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The Effect of Concept-Mapping Instructional Strategy on Physics Achievement in Secondary Schools in Ekiti State, Nigeria

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Abstract. The study investigated the comparative effectiveness of concept-mapping instructional strategy and conventional method of presenting secondary school physics concepts to learners. The research study adopted the quasi experimental research design. The population comprises of all senior secondary school II physics students in Ekiti State. Eighty physics students from senior secondary school two were used as sample and were randomly distributed to concept-mapping group and conventional group. They were respectively taught with the concept of motion. The groups were post-tested after two weeks of treatment for any significant difference in the physics achievement. Analysis of the post-test scores indicated that the group taught with concept-mapping instructional strategy performed significantly ($P < 0.05$) better than the conventional group counterpart. Result established that the concept-mapping instructional strategy when integrated with other method of instruction resulted in improved learning achievement.

Keywords: Physics, Achievement, Concept-Mapping and Gender

1. Introduction

The need to acquire knowledge in science and technology in the world over has become very obvious. In a developing country like Nigeria, where means of achieving technological development and economic survival are sought, high priority is placed on the teaching and learning of science in schools. This account for reasons why Physics which is one of the core science subject cannot be toyed with by science educators and students who want to pursue science oriented-courses. The usefulness of Physics as a science-based course in technological development of all nations as well as to mankind is no longer news at conferences, workshops and different academic forum (Ifemuyiwa, 2007, Egbujuo, 2009 & Egbujuo & Oriji, 2010). Physics has been introduced in Nigeria secondary curriculum to achieve the following objectives:

- To provide a solid foundation for everyday living
- To develop computational skills and ability to be accurate to a degree relevant to the problem in hand
- To stimulate and enhance creativity (FGN, 2004).

As important as the subject is, the tremendous and persistent failure of Nigerian students in Physics as remained a major threat to its learning (Ajewole, 2006,

Abakpa & Agbo-Egwu, 2008). This study is against the backdrops of increased annual higher percentage of students in Nigeria that failed Physics examination conducted by the West African Examination Council (WAEC) and the inability of prospective undergraduate to gain admission to tertiary institutions due to poor mark scored in Physics at the universities Tertiary Matriculation Examination (UTME). This is in addition to the question of what learners find easy or difficult to retrain in term of meaningfulness of materials after Physics instruction. According to Meyer (2003), certain materials are better understood than others when they are presented in a meaningful manner. He opined that meaningful materials stand a better chance of being remembered than non-meaningful materials and that since understanding comes from meaning,, things that are meaningful are better understood, retained and recalled than things that are not meaningful.

Thus for the content and concepts of a subject to be retained and recalled, there is need to make the subject meaningful to the students by presenting it in a meaningful way using appropriate instructional strategies (Abimbade, 2010).

Finding from a study conducted by the curriculum Development Centre, Ministry of Education, Malaysia in 2002 cited in Missilidine, (2004) showed that students do not know how to interpret problems that involve pictures, stories and which required students' creativity. As, a result of this, many approaches to teaching were introduced so that teaching would focus more on the students ability to learn and one of such is the use of concept-mapping instructional strategy.

Concept-mapping as a metacognitive strategy is a learning technique that empower learner to take charge of his/her own learning in a highly meaningful fashion. Concept-mapping is base on Ausubel-Novak theory of meaningful learning. (Novak & Carnas, 2008). It relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognitive bridging and progressive integration. It is a designed to assist students 'learn how to learn in science'.

Concept mapping is a way of displaying graphically the relationship that exists among concepts. The heuristic of concept mapping is a kind of a meta cognitive strategy that assist learners in understanding concepts and relationship between them and in seeing the hierarchical, conceptual, propositional nature of knowledge (Hibberd, Jones & Morris 2002). The unique characteristics of concept mapping suggest that meaningful learning occur when a learner is aware of and can control the cognitive processes associated with learning.

Concept mapping is a systematic device for presenting a set of concept-meanings embedded in a framework of propositions (Kaenin, 2004). Concept maps are two dimensional hierarchical diagrams which illustrate the connection between individual concept (Caff & Caralho, 2006). It is based on the premises that concept do not exists in isolation but depend upon others for its meaning.

According to Ault (1985) cited in Uchenna & Philomena (2012), the following steps are necessary when constructing a concept map:

- Select an item in mapping. This could be an important text, message, lecture notes for laboratory background materials.
- Choose and underline key words or phrases; including objects and events in the list

- Rank the list of concepts from most abstract and include to the most concepts and specific
- Cluster the concepts according to two criteria: concept that function at a similar level of abstraction and concept that interrelate closely
- Arrange the concepts as a two-dimensional array analogous to a road map
- Link related concepts with lines and label each line in propositional form.

To successfully teach physics concepts, there is the need to dedicate substantial time to instruction technique that empowered learner to take charge of their learning activity, use hand-on methods and incorporate extensive practical activities.

Therefore there is need to find out if concept-mapping instructional strategy could really enhance students' achievement in physics.

Again, there has been a report that gender differences influence achievement in science. Okebukola and Jegede (1997) reported after extensive review of literature on gender differences in science achievement that male students perform better than their female counterparts. The wide gaps in science achievement between male and female students has been considerably reduced over the years, however a lot still need to be done to close up the gap completely. Furthermore, a lot of reasons have been assigned for this difference, among them is inappropriate use of instruction strategy. Pendel (2006) reported that concept-mapping instructional strategy is an effective method of presenting science concepts to students to achieve meaningful learning. On this premises, the study intends to examine if concept-mapping instructional strategy could improve students' achievement in Physics.

