

ISSN 0794-4543

Beino. 5 42-49

JOURNAL OF CURRICULUM AND INSTRUCTION

VOLUME 5, NUMBERS 1 & 2, 1998

Published by:-
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Ilorin, Nigeria.

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EDITORIAL

CURRICULUM AND INSTRUCTIONAL ISSUES IN NIGERIAN EDUCATION

This edition of the **Journal of Curriculum and Instruction (JCI)** contains sixteen (16) empirical and theoretical articles on educational technology, science education, mathematics education, health education and curriculum development. The wide range of issues discussed and the geographical spread of the contributors are eloquent testimonies to the focus of **JCI** to address instructional and curriculum matters from national and global perspectives.

Within the purview of educational technology issues addressed are empirical studies on the adequacy of introductory technology facilities in secondary schools, utilisation of instructional materials in primary schools and effects of mediated instruction on students' performance in social studies. Theoretical articles dealt with adaptation of instructional television for the special learners, and utilisation of instructional strategies in teaching.

In the area of science education, empirical studies have covered students' perception of teachers' effectiveness and their performance in physics; comparative effects of two forms of concept mapping instructional strategies on students' achievement in evolution; and an examination of the influence of students' proficiency in English language as a factor in students' performance in biology. The issue of sign of the 3rd order determinant was also addressed under mathematics education.

Also, included in this volume are theoretical papers on physical and health education issues such as: the development of physical education curriculum for emotionally disturbed children in Nigerian schools, the need for the separation of the physical and health education programmes at the undergraduate level in Nigeria and the role of the curriculum in achieving the national health goals. Curriculum matters discussed in this paper included the challenge of curriculum implementation to teachers, values and the Nigerian school curriculum, and participatory learning for functional literacy. Furthermore, an overview of Islamic education vis-à-vis Western education was examined. The strands of coverage of these papers show concern for aspects of students' learning, teachers' effectiveness, curriculum and instructional evaluation, and innovations in instruction from primary school, through secondary school, to tertiary level.

I wish to express sincere thanks to the journal's assessors and reviewers, and editorial board members for their prodigious contributions in making this volume possible. Finally, on behalf of the Editorial Board members I thank our contributors and readers for their faith in the **JCI** and I convey profound apology to them for the delay in producing this volume.

Prof. I. O. Abimbola,
Editor-in-Chief
20th April, 2001.

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COMPARATIVE EFFECTS OF TWO FORMS OF CONCEPT MAPPING INSTRUCTIONAL STRATEGIES ON STUDENTS' ACHIEVEMENT IN EVOLUTION

G. BELLO

Abstract

This study determines the effects of students and teacher-centred concept-mapping instructional strategy and teacher-centred concept-mapping instructional strategy on students' achievement in evolution. It is a quasi-experiment study involving two experimental groups and one control group. Data gathered in the study were analysed using t-test and Analyses of Variance statistical techniques. Results of the study clearly showed that the student and teacher-centred concept-mapping instructional strategy significantly enhanced students' achievement in evolution than either teacher-centred concept-mapping instructional strategy or expository instructional strategy. Findings from the study equally revealed that two-way interaction effect of gender and mode of instruction had no significant effect on students' achievement. The researcher recommended the use of student- and teacher-centred concept-mapping instructional strategy by biology teachers for teaching difficult theory such as evolution.

Introduction

Biology is the most popular basic science discipline among Nigerian senior secondary school students. It is however, astounding to note that Nigerian secondary school students' performances in biology at the final senior school certificate examinations (SSCE) are not better than their performances in the other basic science disciplines as revealed in several studies (Ajayi 1988; Bello, 1990; NEDRC, 1992; Soyibo, 1984 & WAEC, 1984). Ineffective modes of instruction, inadequate facilities, high student-teacher ratio, over loaded syllabus, and students' attitude to biology are some of the reasons adduced by Nigerian science educator for the poor performances of Nigerian students in biology.

Many studies have been conducted on several familiar instructional strategies such as concept mapping, vee mapping, semantic networking, conceptual change instructional strategy; among others have been introduced into the classroom by educational researchers (Chian-song & Yager, 1991; Fisher, 1990; Novak & Gown, 1984; etc.). Since instructional strategy is an important determinant of the outcome of teaching and learning process, this study sought to determine the efficiency of one of the recent instructional strategies in science education.

