Effects of computer-based instructional strategies on students performance in physics in senior secondary schools in Jega local government, Kebbi state, Nigeria

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Abstract

This study examined the effects of computer-based instructional strategies on the performance of physics students in secondary schools in Jega Local Government, Kebbi State. The study was guided by two (2) research questions and two (2) null hypotheses which were tested at 0.05 alpha levels. The comparative effects of the spider and hierarchical modes of computer-based concept mapping strategies were explored. The instrument used in the study were: researcher adapted Physics Performance Test (PPT), Computer-Based Concept Mapping Instruction Packages (CBCMIP) and Computer Based Instruction Package (CBIP), which were validated by experts. The sample population comprises of 100 SS2 Physics students drawn from one (1) public and two (2) private secondary schools in Jega Local Government Area of Kebbi State. Three intact classes were selected through simple random sampling technique from each of the selected. From the data collected, mean and standard deviation were used to answer the research questions while ANCOVA was used to test the null hypotheses. Findings of the study revealed that students taught with computer-based concept mapping strategies have almost the same level of performance with those taught using just computer based instruction. The findings also revealed that gender has no significant effect on the academic performance of students when taught using computer-based concept mapping instructional strategies. Finally, it was recommended that the workshops and seminars should be organized for teachers by education authorities of the Federal and State Ministries of Education, on the use of computer-based concept mapping strategies to improve students' performance in Physics.

Keywords: physics, computer-base, concept mapping, gender, ANCOVA

1. Introduction

The growth and development of most nations are dependent on science, technology and mathematics education. Science is an organized body of knowledge, which enhances the ability to acquire skills. It is a search for meaning or exploration of events in nature (Ifeakor, 2006) [6]. Science and Technology related subjects that would enable students have a substantial understanding of science and be able to apply scientific knowledge in solving problems in their ever-changing society are mathematics, chemistry, biology, health science, introductory technology and physics.

Physics is one of the compulsory subjects for one to study science and technology related courses in tertiary institutions. It is a science that uses quantitative measurement and experimental observations in order to understand natural events.

It can explain natural events mathematically and can relate these events to daily life events (Tekbiyik & Akdeniz, 2010) [12]. Of all the sciences, Physics is the one that students experience the most difficulties with because most of the physical notions are abstract. Also, when compared to other lessons, although there are many relationships between main subjects and number of the subjects to be learned, simply knowing definitions is not enough to teach the subject (Karaca, 2013) [8]. Theories and numerical expressions also make it difficult to understand Physics and to make a connection between the subjects (Arvind & Heard, 2010; Jian-Hua & Hong, 2012; Bakac, Tasoglu & Akbay, 2011) [1, 7, 4].

The technological development of any nation lies in the study of science especially physics. The role of physics in national development is acknowledged in the whole world.

The Federal Government of Nigeria made special provisions and incentives through the provision of laboratory facilities, instructional materials, training and retraining of teachers, provision of research grants and adoption of Information and Communication Technology (ICT) to improve the teaching and learning of science (physics inclusive) in the secondary schools (FRN, 2015) [5]. Part of the requirements for any school to be enrolled for WAEC and NECO is that the school must have science laboratories. Also, schools are expected to be provided with computer systems. Furthermore, the Federal Government stated that "In recognition of the prominent role of information and communication technology in advancing knowledge and skills necessary for effective functioning in the modern world, there is an urgent need to integrate information and communication technology into education in Nigeria (FRN, 2015) [5]. Despite all the efforts made by the Federal government, physics students perform very poorly (WAEC, 2016) [14].

Gender in relation to performance has been an issue of interest

and concern to researchers in education. There are varying opinions on which gender (either males or females) achieves better than the other. On this, there are those that claim that males performed better than females, yet others claim that females achieved higher or better than their male counterparts (Ofoegbu, 2008) [10]. On the debate, the widely held view that females were superior in language use (acquisition and performance) was based mainly on studies in foreign countries especially English-speaking ones and that this position is not tenable in Nigeria.

