is of a three-year duration. Therefore, if proper foundation is laid from the onset, such poor performance as a result of poor learning and understanding of concepts can be checked and addressed before students get to senior secondary school.

One of the factors interacting with learning is gender difference and researches have produced mixed findings. While some findings revealed that male students have higher level of achievement than their female counterparts in science, others found that female students achieved better than male students, yet some findings showed no significant difference. For instance, Danmole (1998), reported that male students performed better in integrated science than female students with mean scores of (23.25 and 21.68 respectively) in a study carried out on performance of junior secondary school entrants. However, despite that the mean score of male students was found to be higher than that of the female students, there was no statistically significant difference in their performance. Furthermore, she noted that though males as a group performed better than females, her findings showed many cases in which individual female students out performed individual male students. Roach (1979), found that females had higher mathematics achievement than males in his study on the effect of conceptual style performance, related cognitive variables and sex on achievement in mathematics. However, Bello (1996), found that gender did not have any significant influence on students’ understanding of biology concepts. Because of the diverse nature of results of obtained as above, this study also looked at the effect of gender on students’ performance in integrated science.

PURPOSE OF THE STUDY
The purpose of this study was to provide answers to the following research questions from which four corresponding hypotheses were formulated.

1. Is there any difference in the performance of students taught using concept mapping and those taught using conventional teaching only in integrated science concepts?

2. Would there be any difference in the performance of male students exposed to concept mapping and male student exposed to conventional teaching only in integrated science concepts?
3. Will female students exposed to concept mapping perform better than female students exposed to conventional teaching only integrated science concepts?

4. Will female students exposed to concept mapping perform better than female students exposed to the same treatment?

METHODOLOGY

The study is a quasi-experimental study. The research was pretest-posttest non-randomized non-equivalent control group design (Stanley and Campbell, 1966). The research design involved two components namely: the independent variable which is concept mapping and the treatment for the pre-and posttests. The target population was JSS III students in co-educational schools in Ilorin metropolis.

SAMPLE

The sample was selected from JSS III students in one chosen co-educational school in Ilorin metropolis. The choice was informed by the fact the students have been exposed to basic concepts of science at this level, serving as a means of assessing their level of understanding of these concepts. Two intact classes were used for this study. Intact classes means the students who were members of such class only. No student was brought in from other classes. The experimental group comprised of 67 students (45 males and 22 females) and the control group of 61 students (38 males and 23 females).

INSTRUMENT

The instruments consisted of a 20-item multiple choice and a 10-item short answer Essay Integrated Science Performance Test (ISPT). The topics on which the students were tested were water and solution derived from the recommended JSS syllabus textbooks. The students had no prior knowledge of the two topics. These topics feature prominently in the basic science subjects making them relevant to the learning of science beyond the JSS level. A reliability coefficient of 0.68 was obtained using the test-retest method. Subject specialist and science educators adjudged the contents of the adequate in scope and depth of coverage. Their judgment in terms of the content of coverage of the area of interest, clarity of items, cognitive levels measured based on Bloom’s taxonomy was used in selecting the instrument. Bloom’s taxonomy of educational objectives assessed in the instrument are the first level (rote recall of specific information) in the 20-item multiple choice ISPT and the fourth and fifth levels (analysis and synthesis) in the 20-item theory ISPT.

PROCEDURE FOR DATA COLLECTION

The treatment for the experimental group was concept mapping along with suitable teaching method(s). The treatment took place in a six 60-minutes lessons for a period of two weeks. Three lessons were conducted each week. The first two lessons are devoted to training the students in the concept mapping technique in which operational definition of key terms such as concept, object, event link(ing) word, proposition, hierarchy, cross-link, were taught. The remaining four lessons were used to apply their knowledge and understanding of concept mapping derived from the first two lessons to drawing of concept maps of the topic taught. Although the students were required to draw concept maps, such maps were not scored; it was meant to facilitate their understanding of the concepts. The control group was not exposed to concept mapping. They were exposed to conventional teaching using any suitable teaching method(s).
However, they were also taught how to map after the study.

Data Analysis technique involved calculation of the mean and standard deviation of the scores obtained from the two groups in pre-and posttest treatment and t-test statistical analysis was used to test the hypotheses at 0.05 significant level.