Recent studies in Nigeria and several other nations indicated that most biology teachers and students regarded the theory of evolution as difficult to teach and learn respectively (Anderson & Bishop, 1990; Okebukola, 1994; Pankratius, 1993 and Rudolph & Stewart, 1998). The unifying role of the theory of evolution in modern biology has been well acknowledged in science education literature. However, in spite of this important role, the theory is relatively under researched as rightly observed by Commins, Demastes, and Hafner (1994). Indeed, many people rejected the theory right from its early dates to date. This situation is compounded by the failure of the science education community to help biology teachers to present the theory in ways that can ensure meaningful learning (Smith, Siegel, & Melnerney, 1995). In the view of Rudolph and Stewart (1998), this prevailing situation is one of the major problems confronting evolution education and the public perception of the theory of evolution as the most suspect representative of science. The seemingly difficulty and the amorphous nature of the theory, among others are reasons adduced by Rudolph and Stewarts (1998) for its neglect as a research field of study by science education community. Science instructions based on philosophical conceptions of science that are inadequate representative of the diverse nature of scientific practice partially accounted for the difficulties experienced by students in understanding evolution according to these researchers. Esiobu and Soyibo (1995) reported that some biology educator and biologists have demanded the elimination of theory of evolution among other difficult topics from secondary

school curriculum. In view of the unifying role-played by the theory in the meaningful understanding of modern biology and the difficulty faced by teachers and students in teaching and learning the theory respectively, it is imperative to continue to search for ways to improve evolution. This study is an effort in this direction.

Concept mapping is a recent versatile education media in science education. It involves construction of logical relationship among concepts in hierarchical order. It is an important strategy to help students to learn how to learn meaningfully and to learn about the structure of knowledge as well as knowledge production process. It has been used to identify students' misconceptions, as an evaluation tool, and as instructional strategy to promote meaningful learning by several researchers (Beyerbach & Smith 1990 and Esiobu & Soyibo 1995). Concept mapping as an instructional strategy involves pre-instruction construction of concept-maps by the teacher; concept map based lesson plan; construction of concepts maps by students individually during class instruction; joint construction of concept-maps by students and teacher; using concept maps as instructional aid; and as an evaluation tool, among other systematic instructional activities.

In recent time some science educators conducted studies on concept-mapping instructional strategy. For instance, in 1993, Trowbridge & Wandersee conducted extensive study to (a) describe how concept-mapping could be used as an integral instructional strategy for learning a college evolution course (b) determine whether or not students concept-maps revealed difficult learning points (c) evaluate the effects of concept mapping on students' study practices and understanding of course content, and (d) evaluate the utility of incorporating concept-mapping in a college course on evolution. Results of the study revealed that difficult points in learning evolution could be identified in the students' concept-maps by checking the degree of concordance of super-ordinate evolution concepts appearing in students' concept maps. Students were noted to spend an average of 37% more study time on the biology course than the previous biology courses. The use of seed concepts, micro mapping, a scoring format, and a standard concept-map checklist, were noted to make the use of concept-mapping strategy feasible for the instructor to implement and for students to adopt.

Recently, Esiobu and Soyibo (1995) carried out a study among Nigerian secondary school students to determine the effectiveness of concept and vee-mapping strategies on enhancing meaningful learning of difficult biology concepts. The study also sought to determine the appropriate class interaction pattern to tackle the problem of large student/teacher ratio in biology. The subjects of the study were 808 students randomly selected from five secondary schools. They were divided into experimental and control group. Each group was further subdivided into pure cooperative, cooperation – competitive and whole class, interpersonal competitive learning groups. Analysis of variance and analysis of covariance statistical techniques were used to analyse data gathered in the study. Findings from the study showed that the experimental group that were exposed to concept mapping performed better than the control group.

Horton, Micconney, Galio, Wood, Senn and Hathlein, (1993) conducted a meta-analysis on studies that employed concept mapping as instructional strategy. The four research questions posed in the study were:

- (1) What is the effectiveness of concept mapping as instructional strategy for improving students' achievement?
- (2) What is the effectiveness of concept mapping as a strategy for improving students' attitude?
- (3) Is there any difference in the effectiveness of teacher prepared versus student prepared concept-maps in improving students' achievement and attitudes? and
- (4)* Is there gender effect when concept mapping is used as an instructional strategy?

