Potency of Concept Mapping and Reflective Writing Strategies on Attitudinal Change of Pre-Service N.C.E. Biology Teachers in Nigeria

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Abstract

This study investigated the potency of combining concept mapping with reflective writing strategies on attitudinal change of pre-service N.C.E. teachers in biology. One null hypothesis and one research question were formulated and tested at the 0.05 level of significance. A pre-test, post-test control group experimental design was used in this study. The instrument used to test the null hypothesis was the Biology Attitudinal Questionnaire (BAQ) constructed by the researcher. Analysis of Covariance (ANOVA) was used to analyse the attitudinal data which was based on a five-point scale of strongly agree, agree, neutral, disagree and strongly disagree. Numerical values of 5, 4, 3, 2, and 1 and 1, 2, 3, 4, and 5 were allotted to the responses of all positive and negative responses respectively. The result revealed significant difference between the experimental and the control groups in terms of attitudinal change in biology with concept mapping ranking first, followed by lecture method alone, then a combination of concept mapping and reflective writing and the least was a combination of lecture method and reflective writing strategy. The findings led to the rejection of the null hypothesis. Suggestions and recommendations were made based on the findings. The discussions of the findings ended with drawing out implications of the findings for open and distance learning.

Keywords: Concept mapping, Reflective thinking, Attitudinal Change and Teaching, Education, Hyararchy

Introduction

Science, as part of the school curriculum at the elementary level in Nigeria has come a long way, starting as nature study, through rural science and hygiene. What was taught as science in the early part of this century in Nigeria has now evolved into integrated science, biology, physics, chemistry and other science

subjects. Jegede and Okebukola (1986:10) observed that as the status of these science subjects changed, so did the concern on the part of the various authorities and bodies that managed their teaching in the school system. It appears that the more the efforts put in to make the teaching and learning of science in schools better, the less the derived positive returns by way of the number of students who excelled in science subjects. Underachievement in science subjects in schools does not only make nonsense of the drive of "science for all" but points to its failure and a possible negative attitude of the general populace to the learning of science.

The poor performance of students in science subjects, particularly in biology is evidenced in the secondary school certificate examinations conducted by the West African Examinations‟ Council (WAEC) and the National Examinations Council (NECO) in 2005, 2006, 2007, 2008, 2009 and 2010 (http://www.weac.org.ng&htt: www.neco.org.ng). This poor performance is of major concern to all and particular? to those in the mainstream of science teaching. Besides, considering the prominent role played by science and technology in the race for national development and a worldwide trend of "science for all" currently sweeping through the globe, on nation will be happy seeing her youngsters performing poorly in science subjects. Some of the reasons for the poor performance in the subjects could be due to the frequent use of lecture methods of teaching. This view has been supported by many researchers such as: (Aghenta, 1982; Akpan, 1983 and James, 1991).

The researcher, a science teacher of over 20 years at both secondary and tertiary institution levels, strongly believes that combining concept mapping with reflective writing strategies could complement science teachers‟ conventional methods of teaching science. This will consequently improve students‟ academic performance in science subjects and it will change students‟ attitudes positively towards learning science. However, there has not been any empirical studies known to the researcher, to prove this belief, which has thus remained only at the level of a hypothesis. One of the aims of this study therefore, was to test the efficacy of the concept of mapping and reflective writing strategies as a model for attitudinal change in pre-service NCE biology teachers.

Concept Mapping and Reflective Writing Strategies

Concept mapping is a meta-cognitive strategy which enables learners to focus err reflect on how they learn or make meaning of concepts through maps, which are called concept maps. According to Novak (2007), concept maps include concepts. Usually enclosed in circles or boxes of some type and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts. Concept maps were developed in 1972 in the course of Josezm Novak‟s research, where he sought to follow and understand changes in children's knowledge of science (Novak and Musonda, 1991). The idea of concept map was

based on the learning psychology of David Ausubel (Ausubel et. al., 1978). The fundamental idea in Ausubel‟s cognitive psychology is that learning takes place the assimilation of new concepts and propositions into existing concept and propositional framework held by the learner.

Concept mapping is a meta-cognitive strategy, which enables learners to focus or reflect on how they learn or make meaning of concepts. This is done by identifying concepts in an area of study, ranking these concepts and linking them with words, which show their interrelationships. It is presumed that students are rediscovering or retracing how certain concepts have been learned and these result m more meaningful learning for them. Generally, concept mapping has become a useful instructional tool for science teachers‟ preparation (Beyerback and Smith, -990); curriculum development (Standard Kajcik. 1990) and assessment (Vargas md Alvarez, 1992). Donovan (1991) sees concept mapping as a technique based :n David Ausubel‟s theory of meaningful learning, which makes use of the organisation of concepts into a hierarchy.

