EFFECT OF CONCEPT MAPPING TECHNIQUE ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND RETENTION OF ECOLOGY CONCEPTS

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Effect of Concept Mapping Technique on Senior Secondary School Students’ Achievement and Retention of Ecology Concepts

Dr. B. T. Danmole & K. O. Femi-Adeoye

Abstract
The study attempted to verify the efficacy and potency of concept mapping technique in improving senior school students’ achievement in ecology. A total of 137 students, comprising 58 males and 79 females, were involved in the study. A pretest-posttest control quasi-experimental research design was used to determine if any significant difference existed between experimental group taught with concept mapping technique and the control group taught with lecture method using Biology Achievement Test (BAT). The result shows that the experimental group performed significantly better than the control group. Also, the result obtained from posttest scores administered to the experimental and control group six weeks after the first posttest to check their level of retention showed that the experimental group again performed better than the students in the control group. This is further supports other research efforts which shows that concept mapping technique is an effective technique for causing meaningful learning in students.

Introduction
Science and technology constitute essential components of our contemporary world. Indeed, the characteristics of societies in modern times are determined by the advancement in the two interrelated human activities.

According to Brow Acquaye (2001), today apart from raising man’s standard of living, science has enabled developing nations to improve on their desire to match the fact of advancement made in industrialized countries in all facets of development. These include health, agriculture, shelter, communication, transportation, environment and many more. Modern development is no longer possible outside the frame work of science and technology, hence, the need to teach science in schools in line with this observation. Some states in Nigeria e.g. Oyo, Kano, Niger, Plateau, Sokoto and Kaduna have established special science schools in order to popularize science and make its teaching and learning more effective.

In the secondary school educational programme, biology occupies a unique position. It is most favoured by all students considering the numbers of candidates that offer it in public examinations, in line with Federal Government policy that all students must compulsorily offer one of chemistry, physics or biology. The high numbers of students is probably because of their belief that biology is a ‘cheap’ subject (Soyibo, 1982). Hence, students’ failure may be due to the fact that biology is difficult subject.

Several studies have shown that there is an increasing yearly enrolment in the science subject especially biology but the performance in West African Senior School Certificate Examinations continue to decline (Ogunniyi 1986; Ajeyalemi, 1990). Poor teaching method was observed by Abdullahi (1982) and Ogunniyi (1986) as one of the major causes of students’ dismal performance in biology. Soyibo (1991) stated that the use of didactic method of teaching, which is teacher-centered, is the common mode classroom instruction in biology. Except there is re-orientation and the use of method (s) that will involve students’ active participation, the present trend of poor performance in Biology may continue.

Though, Areola (1983) and Novak (1987) submitted that no single method is best for the teaching of science and especially biology, they unanimously agreed that method that would involve active students’ participation such as field work, laboratory work, group work, concepts
mapping etc would ensure higher performance. Therefore, the desire to improve science achievement through more effective instructional strategy and the increasing awareness, in recent years of learner centredness has focused attention to understanding how learners learn and how to help them learn (Jegede, Alaiyemola and Okebukola, 1990). This has led to the development of meta-cognitive strategies (Flavell, 1976; Briggs, 1988). Meta-cognitive strategies according Novak (1987), involve the empowerment of the learner to take charge of his/her own learning in a meaningful way. One of the meta-cognitive strategies is learning about meaningful (meta-learning) which could be realized through concept mapping technique.

The technique of concept mapping as detailed by Novak and Gowin (1984) is a procedure for assisting learners to recognize concepts and other information about a properties of objects, events, processes in meaningful entities. It is a structured, visual means of representing concepts and their relationships (Lehman, Carter and Kahle, 1985). The steps in concept mapping technique are clearly elucidated by Novak and Gowin (1984) pp 34-44. Hence, concept mapping technique aids learners in understanding concept and relationship between them.

Some studies which tested the contention of the facilitative effect of concept mapping technique have produced positive findings. For instance, in engaging a sample of eight grade (JSS II) student, Novak, Gowin and Johansen (1983) found that the experimental classes which received instruction on concept mapping technique demonstrated superiority over control classes in the posttest scores. Okebukola (1988) also found that concept mapping technique improved significantly pre-degree students’ achievement in genetics and ecology. Other studies which showed the potency of concept mapping technique in enhancing meaningful learning include Cullen (1990); Novak and Mosunda (1991); Soyibo (1991); Okonkwo (1998); Dannmole and Adebayo (2004). From the findings, it may be that concept mapping technique would help the students retain learnt concepts as they would be constructing the maps based on their understanding of the concepts. Hence, this study would attempt to measure the level of retention of the students’ understanding of ecology concepts six weeks after the first treatment.