Dissertation Abstract International, Psychological Abstracts and Educational Resources Information Centre (ERIC) were the computerised database that provided the investigator the data gathered in the study. On studies that had taken place in actual classroom setting using

concept mapping as instructional strategy were selected. A total of 19 out of 133 potentially acceptable studies met the requirements for selection for the meta-analysis. Findings from the study showed that concept mapping had positive effect on both students' achievement and attitudes. Results of the study also revealed that there was little difference in the effectiveness of teacher-prepared versus student-prepared concept-maps in improving students' achievement. Insufficient data however, did not enable the researcher to provide answer to research question 1, and 4.

Sufficient investigation has not been directed towards the effects of concept-mapping instructional strategies on teaching and learning of scientific concepts (such as evolution) perceived to be difficult to teach and learn by the teachers and students respectively. Hence, this study sought to determine the effects of two forms of concept-mapping instructional strategies on students' achievement in evolution. Findings from the study would significantly contribute to evolution education. The two forms of concept-mapping instructional strategies are:

(1) **Student and Teacher-Centred Concept-Mapping Instructional Strategy:** This is a series of systematic instructional activities. It involves a pre-instructional construction of construction of concept-maps and concept-map based lessons planned by the teacher; construction of concept-maps by students individually and joint construction of concept-maps by the teacher and students during class instruction. This is in addition to the use of concept maps as instructional aid.

(2) **Teacher-Centred Concept-Mapping Instruction Strategy:** This is a series of systematic instructional activities by the teacher. It involves a pre-instructional construction of concept-maps, concept-map based lesson plan and the use of concept-map as instructional aid. Students would not be involved individually in concept-map construction during class lesson.

(3) **Expository Instructional Strategy:** This is the familiar lecture method. It involves presentation of information on the content to the students by the teacher verbally without any overt interaction between the teacher and the students.

Statement of the Problem

Several studies have been conducted on concept-mapping instructional strategies (Esiobu & Soyibo 1995, Novak, 1983; Okebukola & Jegede, 1987; Olumide, Okebukola & Odunbunmi, 1987 etc). The remarkable efficacy of concept-mapping instructional strategies was equally well reported by the aforementioned researchers among others. However, some important aspects were not either investigated or sufficiently reported. These include the comparative effects of the two forms of concept-mapping instructional strategies on students' achievement, and the effects of the concept-mapping instructional strategies on teaching and learning of concepts and theories perceived difficult to teach and learn by biology teachers and students. The two forms of concept-mapping instruction strategies are (1) Student and teacher-centred concept-mapping instructional strategy and (2) Teacher-centred concept-mapping instructional strategy. Gender influence on concept-mapping ability is also sparingly reported as observed by Horton, Micconney, Galio, Wood, Senn & Hathlein (1993). Hence, this study examined some of these sparingly investigated and reported areas in concept-mapping instructional strategy.

Purpose of the Study

This study sought to investigate the comparative effects of two forms of concept-mapping instructional strategies on students' achievement in evolution. This was achieved by:

- (i) Investigating the effects of each form of concept-mapping instructional strategy on students' achievement in evolution and comparing their relative effects.
- (ii) Investigating the effects of gender influence of students' achievement in evolution when the students received instruction on evolution through each form of concept-mapping instructional strategy.

Research Questions

1. Will there be any significant difference between the achievements of students who received instruction on evolution through:
 - (a) Student – and teacher-centred concept-mapping instructional strategy, and teacher-centred concept-mapping instructional strategy?
 - (b) Student – and teacher-centred concept-mapping instructional strategy and expository instructional strategy?
 - (c) Teacher-centred concept-mapping instructional strategy and expository instructional strategy?
2. Is there any significant difference between the achievement of male and female students when taught evolution using:
 - (a) Student-and teacher-centred concept-mapping instructional strategy and
 - (b) Teacher-centred concept-mapping instructional strategy?

Research Hypotheses

1. The achievement in evolution of students that were exposed to student – and teacher-centered concept-mapping instructional strategy did not differ significantly from the achievement in evolution of those exposed to teacher-centered concept-mapping instructional strategy.
2. The achievement in evolution of students exposed to teacher-centered concept-mapping instructional strategy and those exposed to Expository instructional strategy did not differ significantly.
3. There is no significant difference between the achievement in evolution of male and female students exposed to:
 - (a) Student and teacher-centered concept-mapping instructional strategy
 - (b) Teacher-centered concept-mapping instructional strategy.
4. The two-way interactions of students' gender and mode of instruction do not have any significant effect on students' achievement.