Reflective writing on the other hand probably took its root from Piaget‟s cognitive theory and Brunner‟s conservative focusing strategy (Boyle, 1669 in Abdullahi, 1982; Mukherjee, 1978). Jean Piaget grouped children‟s cognitive development into four major stages: the sensory-motor; pre-occupational, concrete operational and formal operational stages. Some of the characteristics of children at formal operational stage include:

(i) ability to carry out topical thinking
(ii) ability to carry abstract and reflective thinking
(iii) ability to carry out hypothetico-deductive reasoning (Abdullahi, 1982).

The process of reflection is a difficult task for students to develop and practise iKibome, 1991; Linder, 1993). It seems reasonable that providing guidelines for the reflection should allow for greater reflection.

The study has, therefore, attempted to investigate whether or not the use of concept mapping combined with reflective writing used separately and jointly will have differential effects on the attitudinal change of pre-service NCE teachers in biology. Biology has in many cases been written with an initial capital letter. Decide and maintain consistency.

Literature Review

A variety of studies have investigated the effectiveness of concept mapping as it enhances meaningful learning in students. Rye and Rubba (1996) in a study entitled “An exploratory study of concept mapping as a tool to facilitate the externalization of students‟ understanding about global atmospheric change in the

interview setting" used Junior high school students in a semi-urban area of the North Eastern United States. The study was about an interview that embedded a concept mapping process compared with an interview that excluded concern mapping. It was concluded that an interview that embedded a concept mapping process did effect, statistically, a significant change in the externalisation of students‟ conceptual understanding.

Further, Schmid and Telaro (1990) compared concept mapping as an instruct strategy for high school biology with an established curriculum approach. Ii concluded that concept mapping is an efficient technique in terms of its ability individualise and raise the quality of learning.

In another study carried out by Stice and Alvarez (1987) entitled "Hierarchical concept mapping in the "Early Grades". The researchers examined the potential of concept mapping as a learning strategy to be used with children in Kindergarten through fifth grade. Concept mapping was found to increase children‟s ability to organise represents their thoughts. In a related study, Bousquet (1982) compared three versions of concept mapping. The subjects were made up of students (N=14) taking an introductory „natural resources‟ course at the Ohio State University H subjects were divided into high and low prior knowledge groups based upon pre-test results. Within each group, learners were randomly assigned to:

a) Hierarchical-Propositional
b) Hierarchical
c) Propositional

Each student constructed three assigned map of environmental concepts d the course and completed a post-test on these concepts and an attitude instrument was administered at the end of the course. Findings indicate that prior knowledge cognitive development and reasoning ability showed little relationship to students concept mapping performance. For two groups, prior knowledge explainer variability in post -test scores than did cognitive development.

Here in Nigeria, quite a number of studies on concept mapping have been out. Jegede et al (1989) investigated the effects of a meta-cognitive strategy students‟ anxiety and achievements in biology. A total of 51 senior secondary one (SS 1) students participated in this study. Two instruments - the Zuckad Affective Adjective Checklist and a Biology Achievement Test were used in pre and post-tests to measure the treatment effect on anxiety and achievement respectively Findings support the stand that concept mapping is significantly more effective than traditional expository strategy in enhancing learning in biology. In ad: has positively affected students‟ anxiety toward the learning of biology.

The literature reviewed has also revealed that little research has been carried out

on reflective writing particularly in Nigeria and outside Nigeria. Lavoi (1996) investigated the effects of combining concept mapping and reflective writing strategies on post secondary students‟ conceptual understanding of biology (N=58). The subjects for the study were biology education majors at the University of Northern Iowa, USA. It was an experimental design, where by the experimental group was taught with concept mapping combined with the reflective writing strategies while the control group was taught with only concept mapping strategy. Analysis of the results showed that the students taught with concept mapping and reflective writing strategies performed better than those taught with concept mapping only. Also, it was concluded that they developed more positive attitudes towards science learning than those taught with concept mapping alone. Resnic (1992) conducted an experimental study on the potency of reflective writing on the achievement of science students (N=127). The subjects were divided into two groups. The first group was instructed using reflective writing combined with concept mapping while the second group was instructed using the expository method. The study lasted for six weeks. Analysis of the data using t-test revealed a significant difference between those taught using expository method. The analysis also showed that the group taught using a combination of reflective writing and concept mapping performed better in terms of achievement than those taught using expository method. Yore (1996) carried out a similar study using elementary pupils (N=120). His findings point to the same direction with the findings of Lavoie (1996) and Resnic (1992) that a combination of reflective writing tends to enhance academic achievement more than the traditional expository or lecture method. This study will attempt to confirm or refute the potency of this method in Nigeria.