RESULTS

The following are the findings:

1. There is a significant difference in the performance of students exposed to concept mapping and students exposed to conventional teaching in integrated science concept as shown in Table 1 i.e. students exposed to concept mapping performed better than their counterparts exposed to conventional teaching only in integrate science concepts.

2. A significant difference exist in the performance of male students exposed to concept mapping and male students exposed conventional teaching only in integrated science concepts (Table 2) showing that male and female students exposed to concept mapping performed better than their counterparts (male and female) exposed to conventional teaching only in integrated science concepts.

3. A significant difference also exists in the performance of female students exposed to concept mapping and female students exposed to conventional teaching only in integrated science concepts (Table 3)

4. There is no significant difference in the performance of male students and female students exposed to concept mapping (Table 4) i.e. male students exposed to concept mapping performed significantly better than female students.

Table 1: Means and Standard Deviations of Pre-and Posttest Scores for Hypothesis 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>No</th>
<th>Mean score</th>
<th>Standard Deviation</th>
<th>t-value</th>
<th>Critical value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>67</td>
<td>8.6</td>
<td>8.3</td>
<td>3.4</td>
<td>3.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group</td>
<td>61</td>
<td>26.5</td>
<td>20.1</td>
<td>5.0</td>
<td>4.7</td>
<td></td>
</tr>
</tbody>
</table>

Significant at 0.05 level, calculated t-value > table value i.e. 7.7 and 1.96 respectively. Hypothesis rejected.

Table 2: Means and Standard Deviations of Pre-and Posttest Scores for Hypothesis 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>No</th>
<th>Mean score</th>
<th>Standard Deviation</th>
<th>t-value</th>
<th>Critical value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>45</td>
<td>8.8</td>
<td>4.1</td>
<td>5.4</td>
<td>6.1</td>
<td>1.980</td>
</tr>
<tr>
<td>(male)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>38</td>
<td>8.1</td>
<td>20.7</td>
<td>2.7</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>(Female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significant at 0.05 level, calculated t-value > table value i.e. 6.1 and 1.980 respectively. Hypothesis rejected.
Table 3: Means and Standard Deviations of Pre-and Posttest Scores for Hypothesis 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>No</th>
<th>Mean score</th>
<th>Standard Deviation</th>
<th>t-value</th>
<th>Critical Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental (female)</td>
<td>22</td>
<td>8.1</td>
<td>25.2</td>
<td>3.4</td>
<td>4.8</td>
<td>2.78</td>
</tr>
<tr>
<td>Control (Female)</td>
<td>23</td>
<td>8.3</td>
<td>21.9</td>
<td>4.8</td>
<td>5.8</td>
<td></td>
</tr>
</tbody>
</table>

Significant at 0.05 level, calculated t-value > table value i.e. 2.78 and 2.01 respectively. Hypothesis rejected.

Table 4: Means and Standard Deviations of Pre-and Posttest Scores for Hypothesis 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>No</th>
<th>Mean score</th>
<th>Standard Deviation</th>
<th>t-value</th>
<th>Critical Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Experimental</td>
<td>45</td>
<td>8.8</td>
<td>8.1</td>
<td>4.1</td>
<td>5.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Female (Experimental)</td>
<td>22</td>
<td>26.6</td>
<td>26.2</td>
<td>5.4</td>
<td>4.8</td>
<td></td>
</tr>
</tbody>
</table>

Significant at 0.05 level, calculated t-value < table value i.e. 0.5 and 1.980 respectively. Hypothesis accepted.

DISCUSSION

The findings in tables 1, 2 and 3 are in agreement of with previous studies of science educators such as Novak and Gowin (1984); Okebukola and Jegede (1988); Jegede et al (1990); Esiobu and Soyibo, (1995); Ahove (1998) etc on the effectiveness of concept mapping as an instructional strategy. The significant difference is partly attributable to the capability of concept mapping to enable the experimental group to observe clearly the relationship among concepts and to link these to related concept they already possessed. Prior knowledge has been observed to influence subsequent learning by Pines and Leith (1981). They contend that two students with different cognitive structures prior to instructions would diverge further with subsequent instruction. In other words, what a child hears and learns depends on what he already knows. Concept mapping also enabled learners to actively and individually construct their own understanding of the lesson topic taught and become active information processors instead of passive listeners.