Ecology has been identified as one of the difficult topics in biology (Johnstone and Mahmoud, 1980). But its importance as a vital topic in biology has been increasingly recognized (Booth and Sinker, 1979; Okeke and Ochuba, 1986) as it consists about 40% of the total learning content in WASSCE syllabus (1998-2000). The development may not be unconnected with the fact that ecology has many applications aimed at maintaining a healthier and more habitable biosphere for man, the importance of which has been more widely realized and demonstrated in recent times. For instance, the June 3 to 5, 1992 United Nations Conference on environmental development tagged ‘Earth Summit’ was as a result of a global concern to save out common habitat-Earth.

Ecology, apart from being a difficult topic (Johnstone and Mahmoud, 1980; Adeniyi, 1983; Uma, 1988; Nwoke, 1995) has not been well taught in senior secondary biology, which has resulted in students’ failure of biology, Netejinyin (1995). For example, Okeke and Ochuba (1986) submitted that the steady decline in students’ performance over the years in biology was particularly due to the fact that most students do not fare well in ecological question items. There is therefore the need to look at an effective way of teaching biology to improve students’ performance, hence this study.

Gender is one of the factors interacting with achievement and studies on it have been unresolved (Nussbaum, 2000) as some researchers found that male students have a higher achievement than female students (Soyibo, 1981; Bank 1983; Okeke and Ochuba, 1986; Novak and Mosunda, 1991; Dannmole, 1998). Other observed that it is the opposite i.e. female students perform better than male students (Kelly, 1970, 1979; Roach, 1979). Yet other researchers found no significant difference between males and females achievement (Ojo, 1986; Price, 1993; Bello, 1996; Nussaum, 2000). Hence, this study looked at the effect of gender on students’ achievement in ecology in biology.

Specifically, the study attempted to test the following research hypotheses derived from research questions.

1. There is no significant difference in the mean scores in a biology achievement test of students exposed to concept mapping technique and those exposed to the conventional instruction.

2. There is no significant difference in the mean scores in a biology achievement test of male and female students exposed to concept mapping technique.
3. No significant difference exists in the mean scores in a biology achievement test of male students exposed to concept mapping technique and male students exposed to conventional instruction.

4. No significant difference exists in the mean scores in a biology achievement test of female students exposed to concept mapping technique and female students exposed to conventional instructional technique.

5. There is no significant difference in the mean retention scores as measured in a biology achievement test of student exposed to concept mapping technique and those exposed to conventional instruction.

Methodology
A quasi-experimental study using a non-randomised control group pretest and posttest design was used in the study. Two separate intact classes were used, one for the experimental and the other for the control groups. A total of one hundred and thirty-seven (137) students participated in the study. Fifty-eight (58) males and seventy-nine (79) females. The sample was drawn from a co-educational secondary school in Iseyin Local Government Area of Oyo State.

The instrument was a Biology Achievement Test (BAT) made up of 20-items multiple choice questions and 5-item essay questions. The (BAT) was adjudged adequate in scope and content based on the chosen topic by a subject specialist at the University, two lecturers of Biology at a college of Education and two experienced biology teachers at the secondary school level. A reliability coefficient of 0.67 was obtained using Kuder-Richardson formula 20 from the test-retest using SS II students in a non-participating school. The treatment for the experimental group took place in six 80-minutes lessons and lasted for two weeks. The first lesson was used for training with other sessions focused teaching of the chosen topics, ecological concepts and the ecosystem. The control group was taught using lecture method on the same topic on ecology. Six weeks after the posttest, a retention test, using the posttest was administered to check the students’ level of retention of concepts learnt in ecology. Results obtained from the two groups were analyzed using Analysis of Covariance (ANCOVA).

Results
A comparison of the pre and post-test means of the two groups gave the following results:

1. There was significant difference in the achievement of students exposed to concept mapping technique and those exposed to conventional instruction.

2. There was no significant difference in the achievement of male and female students exposed to concept mapping technique.

3. There was a significant difference in the achievement of male students exposed to concept mapping technique and male students exposed to conventional instruction.

4. There was a significant difference in the achievement of female students exposed to concept mapping technique and female students exposed to conventional instruction.

5. There was a significant difference in the mean retention scores to concept mapping technique and those exposed to conventional instruction based on retention of ecology concepts.