Research Question

Which of the following will have statistically significant difference in the attitudes of pre-service NCE teachers in biology learning?

(a) concept mapping alone
(b) lecture method alone
(c) A combination of reflective writing with concept mapping
(d) A combination of reflective writing with lecture method.

Methodology

Sample and Design

The study involved one hundred and twenty five biology students at the 100 level pursuing the National Certificate in Education programme (N.C.E.), from two Federal Colleges of Education, Zaria and Kano (51 boys and 74 girls). The subjects were randomly selected using balloting. Also a pre-test, post-test control group quasi- experimental design was used. In this study, there were four groups (one control and three experimental groups). The subjects, who were members of the same class, were randomly assigned to the various groups using balloting method i.e. concept mapping plus reflective writing (33), lecture method plus reflective writing (31), concept mapping alone(31) and lecture method alone(30).

Instrumentation

The instrument used for this study was the Biology Attitudinal Questionnaire (BAQ). The questionnaire consisted of 20 items. The opinion of the respondents was indicated on the issues in the questionnaire, according to Likert-type-five-point scale. The response patterns of their scales were: Strongly Agree (SA). Agree (A), Neutral (N), Disagree (D) and Strongly Disagree (SD). The attitudinal questionnaire covered such areas like learning biology, teaching biology and doing biology experiments. The questionnaire was developed by the researcher from two theoretical literature sources i.e. Thomson and Shringley (1986) and Lavoie (1996). The questionnaire was administered before and after treatment to measure the attitudinal change of the subjects towards learning.

The draft of the questionnaire was validated by a panel of four science educators, who are familiar with concept mapping and reflective writing strategies. The panel included a professor of Science Education and three lecturers in Science Education not lower than the rank of senior lecturer from two Nigerian universities.

These experts were asked to examine the questionnaire for content validity appropriateness of the items, in terms of reading difficulty for the groups they were meant for, and clarity of the statements in the instruments and learning materials.
The test re-test reliability coefficient of the test items was found to be 0.69 using Kuder-Richardson formula.

Procedure

After assigning the subjects into 4 groups (33,31,31.&30), the attitudinal questionnaire was administered before the pre-test was administered. Treatment was carried out for six weeks. The same questionnaire was given to the students

after which the post-test was administered. The achievement Test on ecology Concepts (ATEC) was constructed by the researcher and was employed as pre and post-test in the study. The test consisted of twenty, four- option, multiple choice questions to test knowledge of the concepts taught in ecology topics in biology. The subjects were expected to answer all the questions.

Data Analysis

The responses for the statements in the Biology Attitudinal Questionnaire were based on a five-point of Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. Numerical values of 5, 4, 3, 2. and 1 respectively were allotted to the responses of all positive attitude statements while 1, 2, 3, 4. and 5 were allotted to all negative attitudinal statements. The frequencies and percentages of the responses to each category were determined. Covariance Analysis was used to analyse the attitudinal data collected with the pre-test scores serving as covariance of the post-test scores. Again, Multiple Classification Analysis was computed to identify the contribution of each method towards the attitudinal change through the adjusted means.

Table 1: Analysis of Covariance on Attitudinal Scores of Experimental and Control Groups

Source	df	ss	ms	f. Ratio	Significance of f
Co vari ate (pre-test)	1	60.089	60.089	2.006	0.159 (ns)
Main effect	3	386.145	124.715	4.297	0.006†
(Attitude) explained	4	44.235	111.559	3.724	0.007*
residual	120	3594.965	29.958		
TOTAL	**124**	**4041.200**	**32.590**		

*Significant at $p < 0.05$
NS = Not Significant at $p > 0.05$

Table 1 above indicates that there is significant difference in terms of attitudinal change between pre-service NCE science teachers taught using the four methods. The Null hypothesis was therefore rejected. To further confirm this finding, a post- hoc analysis was carried out using the Scheffe's procedure. Also M.C.A. table was computed to know the magnitude of each method in the tables presented below.

