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Effects of Computer Assisted Concept Mapping and Analogical Instructional Packages on Niger State Secondary School Students' Achievement in Biology

BY

'Koroka, M. U. S., 'Ezenwa, V. I.(Mrs.), 'Wushishi, D. I. & 'Omalu, I. C. J.

'Centre for preliminary and extra-mural studies; ¹²³Department of Science Education & ¹²⁴Department of Biological Sciences, Federal University of Technology, Minna, Nigeria

E-mail: muskirk@ymail.com

Mobile No: 08035965281 / 08056470601

Abstract

The study examined the effects of computer assisted concept mapping and analogical models on achievement among Niger State secondary school biology students. A research hypothesis was formulated and tested at .05 alpha level. Quasi-Experimental design (Pretest-Posttest-Control group design) was adopted for the study. The sample for the study was 170 year II Senior Secondary (SSII) biology students of Niger State. Three (3) Niger State Government owned co-educational Senior Secondary Schools were purposively selected from each of the three Senatorial zones of the State, making a total of nine (9) schools that were used for the study. One (1) school from each zone was used as experimental group 1, another one (1) as experimental group 2, and the third one (1) as control group. The sample was randomly selected (by simple balloting) from the nine (9) schools used for the study. Thirty (30) SSII students (15 males and 15 females) were selected from each school for the study. The instruments used were Test instrument and Treatment Instruments (50-Multiple Choice Test Items on Metabolism (MCTIM) and the developed CAI packages respectively). A pilot test was conducted and the reliability coefficient (r) of 0.96 was obtained. Analysis of Covariance (ANCOVA) was used to test the hypothesis formulated at 0.05 significant level. The result revealed that students exposed to CAI packages achieved higher than those exposed to conventional method. It was recommended that, the use of Computer Assisted Concept Mapping Instructional Model (CACMIM) and Computer Assisted Analogical Instructional Model (CAAIM) should be adopted by science teachers in secondary schools.

Keyword: Achievement, biology, concept, effects, metabolism, students, and Niger State.

Introduction

Biology is a branch of science dealing with living organisms. It seeks to explain the nature, structure and roles of living organisms in their environments. Abu (2000) in discussing the usefulness of biology to man stated that, the study of biology enables one to be aware of his changing environment and the need to contribute positively to national development. Biology is also a core and compulsory subject for all students in secondary schools. This is because the knowledge of biology is needed in the study of medicine, dentistry, veterinary science, agriculture and biotechnology, genetic engineering, among others. Because of the above and many other usefulness of biology to man, the objectives of the current biology curriculum used in secondary schools is directed towards the realization of the usefulness of biology as a field of study and they include amongst others the preparation of students to acquire: (i) adequate laboratory and field skill in biology (ii) meaningful and relevant knowledge in biology (iii) ability to apply scientific knowledge to everyday life in matters of personal, community, health and agriculture as well as (iv) reasonable and functional scientific attitudes.

Statement of the Problem

In spite of the richly designed biology curriculum, tremendous importance of biology as a science subject to mankind and efforts of biology teachers to help students perform well in biology, evidence continues to abound that little progress has been made in terms of students' achievement in biology especially at the Secondary School Certificate Examination (SSCE) level. The West African Examination Council Chief Examiners' report (2000, 2002, 2003, 2004, 2006, 2009, 2010 & 2011) revealed that biology students performed below average. A five year WAEC results (2006 - 2010) of Niger State biology students indicating students' poor performance at SSCE is presented in table 1.

Table 1: A 5-Year WAEC Result of Niger State Biology Students (2006 - 2010)

Subject	Year	Total that sat	Credit pass (A1 - C6) & %	Pass (P7- P8) & %	Total that failed (F9) & %
Biology	2006	6640	1190 (17.92)	1563 (23.54)	3887 (58.54)
	2007	3395	289 (8.51)	453 (13.34)	2653 (78.14)
	2008	6385	698 (10.93)	1092 (17.10)	4595 (71.97)
	2009	6526	1134(17.38)	1301(19.94)	4091(62.68)
	2010	6845	1308(19.11)	1580(23.08)	3957(57.81)

Source: Niger State Ministry of Education (2011)

Table 1 reveals poor performance of Niger State biology students as their percentage pass at credit level were 17.92% (in 2006), 8.51% (in 2007), 10.93% (in 2008), 17.38% (2009) and 19.11% (2010) while the percentage failure (combining D7, E8 and F9) were 82.08% (in 2006), 91.48% (in 2007), 89.07% (in 2008), 82.62% (in 2009) and 80.89% (in 2010).

Table 2: Senior Secondary School Biology Students' WAEC Result (2006 - 2012)

Subject	Year	Total that sat	A1-C6 (%)	D7 - E8 (%)	F9 (%)
Biology	2006	380,104	170670(44.90)	86423(22.73)	114475(30.11)
	2007	422,681	194284(45.96)	104680(24.76)	111322(26.33)
	2008	418,423	185949(44.44)	114697(27.41)	110417(26.38)
	2009	468,546	204725(43.69)	114020(24.33)	119260(25.45)
	2010	465,643	236059(50.70)	109944(23.61)	98165(21.08)
	2011	882,119	278122(31.53)	270301(30.64)	333696(37.83)
	2012	1,005,553	424636(42.23)	271058(26.96)	266222(26.48)

Source: W WAEC Office Minna, Niger State

A critical look at table 2 reveals that biology students' poor performance at SSCE level, is a national problem which needs the attention of all the stake holders in education. Also, analysis of National Examinations Council (NECO) result of biology students at SSCE level over a period of seven years (2006 - 2012) as shown in table 3 reveals general poor performance of secondary school students.