Table 1: Summary of Analysis of Covariance, ANCOVA of the treatment and control groups.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. Df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effects</td>
<td>1408.524</td>
<td>2</td>
<td>704.262</td>
<td>85.858</td>
<td>.000</td>
</tr>
<tr>
<td>Treatment</td>
<td>1367.155</td>
<td>1</td>
<td>136.155</td>
<td>166/673</td>
<td>.000*</td>
</tr>
<tr>
<td>Residual</td>
<td>1082.748</td>
<td>132</td>
<td>8.264</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3694.015</td>
<td>137</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at P<0.05
Table 2: Summary of Analysis of Covariance, ANCOVA on male and female students taught using concept mapping technique.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. Dff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates (Pretest)</td>
<td>233.598</td>
<td>1</td>
<td>232.598</td>
<td>35.418</td>
<td>.000</td>
</tr>
<tr>
<td>Main effects (gender)</td>
<td>.692</td>
<td>1</td>
<td>.692</td>
<td>105</td>
<td>.7474*</td>
</tr>
<tr>
<td>Explained</td>
<td>222.289</td>
<td>2</td>
<td>116.645</td>
<td>17.761</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>407.172</td>
<td>62</td>
<td>6.567</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>640.462</strong></td>
<td>64</td>
<td><strong>10.007</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Not significant at P<0.05

Table 3: Summary of Analysis of Covariance, ANCOVA no male students exposed to concept mapping technique and male exposed to conventional instruction.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. Dff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates (Pretest)</td>
<td>376.436</td>
<td>1</td>
<td>376.436</td>
<td>55.378</td>
<td>.000</td>
</tr>
<tr>
<td>Main effects (males)</td>
<td>451.419</td>
<td>1</td>
<td>451.419</td>
<td>66.405</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>373.870</td>
<td>55</td>
<td>6.795</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1201.724</strong></td>
<td>57</td>
<td><strong>21.08</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at P<0.05

Table 4: Summary of Analysis of Covariance of female students exposed to concept mapping technique and female students exposed to conventional instruction.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. Dff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>826.154</td>
<td>1</td>
<td>826.154</td>
<td>88.828</td>
<td>.000</td>
</tr>
<tr>
<td>Main effects (female)</td>
<td>927.885</td>
<td>1</td>
<td>927.885</td>
<td>99.766</td>
<td>.000</td>
</tr>
<tr>
<td>Explained</td>
<td>1754.039</td>
<td>2</td>
<td>877.019</td>
<td>94.297</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>706.547</td>
<td>76</td>
<td>9.301</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2460.786</strong></td>
<td>78</td>
<td><strong>31.550</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at P<0.05

Table 5: Summary of Analysis of Covariance, ANCOVA on Retention of BAT posttest scores of experimental group exposed to concept mapping technique and control group exposed to conventional instruction.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. Dff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effects</td>
<td>87.089</td>
<td>1</td>
<td>87.089</td>
<td>6.058</td>
<td>.000</td>
</tr>
<tr>
<td>Treatment</td>
<td>1336.940</td>
<td>1</td>
<td>1336.940</td>
<td>.166</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>1897.511</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3605.985</strong></td>
<td>136</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at P<0.05

**Discussion**

The main objective of this study was to investigate whether the use of concept mapping technique would significantly improve students’ achievement in ecology. The results obtained confirmed the accomplishment of such significant improvement. These findings support the findings of previous studies (Ault, 1985; Jegede, 1998; Soyibo 1991; Danmole and Adebayo, 2004) which provided evidence attesting to the potency of concept mapping technique in aiding a clear
understanding of concepts. The significant difference was due to the capability of the technique in aiding the experimental group's ability to observe the relationship among concepts in ecology and to link these to related concepts they already have (Table 1, 3 and 4). This was also evident when the posttest was re-administered on the experimental and control groups six weeks after the first posttest (Table 5). The experimental group outperformed the control group. This may have been as a result of concept mapping technique enabling the students to understand and retain the learnt ecology concepts better than the control group. Table 2 confirmed that there was no significant gender difference in students' achievement of male and female students exposed to concept mapping. This finding supports previous studies as Ojo, 1986; Price, 1993; Bello, 1996; Danmole and Adebayo, 2004 as opposed to the findings of some studies which found that male students were better (Bank, 1983; Novak and Mosunda, 1991; Soyibo, 1991).

Figure 1: A concept map on the topic “Ecology” in biology showing the hierarchical structure and progressive differentiation of the main inclusion concepts by Danmole, B. T (2000).

Conclusion
This study examined the efficacy of concept-mapping technique in improving students' achievement of biology concepts and enhancing conceptual understanding. The results of the finding from the study suggested substantial and important changes in the understanding based on the achievement of students after treatment. Concept mapping has also been found to aid retention of concepts learnt. It appears that concept mapping offered a valid and useful mechanism for enhancing meaningful concept of knowledge.

Recommendations
Based on the findings of the study, it is recommended that:
1. the technique should be used in teaching in addition to other methods so as to enhance effective teaching and learning.
2. the Federal, state government and other educational bodies should sensitize relevant agencies on the use of concept mapping technique as an effective teaching strategy by organizing workshop/seminars for stakeholders in the education sector on its efficacy.
Reference