She concluded that her survey on research studies on gender influence on achievement in language in Nigeria indicate that many studies did not establish enough evidence to support the claim that females are better than males in language (Azikiwe, 2009) [2].

Furthermore, Njoku (2009) [9], in his study on enhancing the relevance of chemistry curriculum delivery using science, technology and society (STS), stated that female students underachieve in science, technology and mathematics education relative to their male classmates.

The issue of gender becomes crucial in this present day because the schools in the research are co-educational. Also, the contradictory evidences in academic performance due to gender has necessitated the need to verify how computer-based concept mapping instructional strategies can influence students 'performance in physics. This study therefore, will examine the effects of computer-based concept mapping instructional strategy on students 'performance in physics.

Computer-based instructional strategy refers to instruction or remediation presented on a computer. These modes of instructions are interactive and can illustrate a concept through attractive animation, sound and demonstration. It allows students to progress at their own pace and work individually. Computers provide immediate feedback, letting students know whether their answer is correct or not. If the answer is not correct, it shows how the students can get the correct answer. Many researchers have used computer-based instruction indifferent subject areas to improve effective teaching and learning. For instance, Yusuf and Afolabi (2010) [15], investigated the effects of computer assisted instruction on secondary school students' performance in biology.

The findings of the study showed that the performance of students exposed to Computer Assisted Instruction either individually or cooperatively were better than their counterparts exposed to conventional classroom instruction. Also, Tapscott (2008) [13] investigated the effect of computer-based instruction on academic achievement in sciences; the result was also positive in favour of the students engaged in the computer assisted instruction.

Computer-based concept mapping instructional strategy incorporates the use of computer instruction and other ICT tools with concept mapping. With computer-based concept mapping, concept representations and their respective links are not static; both can be expanded as knowledge or elaboration of an idea increases. Errors in describing ideas can be easily corrected and adapted. Most computer-based concept mapping tools allow the user to point and drag a concept or group of concepts to another place on the map and automatically update all the appropriate links (Anderson-Inman &Zeitz, 2013).

1.1 Statement of the problem

The persistent poor performance, according to the Chief Examiner for the year 2015- 2016 was as a result of: Poor understanding of general principles and concepts, heat, energy changes, matter and motion (WAEC, 2016) [14].

This poor performance as indicated by the results can be attributed to many factors which include; ineffective teaching methods, unqualified and inexperienced teachers teaching the subject, lack of appropriate and effective use of media among others (WAEC, 2016) [14].

Despite all that has been done to improve students 'achievement especially in physics, students still perform poorly. The researcher is of the view that an alternative teaching method like the computer-based concept mapping strategies if employed might improve the performance of physics students. Therefore, this study seeks to determine the effects of computer-based concept mapping instructional strategies on students' performance in physics in Kebbi State, Nigeria.

1.2 Research questions

The study was guided by the following research questions:

1. What is the difference between the performance of students taught physics using computer-based concept mapping strategies and those taught using computer assisted instruction?
2. What is the difference between the performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy?

1.3 Research hypotheses

The following hypotheses were formulated and tested at 0.05 alpha levels:

HO_1: There is no significant difference between the mean performance of students taught physics using computer-based concept mapping strategies and those taught with computer assisted instruction.

HO_2: There is no significant difference between the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy.

2. Methodology

2.1 Research Design

The research design adopted for this study is a quasi-experimental design. It is a pre-test, post-test, non-randomized, non-equivalent control group design (Sambo, 2008) [11]. A 3 x 2, multiple treatment factorial design was used in this study.

This design represents three levels of treatment (computer-based concept mappings using hierarchical and spider modes respectively and computer assisted instruction method; and two levels of gender (male and female).

The illustration of the design is shown in Table 1 below:

Table 1

Experimental groups	Pre-test	Treatment	Post-test
Experimental Group 1	X_1	CBCM (X_1)	X_2
Experimental Group 2	X_1	CBCM (X_2)	X_2
Control Group	X_1	CBCM (X_3)	X_2

Source: Field Survey (2022)

The study concerns itself with the following variables; independent variable and dependent variable. The independent variables in this study are the teaching methods and gender. The dependent variable is student's performance in physics concepts.