Methodology

Research Design

The post-test only non-equivalent, non-randomised control group, quasi-experimental design involving 3x2 factorial model was adopted in conducting this study. In this design instructional strategies operating at three levels (Student and teacher-centered, & Teacher-centred concept-mapping instructional strategies and Expository instructional strategy) were crossed with students' gender operating at two levels (male and female). The design involves two experimental groups and a control group.

Research Instruments

Using the West African Examinations Council biology syllabus as a guide, the required content material for the theory of evolution was extracted from Nigerian secondary school biology textbooks. The extracted materials were used in preparing two research instruments. These were: Evolution theory test (ETT) and Instructional strategy packages.

Evolution Theory Test (ETT): - This consisted of 50 multiple-choice items and 3 open-ended essay items. The items in the test covered all the cognitive levels in the bloom's taxonomy. The test was submitted to a panel of validators comprising a University professor in biology, two science education senior lecturers in biology from a college of education, and an experienced biology teacher in a secondary school. The panel was asked to judge the cognitive levels, the items in the ETT measured, suitability of the items to the target population, and whether or not the item can elicit the desired responses from the students. The panel's comments were used to revise the test before it was trial-tested among 123 students randomly selected from a secondary

school. The test was re-administered to the same set of students, four weeks after the first administration of the test, in order to calculate its reliability coefficient using the test-retest method. The reliability coefficient of the test was found to be 0.76.

Instructional Strategy Packages: These were,

- (1) **Student-and teacher-centered concept-mapping instructional strategy.** It contained lesson notes, concept-maps, charts on theory of evolution, and other relevant instructional materials. The focus of instructional activities in the package was student-prepared and teacher-prepared concept maps on evolution.
- (2) **Teacher-centered concept-mapping instructional strategy.** The content of this package is similar to the first package except that the focus of instructional activities was on the teacher-prepared concept-maps.
- (3) **Expository instructional strategy package.** This contained lesson notes and relevant instructional materials as in the other instructional package but excluding concept-maps on evolution. The instructional packages were submitted to the same panel of validators mentioned earlier for validation.

Pilot Study

A pilot study was conducted among a small sample size. This was to enable the investigator to detect any weakness in the research instrument and determine appropriate remedial measure that could improve the instrument and treatment fidelity of the study. A final revision of the instructional packages and the evolution theory test was carried out after the pilot study to improve their effectiveness and reliability. The sample used for the pilot study was not used during the main study.

Sample Selection

The target population for this study consisted of all second year (SS II) senior secondary school students in Kwara State. However, due to the quasi-experimental nature of the study and the need to check several extraneous variables, only SS II students in three secondary schools in Kwara State were selected as representative sample of the population using simple random sampling technique. One of the schools was randomly assigned to experimental group A; another was assigned to experimental group B and the third school served as the control group. All the 431 SSII students in the selected schools took part in the study and have not been taught the theory of evolution in the class before the study. Traditionally theory of evolution is taught during the third year (SSIII) of the senior secondary school level.

Data Gathering

The researcher did data collection personally to ensure accuracy and authenticity of the data. This was carried out in three steps:

In step 1 experimental group A and B students were taught how to construct and use concept-maps within two weeks in 6 lessons.

Step 2: Experimental group A students were taught evolution using student and teacher-centred concept-mapping instructional strategy. Experimental group B students were taught evolution using Teacher-centred concept-mapping instructional strategy. The control group students were given instructional on evolution through the expository instructional strategy. This stage lasted for 4 weeks (12 lessons).

Step 3: The evolution theory test was administered as a post-test to the experimental and control groups.

Data Analysis

The post-test scores of the students were the data statistically analysed in this study.

Hypothesis (1): was tested using the t-test statistical technique as shown in table 1. The calculated t-value $\{t(285, 0.05) = 7.22\}$ was found to be significant hence, the hypothesis was rejected.

Table 1:
t-test of Difference Between the Post-test Mean Scores of Experimental Group A and Experimental Group B Students.