2. Research Hypotheses

The following hypotheses were formulated to give appropriate direction for this study;

- There is no significant main effect of treatment (concept-mapping) on the students' achievement in Physics
- There is no significant main effect of gender on students' achievement in physics using concept mapping instructional strategy.

3. Methodology

The study adopted pre-test, post-test control group quaisi-experiment design.

The target population for this study comprised all the senior secondary school two (SS2) students offering physics in Ekiti State, Nigeria. A sample of 80 students were purposely selected. There were two activity groups i.e. the experimental group and the control. The instruments used in the research study were of two types namely: Physics Achievement Test and [ii] The incomplete motion concept map which the experimental group were expected to complete after treatment.

A 30 –item multiple choice pretest of internal consistency 0.75 measured through Combach alpha was developed by the researcher and administered to the subject prior to the experiment. This is to establish the pre- experimental abilities of the samples. The pre-test items were derived from senior secondary class two Physics syllabus.

Two treatment conditions namely the concept mapping and the conventional

instructional technique were used to present the concept of motion for two weeks to the subjects.

Fig 1: showed the concept map prepared by the researcher to aid the instructional process. At the end of the treatment period, the concept-mapping group prepared their own maps which were used for diagnosing learning difficulties and learning misconceptions.

The conventional technique is the normal popular method of teaching physics in most secondary Schools. This technique consists of the presentation of the Physics concepts and the students were mainly asked to listen to the lectures and take down notes. Both groups were exposed to post-test after the treatment.

3.1 Procedure for Data Analysis

The two hypotheses formulated in this study were tested using t-test. The t-test of significant was used to compare the magnitude of the mean achievement of the two groups and the tests were computed at the 0.05 level of significance.

4. Result

Research Hypothesis 1

There is no significant difference between the post-test mean scores of concept-mapping and control groups in Physics.

Table 1: T-test summary showing difference between the post-test mean scores of concept-mapping and control groups

Source	N	Mean	S.D.	Df	t-cal	t-table
Concept-mapping	40	32.40	6.029	78	26.14	1.96
Control group	40	59.10	2.318			

$P < 0.05$

Table 1 above revealed that the calculated t-value [t-cal] is greater than the table value at 0.05 level of significant [i.e. t-cal =26.14 > t-table = 1.96, df = 78, $p < 0.05$). Hence the null hypothesis is hereby rejected. That is, there is a significant difference, in the achievement mean scores of concept-mapping and the conventional group in Physics.

Research Hypothesis 2:

There is no significant difference in the achievement mean score of male and female students using concept mapping.

Table 2: Summary of Paired sample t-test showing difference in the achievement mean scores of male and female students using concept mapping.

Source	N	Mean	S.D.	Df	t-cal	t-table
Male	18	55.22	2.203	38	-.0298	1.96
Female	22	59.00	2.510			

$P < 0.05$

Table 2 above revealed that the calculated value [t-cal] is less than the table value at 0.05 level of significant (i.e. t-cal = 0.398 < t –table = 1.96 df = 38, p> 0.05). Hence the null hypothesis is hereby accepted. That is there is no significant difference in the achievement mean scores of male and female in Physics using concept mapping.

5. Discussion

The data from this study provide support for the potency of the concept-mapping technique in bringing about meaningful learning of Physics concepts. The experimental group involved in concept mapping was found to achieve significantly better than their control group counterparts in the Physics achievement post-test ($t = 1.96$; $p < 0.05$) as reported in table 1. This is in agreement with the findings of previous studies (Pankratius, 2002, Novak & Canas, 2008, Safayeni et al 2005) which provided evidence attesting to the efficiency of concept mapping in facilitating meaningful learning.

Another finding in this study clearly indicated that there was no significant difference between male and female students' achievement when they are exposed to concept mapping instructional strategy as shown in table 2. The findings further established the homogeneity of male and female students in terms of academic achievement when exposed to concept mapping instructional strategy, similarly the finding falls in line with that of Alokan, 2010, Kolawole & Poopola, 2011 who attest to it that sex do not have significant influence when exposed to problem solving instructional strategy.. However, the finding of this study is at variance with that of Adesoji and Fisuyi (2001) who reported that more girls than boys had difficulties in problem solving, notwithstanding, the researcher is of the opinion that problem solving by girls could be improved through the use of appropriate teaching strategy.

6. Conclusion

The findings of the study revealed that there was a statistical significance difference in the achievement mean scores of the two groups in problem solving in Physics after they were exposed to the concept-mapping and convention strategies. The concept mapping group performed better than the conventional group. Therefore based on the results of this study concept mapping strategy has a noticeable impact in students' achievement in Physics than the conventional group.

Also, the findings revealed that there was no statistical significant difference in the achievement mean scores of male and female students when exposed to concept mapping instructional strategy.

7. Recommendations

The following recommendations based on the findings of the study were made:

Concept-mapping instructional strategy can lead to improvement in quality of teaching because it would enable the students to focus attention in the inter-relationship between the central concept to be taught and other related concept hence there is the need for physics teachers and science educators to incorporate the use of concept-mapping instructional strategy in the teaching process.

Seminars, workshops and conferences should be organized for science teachers on regular basis on the effective use of concept-mapping instructional strategy.

Apart from this, science educator and other stakeholders should discourage gender stereotype in teaching and learning science subjects.

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