Table 2: MCA Table Showing the Adjusted Mean Scores and Net Effect on the Attitudinal Scores of the Experimental and Control Groups

Variable + Category	n	Unadjusted Mean Score	Adjusted Independent + Covariate	Beta
Con + Reflect	33	- 1.00	- 1.01	
Leet + Reflect	31	- 1.56	- 1.56	
CON MAP	31	2.96	2.97	
CONTROL	30	-3.8	-3.5	
Multiple *R*				.31
Squared				.110
Multiple R				.332

Table 3: Extracted Adjusted Means from the MCA Table (Grand Mean 58.880)

Methods	Mean (Adjusted)
Con + Reflect	57.870
Leet + Reflect	57.320
Concept Map	61.850
Control	58.530

From the MCA Table above, it was found that concept mapping has the highest effect on the attitudes of pre-NCE teachers with an adjusted means of 61.850. This was followed by lecture method, w'hich w'as the control with an adjusted mean of 58.530. A combination of lecture method and reflective writing was the least with an adjusted means of 57.320.The data were further subjected to Scheffes procedure and the result is presented below'. *

Table 4: Scheffe's Test on Means for the Attitudes in the Four Groups

Methods	Mean (Adjusted)
Con + Reflect	57.878
Leet + Reflect	57.354
Concept Map	61.838 **
Control	58.500

*Denotes pair of groups significantly different at the 0.05 level.

From the data in Table 4, it is noted that concept mapping alone tends to significantly affect the pre-service NCE teachers‟ attitude toward biology. The other three methods did not. The contribution of each method can, therefore, be summarised in the following ranking order:

- Concept mapping alone
- Lecture method alone (control)
- Concept mapping plus reflective writing
- Lecture method plus reflective writing.

Discussion

The result of testing the hypothesis revealed statistical difference between the experimental and the control groups in terms of attitudinal changes in biology when analysis of covariance was performed on the data (Table 1). The finding led to the rejection of the hypothesis. Also, the post-hoc test and the MCA Table showed the contribution of each of the methods to the attitudinal changes in the following rank order: Concept mapping alone, lecture method alone, combination of concept mapping and reflective writing strategy.

Findings from this study are contrary to the finding of Lavoie (1996) who found that a combination of concept mapping and reflective writing strategy had a significant positive impact upon students learning and attitudes toward science. However, evidence abounds to support the finding of this study that concept mapping can lead to the development of positive attitudes toward science (Alaiyemola, 1987, Okebukola and Jegede, 1989; Okebukola, 1990 & Horton et al., 1993).

Conclusion

This study was an attempt to test the efficacy of concept mapping and reflective strategies as a model for attitudinal change of pre-service NCE biology teachers in Nigeria. The results of the analysis showed that there was a significant difference between the experimental and the control groups. One possible reason students develop positive attitude when concept mapping was used could be the fact that concept mapping has to do with visual means of representing concepts and since students are engaged in the mapping exercise, they are able to internalise ideas and even extrapolate these to other situations (Novak et al., 1983). Hence, they develop a highly positive attitude. Another possible reason for the development Bf positive attitude with the use of concept mapping could be the educational level of the subjects used for this study. The students used for this study were the NCE 1. This level of students is used to the traditional lecture method of learning. One would not be surprised at a change of attitude with a change of method of instruction. However, it should be noted that lecture method also affected their attitudes positively. This result has also answered the research question positively.

Implications of the Findings for Open and Distance Learning (ODL) in Nigeria

- The findings of this study could help to improve various aspects of ODL. This could be in terms of course material development, facilitation and ODL curriculum planning.
- Concept mapping and reflective writing strategies should be used as useful instructional strategies in developing instructional materials for open and distance learning system. Course material writers should endeavour to incorporate these strategies to complement the conventional methods of teaching through the organisation of concepts into hierarchy.
- Facilitation in ODL system is different from teaching in conventional school system. Facilitation in ODL is a face to face contact between the learner and the facilitator for the purpose of interaction. It is synonymous with tutorials, where students raise issues and discuss areas of difficulty from their course materials with the teacher who is the facilitator. Therefore, concept mapping and reflective writing strategies, when used during facilitation will help the students to think reflectively and focus on important concepts, thereby enhancing meaningful learning. It will also enable ODL students to see at a glance, the interrelationships between concepts.
- Standard Kajcik (1990) has found concept mapping strategy as a useful instructional tool in curriculum development. Therefore, ODL curriculum planners should incorporate concept mapping and reflective writing strategies into ODL curriculum. One of the ways by which this can be done is by arranging the curriculum in a hierarchical way following David Ausubels theory of meaningful learning.

Recommendations

On the basis of the above findings, it is recommended that biology teachers should use concept mapping and reflective writing strategies to compliment their conventional methods of teaching science. This will not only enhance meaningful learning in students, but it will also enable them to develop positive attitudes towards the learning of science.

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