Group	N	$\bar{X}$	SD	t-value
Experimental group A	145	41.81	13.70	7.22
Experimental group B	142	30.03	13.94	

Significant at 0.05

This result means that the mean score ($\bar{X} = 41.81$) of experimental group A students is significantly higher than the mean score ($\bar{X} = 30.03$) of the students in experimental group B. This suggests that the student and teacher-centred concept-mapping instructional strategy improved students' achievement in evolution than the teacher-centred concept-mapping instructional strategy. The result provides answer to the first research question posed in this study.

Hypothesis (2) was also tested using the t-test. The calculated t-value $[t(289, 0.05) = 9.44]$ is significant as 0.05 alpha level therefore, the hypothesis was equally rejected.

Table 2
t-test of Difference Between the Post-test Mean Scores of Experimental Group A and Control Group Students.

Group	N	$\bar{X}$	SD	t-value
Experimental group A	145	41.81	13.70	9.44
Control group	146	27.86	11.42	

Significant at 0.05

This finding means that the mean score ($\bar{X} = 41.81$) of experimental group A students is significantly higher than the mean score ($\bar{X} = 27.86$) of the control group students. This result suggests that the student and teacher-centred concept-mapping instructional strategy significantly enhanced students' achievement in evolution than the expository instructional strategy. The result provides answer to the second research question.

As shown in table 3, hypothesis (3) was tested using t-test. The calculated t-value $[t(280, 0.05) = 1.45]$ is not significant at 0.05 alpha level. The hypothesis was therefore, not rejected. This shows that the mean score ($\bar{X} = 30.03$) of experimental group B students is not significantly different from the mean score ($\bar{X} = 27.86$) of the control group students. It suggests that both the teacher-centred concept-mapping instructional strategy and the expository instructional strategy had similar effect on students' achievement in evolution and provides answer to the third research question in this study.

Table 3

t-test of Difference Between the Post-test Mean Scores of Experimental Group A and Control Group Students.

Group	N	$\bar{X}$	SD	t-value
Experimental group B	142	30.03	13.94	1.45*
Control group	146	27.86	11.42	

*Not significant

The t-test statistical technique was also used to test hypothesis (3a). The calculated t-value [$t(133, 0.05) = 0.58$] was not significant at 0.05 alpha level, hence, the researcher did not reject the hypothesis.

Table 4

t-test of Difference Between the Post-test Mean Scores of Male and Female Students Exposed to Student and Teacher-Centered Concept-Mapping Instructional Strategy.

Group	N	$\bar{X}$	SD	t-value
Male	100	41.76	7.27	0.58*
Female	35	40.94	6.67	

*Not significant at 0.05 alpha level

This result shows that male and female students exposed to the student and teacher-centered concept-mapping instructional strategy did not differ significantly in their achievement in evolution. It provides answer to research question 4.

Hypothesis (3b): was also tested using the t-test. As shown in Table 5 the hypothesis was not rejected because the calculated t-value [$t(140, 0.05) = 1.31$] is not significant at 0.05 alpha level. This result indicated that the achievement of male and female students taught evolution through the teacher-centered concept-mapping instructional strategy did not differ significantly.

Table 5:

t-test of Difference Between the Post-test Mean Scores of Male and Female Students Exposed to Teacher-Centered Concept-Mapping Instructional Strategy.

Group	N	$\bar{X}$	SD	t-value
Male	87	31.07	7.89	1.31*
Female	55	29.00	6.40	

*Not significant at 0.05 alpha level

Hypothesis (4): This hypothesis was tested using the analysis of variance statistical technique. The calculated F-value [$F(2, 427) = 0.00$] is not significant at 0.05 alpha level.

Table 6
Summary of 2-way Analysis of Variance (Treatment by Gender)

Source	SS	DF	MS	F-ratio
Treatment	16349.27	2	8174.64	49.00
Gender	2624.94	1	2624.94	15.73
Treatment X Gender error	0.00	2	0.00	0.00*
Total	71233.93	427	166.8242	
	89250.05	432	10799.58	

*Not significant 0.05

This result shows that two-way interaction effect of gender and mode of instruction had no significant effect on students' achievement in evolution. The result provides answer to research question 6.