Their ability to process information on their own was clearly demonstrated by the students in the construction of their individual maps. Each student constructed his own map based on his understanding of the topic. Brunner (1966), summed it up, saying that it is hardly something outside the learner that is discovered. Instead, the discovery involves an internal reorganization of previously known ideas in order to establish a better fit between those ideas and the regularities of an encounter to which the learner has had to accommodate.

As Novak (1990), has stated, his experience has been that when students are required to construct their own personal concept maps for topics they have been studying, they find new meanings in the subject and new way(s) to relate what they already know to the things they are learning. According to him, subject matter ceases no be a mass of definitions to be memorized or problems to be solved by the routine plugging-
in of numbers or symbols into abstract formulas. This was likely to have aided their relatively better understanding of the concept taught as shown by their better performance over the control group. Figures 1 & 2 are examples of post instruction concept maps drawn by a student in the experimental group.

**Figure 1: A concept map on hardness of water drawn by a student after treatment**

An analysis of such concept maps drawn by the students can provide invaluable feedback to the teacher for improving instruction, as it would give better insight into the logical and hierarchical presentation of concepts in a lesson to the students. The findings in this study also indicate that male and female students exposed to concept mapping performed equally well (table 4), which is consistent with the result of several other studies (Inomiesa, 1989; Soyibo and Esiobu 1995; Bolo, 1996).
It is however in contrast with reports on investigations (on sex related differences) that male students performed better than female students (Jegede et al 1990; Novak and Mosunda, 1991; Danmole, 1998). In traditional inclined societies like Nigeria, females are perceived as the weaker sex and hence cannot perform as well as the male in pursuance of the study of science and science related subjects (Ezenwa, 2001). It may be that concept mapping, a metacognitive strategy, can be used to overcome gender-related differences in performance in learning and performance not only in integrated science, but other subjects as well.

CONCLUSION

This study examined the effects of concept mapping on students’ performance in the learning of integrated science and found out that from the result obtained, substantial important changes in the students’ understanding of science concepts improved after classroom instruction using concept mapping. This suggests that concept mapping serve as a useful means of enhancing better and meaningful conceptual understanding and growth. Also, concept mapping would assist the teacher in evaluating is teaching, concentrate on important aspects of topics that need to be emphasized. By using this instructional strategy, they complement and do not duplicate the work of other teaching methods by enriching their teaching through more students’ participation. This would help students understand difficult concepts which prior to the use of concept mapping, they exhibit difficulty in conceptualizing such concepts through other teaching processes. Furthermore, the integrated science teacher should employ concept mapping strategy as a self-evaluating tool in planning classroom instruction and students’ evaluation to enhance the quality of their lessons.

Individual attention and interaction is also established between the teacher and students in the process of correcting concept maps drawn by each student. Students would have the opportunity of laying claim to the knowledge they have constructed, fostering positive student-teacher relationship which actually help the student to learn better. Consecutive map revisions showed the development of a cohesive conceptual understanding. From these findings, it could be concluded that concept mapping is an effective vehicle for improving students’ performance in integrated science.

RECOMMENDATIONS

It was therefore recommended that:

1. Concept mapping, a more cognitive and student oriented pedagogical instructional strategy should be used in teaching in addition to other conventional method(s) often used in Nigerian schools to enhance effective teaching/learning situation and study skills.

2. The Federal State and Zonal Inspectorate of Education should organize seminars/workshop training periodically for teachers on how to use concept mapping to enhance effective teaching.

3. Female students be given the opportunity to aspire to any academic height, as they are also capable of studying any of the sciences or science related course as the male children.

4. Curriculum planners could use this strategy in determining what should be in the curriculum. The use of concept maps can assist both the science teacher and the curriculum expert to develop a curriculum that is
hierarchically arranged, integrated and conceptually driven that meets the needs of both the teacher and the learner. This is also applicable to science textbook authors.

5. Educational bodies such as Joint Admission and Matriculation Board, (JAMB), West Africa Examinations Council, (WAEC), National Examinations Council, (NECO), Interim Joint Matriculation Board, (IJMB) etc., should use specific information based on developed concept maps to structure questions asked in their examinations.

REFERENCES