2.2 Population of the study

The population for this study consists of all Senior Secondary two (SSII) physics students in all the Senior Secondary Schools in Jega Local Government Area of Kebbi State. The target population is 150 Senior Secondary School Physics Students in SS II. This population comprises 100 Males and 50 Females.

2.3 Sample and sampling techniques

A two-stage sampling technique was adopted. Firstly, a purposive random sampling was adopted to obtain three private secondary schools in Jega Local Government Area of Kebbi State. The schools were purposefully sampled based on equivalence in (laboratories, facilities and manpower), school location (urban area, Jega metropolis), gender composition (mixed schools), well equipped computer laboratories, exposure (students and teachers' exposure to the use of computer in their schools).

Secondly, the three sampled equivalent and co-educational schools were randomly assigned to the experimental groups and the control group. The three schools are coeducational schools that consist of both male and female students.

The study adopted the use of intact class approach where all the students in the class were involved in teaching and testing sessions. Students in the intact classes are stratified along gender (male and female).

The total number of students that were used for this study from the three sampled schools is 100. The sample is illustrated in table 2.

Table 2: Names of sampled Schools

S/N	Schools	Males	Females	Total
1.	Government Day Secondary School, Jega(X)	18	12	30
2.	Ni'ima International School, Jega(Y)	20	16	36
3.	Yasima International School, Jega(Z)	20	14	34
	Total	58	42	100

Field Survey, (2022)

2.4 Instrumentation

The instrument used in collecting data in this study is researcher adapted Physics Performance Test (PPT). The Physics Performance Test (PPT) consists of 30 multiple choice items adapted from past examination questions of West African Examination Council (WAEC) and National Examination Council (NECO) from 2015 to 2020. The Physics Performance Test (PPT) is based on SSII curriculum on the concepts of: Scalar and Vector quantities, Newton's laws of motion and Projectile Motion. These chosen topics were selected from the senior secondary two (SSII) physics syllabuses and scheme of work and correspond to what the students should be taught in their schools at the time of the study

2.5 Procedure for data collection

The researchers visited the schools to check the facilities available in the schools. Also, an approval was sought from the school authorities to carry out the study. The cooperation of the students and the staff in all selected schools were sought. The subject teachers were trained as research assistants in the use of the computer-based concept mapping instructional strategies. The study lasted for four (4) weeks for both the training of staff and conducting experiments.

2.6 Procedure for data analysis

The data obtained from the pre-test and post-test were marked and subjected to data analysis. The research questions were answered using mean and standard deviation while the hypotheses for the study were tested using ANCOVA with Statistical Package for Social Sciences (SPSS) version 21. The significance of the various statistical analyses was ascertained at 0.05 alpha levels of significance. This choice of ANCOVA was to control errors of initial non-equivalent arising from the use of intact classes as subjects for the study.

3. Results analysis

Research question 1: What is the difference between the performance of students taught physics using computer-based concept mapping strategies and those taught using computer assisted instruction? In answering research question one, mean scores of students in the experimental groups (computer-based concept mapping using hierarchical and spider modes) and the control (computer-based instruction) groups were analysed using mean and standard deviation as shown in Table 3.

Table 3: Mean and standard deviations of students' scores using computer-based concept mapping strategies and computer assisted instruction

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
CBCM (Hierarchical)	30	49.50	11.55	77.17	10.80	27.67
CBCM (Spider)	36	47.22	11.24	76.81	10.22	29.59

Table 3 showed the mean and standard deviation of the pre-test and post-test scores of all students in the experimental and control groups. From the result, it can be deduced that the mean score and standard deviation of the pre-test for the computer-Based Concept Mapping (CBCM) of students in Hierarchical group are 49.50 and 11.55 while the mean score and standard deviation of the same students in the post-test are 77.17 and 10.80. The mean gain is 27.67 in favour of the post-test scores. Similarly, the mean score and standard deviation of the pre-test for the CBCM of students in Spider group are 47.22 and 11.24

while the mean score and standard deviation of the same students in the post-test are 76.81 and 10.22 respectively. The mean gain is 29.49 in favour of the post-test score. Also, the mean score and standard deviation of the pre-test for the CBI of students in Control Group are 43.52 and 12.92 while the mean score and standard deviation of the same students in the post-test are 75.34 and 10.91. The mean gain is 31.82 in favour of the post-test scores.