Discussions

Results of this study clearly showed that the student-and teacher-centred concept-mapping instructional strategy enhanced students' achievement in evolution more than either the teacher-centred concept-mapping instructional strategy or the expository instructional strategy. It is therefore, a superior mode of instruction compared with the teacher-centred concept-mapping instructional strategy or the expository instructional strategy. This finding equally revealed that the student-and teacher-centred concept mapping instructional strategy could be used to teach and enhance meaningful learning of biology theory, such as evolution perceived to be difficult by students and teachers more successfully than teacher-centered concept-mapping instructional strategy or expository instructional strategy.

The significantly higher achievement in evolution made by students exposed to student and teacher-centred concept-mapping instructional strategy may be due to the great opportunities provided by this mode of instruction to students to be actively involved in knowledge construction individually and collectively during concept-mapping construction in the class. The active joint is similar to the process of construction of shared meanings through guided negotiation. These probably facilitated students' construction of appropriate conception of evolution that is compatible with those constructed by biologists hence, the higher achievement in the post-test. This may be due to the joint construction of concept-map by experimental group (A) students and the teacher. This may allow the teacher to quickly identify and dispel conceptual confusion in students' cognitive structures.

Results of the findings indicated that significant difference in achievement does not exist between male and female students exposed to the two forms of concept mapping instructional strategies. It also indicated that students' achievement in evolution is independent of joint interactive effects of students' gender and mode of instruction. This finding suggests that there is no gender influence on students' achievement when concept-mapping instruction strategy was used for class instruction. This finding is not unconnected with the fact that concept-mapping instructional strategy is a novel experience to all students that took part in the study. This could be a stimulating factor to all students regardless of their gender. As earlier mentioned, studies had shown that male and female students prefer biology to other science subjects. The appealing nature of biology to both sexes probably produced similar attitude and interest in biology between both sexes resulting in the similar achievement observed in the study.

Summary of Major Findings

The following are the major findings of this study.

1. The student-and teacher-centred concept-mapping instructional strategy improved students' achievement in evolution than either the teacher-centred concept-mapping instructional strategy or the expository instructional strategy.
2. Significant difference in achievement does not exist between male and female students exposed to the two forms of concept mapping instructional strategies.
3. Students' achievement in evolution is independent of joint interactive effects of students' gender and mode of instruction.

Conclusion

In view of the findings in this study the following conclusions could be drawn. The students-and teacher-centred concept-mapping instructional strategy produced significantly higher improvement in students' achievement in evolution than the teacher-centred concept-mapping instructional strategy as well as expository instructional strategy. It could be used successfully to teach and learn the theory of evolution, (a biology theory perceived difficult by Nigerian students and teachers) than the teacher-centered concept-mapping instructional strategy. It can therefore, be said to be a superior mode of concept-mapping instructional strategy, to teacher centered concept-mapping instructional strategy.

The students-and teacher-centered concept-mapping instructional strategy and the teacher-centred concept-mapping instructional strategy can be used successfully in mixed gender class. The expository instructional strategy is not an effective method for teaching the theory of evolution, when compared with the students-and teacher-centered concept-mapping instructional strategy.

In view of the major findings and conclusions drawn from the findings, the investigator hereby recommends:

1. As mean of improving instruction, and students' achievement in biology, biology teacher, must learn and use the student-and teacher-centred concept-mapping instructional strategy for teaching evolution and similar complex theories and concepts. These would enable the teacher to quickly identify and dispel conceptual confusion encountered by students during class instruction, before it became established in the students' cognitive structure.
2. Biology teachers should regularly employ concept-mapping strategy for planning class instruction. This would improve the quality of their lessons because concept mapping would enable the teachers to focus attention on the interrelationship between the central concept / theory (topic) to be taught and other related concepts.
3. Biology students should be introduced to concept-mapping as a tool for meaningful learning. It would enable students to understand meaningfully the numerous interrelated Biology concepts. Concept maps could serve as memory aids to students and could be used for revision exercise by students.
4. Concept-mapping strategies should be incorporated into biology teacher education programme in order to equip pre-service biology teachers with adequate instructional strategies that can make them effective teacher.
5. Biology education researchers may replicate and improve upon this study by selecting other biology theories and concepts such as genetics, ecology, etc to determine the suitability or otherwise of the two forms of concept mapping instructional strategies used in the study in improving students' achievement in biology. Results of such studies could help to indicate the limit of generalisation about the effectiveness of concept-mapping instructional strategies in improving students' achievement in biology.