Research question 2: What is the difference between the performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy?

Table 4: Pre-test and post-test scores of male and female students taught physics using hierarchical mode of computer-based concept mapping strategy

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Male	16	49.69	13.48	77.50	11.40	27.81
Female	14	49.29	9.38	76.79	10.49	27.50

Survey Field, 2022

Table 3.2 showed the mean and standard deviation of the pre-test and post-test scores of male and female students in the experimental group 1 (CBCM hierarchical). From the result, it can be deduced that the mean score and standard deviation of the pre-test for the male students are 49.69 and 13.48 while the mean score and standard deviation of the same students in the post-test are 77.50 and 11.40. The mean gain is 27.81 in favour of the post-test scores. Similarly, the mean score and standard deviation of the pre-test for the female students are 49.29 and 9.38 while the mean score and standard deviation of the same students in the post-test are 76.79 and 10.49 respectively. The mean gain is 27.50 in favour of the post-test score. Therefore, male students (27.81) had a higher mean gain score than the females (27.50).

Null hypotheses testing

HO_1: There is no significant difference between the mean performance of students taught physics using computer-based concept mapping strategies and those taught with computer assisted instruction.

Table 5: ANCOVA results of the treatment groups (CBCM and CBI)

Source	Type III Sum of Squares	df	Mean Square	F-value	*p*-value
Corrected Model	1343.845 [a]	3	447.948	4.360	.006
Intercept	26383.944	1	26383.944	256.813	.000
Pre-test	1271.673	1	1271.673	12.378	.001
Groups	3.304	2	1.652	.016	.984[ns]
Error	10890.019	106	102.736		
Total	652925.000	110			
Corrected Total	12233.864	109			

ns: Not significant atα = 0.05 alpha level

Table 5 shows the ANCOVA results of the two experimental groups (CBCM Hierarchical, CBCM Spider) and the control group (CBI). As illustrated in the table, F (2, 106) = 0.016, p = 0.984. This implies there was no significant effect of the learning strategies on post-test performance of the students. The result indicates that the treatments using CBCM and CBI accounted for no difference in the post-test achievement scores of the students. Hence, hypothesis one is accepted.

HO_2: There is no significant difference between the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy.

Table 6: ANCOVA results of male and female students in experimental group 1 (CBCM Hierarchical)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	252.394 [a]	2	126.197	1.088	.351
Intercept	6256.675	1	6256.675	53.941	.000
Pre-test	248.584	1	248.584	2.143	.155
Gender	2.799	1	2.799	.024	.878[ns]
Error	3131.773	27	115.992		
Total	182025.000	30			
Corrected Total	3384.167	29			

NS: Not significant at α = 0.05 alpha level

Table 6 shows the ANCOVA results of male and female students in experimental group 1 (CBCM hierarchical). From the result, F (1, 29) = 0.024, p = 0.878. This implies that there is no significant difference in the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional package. Hence, hypothesis two is also accepted.

4. Conclusions

Based on the finding of the study, it has been concluded that: The treatments; (hierarchical mode of computer-based concept mapping, spider mode of computer-based concept mapping and computer based instruction) improved students' performance in physics but no significant difference on gender was established on the performance of the students taught using these three modes. There was no significant difference in the performance of male and female students taught with computer-based concept mapping strategies. Therefore, gender is not a militating factor against students' performance in physics when computer-based concept mapping was used.

5. Recommendations

The workshops and seminars should be organized for teachers by education authorities of the Federal and State Ministries of Education, Institutes and Colleges of Education on the use of computer-based concept mapping strategies to improve students' performance in Physics is hereby recommended.

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