References

- Anderson, L. C. (1992). The most important questions facing evolution education. In G.G. Ronald, T. E. John, D. S. Sherry, W. H. James, H. S. Mark, & C. L. Catherine (Eds.), *Towards a research base for evolution* (pp. 78 - 79). Conference held at Louisiana State University, Baton Rouge, December 4 - 5.
- Ajayi, O. O. (1998). *Community science: Implication for science teachers*. Proceedings of the 39th Annual Conference of Science Teachers Association of Nigeria. 105-168.
- Bello, G. (in press). Senior secondary school students' knowledge, misconceptions and alternative conceptions of a major biology proposition. Paper accepted for publication in *Ilorin Journal of Science Education*, 2 (1).
- Bello, G. (1997). *Comparative effects of two forms of concept-mapping instructional strategies on students' achievement in biology*. Unpublished PhD thesis, Department of Curriculum Studies and Educational Technology, University of Ilorin, Ilorin, Nigeria.
- Beyerbach, B. & Smith, J. (1990). Using a computerized concept-mapping program to assess pre-service teachers' thinking about effective teaching. *Journal of Research in Science Teaching*, 27, 961 - 972.
- Commins, L.C., Demastes, S. S. & Hafner, M.S (1994). Evolution: Biological education's under-researched unifying theme. *Journal of Research in Science Teaching*, 31, 445 - 448.
- Esiobu, O. G. & Soyibo, K. (1995). Effects of concept-mapping and vee-mapping under three learning modes on students' cognitive achievement in ecology and genetics. *Journal of Research in Science Teaching*, 32, (9); 971-996.
- Fisher, M. K. (1990). Semantic networking: The new kid on the block. *Journal of Research in Science Teaching*, 27 (ed), 1001 - 1018.
- Horton, B.P., Meconney, A.A. Galio, M. Wood, L.A. Senn, J. G. & Hame, I. D. (1993). An investigation of the effectiveness of concept mapping as an instructional tool. *Science Education*, 77(1), 95 - 11.
- Nigerian Educational Research and Development Council (NERDC)(1992). *Performance of Nigerian students in public examinations: (Final report part A. GCE/SSCE 1987-1991)*. Being part of the final report presented to the joint consultative committee (J.C.C) plenary meeting held in Katsina state, July 27 - 31.
- Novak, J.D. (1983). Can meta-learning and knowledge strategies help students learn how to learn? In H. Helm & J. D. Novak, (Eds.), *Proceedings of the international seminar on misconceptions in science and mathematics*. Department of Education, Cornell University, Ithaca, New York, June 20 -24, 8.
- Novak, J. D. & Gowin, D.B. (1984). *Learning how to learn*. Cambridge: Cambridge University Press.
- Okebukola, P. A .O. & Jegede, O. J. (1989). Cognitive preference and learning mode as determinants of meaningful learning through concept-mapping. *Science Education*, 72 (4), 489 - 500.
- Olumide, F., Okebukola P. A. O. & Odunbunmi, E. O. (1987). Cooperative learning and concept-mapping as heuristic for enhancing freshmen learning in large classes. *Nigeria Educational Forum*, 10 (2), 153 - 162.
- Pankratius, W. J. (1993). *The constructivist transformation of a pre-service teacher's view on teaching creation and evolution*. A paper presented at the 66th annual meeting of national association for research in science teaching, Atlanta, Georgia, U.S.A. April 15-19
- Rudolph, J. & Stewart, J. (1998). Evolution and nature of science: On the historical discord and its implications for education. *Journal of Research in Science Teaching*, 35 (10), 1069 - 1089.
- Smith, M. U.; Seigel, H. & McInerney, J. D. (1995). Fundamental issues in evolution education. *Science Education*, 4, 23 - 46.

- Soyibo, K. (1984). *Progress and problems in Nigerian secondary school science education 1960-1984*. Paper presented at the International Conference on Comparative Education for Nigeria, University of Lagos Nigeria, August.
- Trowbridge, E. J. & Wandersee, H. J. (1993). Using concept-mapping in a college course on evolution: Identifying critical junctions in learning. A Paper Presented at The Annual Meeting of The National Association for Research in Science Teaching, Atlanta, Georgia, U.S.A. April 15-19.

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