Table 3: Senior Secondary School Biology Students' NECO Result (2006 - 2012)

Subject	Year	Total that sat	Credit (A1 -C6) & %	Pass (D7 - E8) & %	Total that failed (F9) & %
Biology	2006	890,866	440,190(49.41)	212,303(23.83)	178,245(20.00)
	2007	980,337	503,388(51.24)	239,909(24.47)	195,189(19.91)
	2008	1,082,262	815,331(75.33)	114,489(10.57)	94,518(8.73)
	2009	1,157,883	501,968(43.35)	267,119(23.06)	125,758(10.86)
	2010	1,110,735	502,677(45.26)	316,249(28.41)	225,055(20.26)
	2011	1,005,894	298,555(29.68)	326,092(32.42)	348,890(34.69)
	2012	1,005,032	316,049(31.45)	455,955(45.37)	264,486(26.32)

Source: Head of research (NECO)

Results of the two different examination bodies as shown above followed the same trend indicating that there must be a general problem responsible for students' poor performance particularly at secondary level of our educational system.

Many studies revealed that teachers' instructional strategy is one of the factors responsible for the students' poor performance. Many of the studies revealed that teachers' instructional strategies are ineffective as a result of which students find many topics difficult to understand (Esiobu, 2000; Okoro and

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Etukudo, 2001; Kareem, 2003; Spencer, 2004; Akour, 2006; and Ahmed, 2008). In search for a better way to improve biology learning, Fafunwa 1990; Glynn, 1991; Abu, 1998; Lagoke, 1992; Okebukola, 1996; Onwukwe & Onwukwe, 2010 and Ijioma & Onwukwe, 2011 among others listed various methods which seemed to bring about meaningful learning to include vee-mapping, concept mapping, metaphor, analogy, Computer Assisted Instructional (CAI) strategy, co-operative learning and problem solving to mention just a few. Many research works conducted on the use of Computer Assisted Instructional (CAI) strategy reported that, CAI has been effective in enhancing students' performance than the conventional classroom instruction otherwise called traditional method (Hall, Hughes and Filbert, 2000; Udousoro, 2000; Mill, 2001; Okoro & Etukudo, 2001; Egunjobi, 2002; Jenk & Spriger, 2002; Spencer, 2004; Ifeakor, 2005; Karper, Robinson & Casado-Kehoe, 2005; Basturk, 2005; Davis, 2005; Akour, 2006; Collazos, Guerrero, Llana & Oetzel, 2008 and Tapscott, 2008). Computer-assisted instruction (CAI) is referred to as an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place (Mudasiru & Adedeji, 2010). However, literature on Computer Assisted Concept Mapping and Computer Assisted Analogical Instructional Models are not commonly available in Nigeria. This is one of the major reasons that motivated the researcher to apply Concept Mapping and Analogy in form of Computer Assisted Instruction (CAI) which is the current global trend in Information and Communication Technology (ICT) for classroom instruction to determine whether secondary school students' achievement will be improved.

Objective of the study

The study aimed at determining the differences in achievement on the concept of metabolism among secondary school biology students exposed to Computer Assisted Concept Mapping and Analogical Models and those exposed to Conventional lecture method.

The purpose of this study was to determine the differences in achievement on the concept of metabolism among secondary school biology students exposed to Computer Assisted Concept Mapping and Analogical Models and those exposed to Conventional method.

Research Question

Will the use of Computer Assisted Concept Mapping and Computer Assisted Analogical Models in teaching secondary school biology students and the concept of metabolism result in higher achievement than when students are taught with Conventional lecture method?

Null hypothesis

The following null hypothesis was formulated and tested at 0.5 level of significant.
 H_0 : There is no significant difference in the mean achievement scores of students taught the concept of metabolism in biology with Computer Assisted Concept Mapping and Analogical Instructional Model and those taught with conventional lecture method

Significance of the study

It would enable the students to connect their prior knowledge to scientific concepts as analogy enables them to link analogue (something familiar) to target (new and unfamiliar concept to be learnt). It would provide students enough opportunity to use the models for practice thereby aiding their understanding of the taught biological or science concepts. It would make teachers aware of Computer Assisted Concept Mapping and Analogical Instructional Strategies as effective instructional strategies in science teaching as the result of the students taught with these methods revealed better performance than those taught with traditional method. It would improve science teachers' ability to use Computer Assisted Concept Mapping and Analogical Instructional Strategies in science instruction and also its effectiveness. It would encourage and encourage educational policy makers to use simple, appropriate, relevant and explicit diagrams as relevant concept mapping and analogies in their textbooks. This is because concept mapping and analogies are known to make explanations in the text books simpler and clearer. It would encourage educational policy makers to allocate a greater percentage of annual budgets to education particularly in the area of science education as concept mapping and analogy instructional strategies have shown to improve students' performance. It would enable Ministry of Education to effectively monitor educational policies and programmes as teachers' instructional strategies will be narrowed to concept mapping and analogical instructions which have been identified to be effective

Scope of the Study

This study covered Niger State Senior Secondary Schools located in the three senatorial zones of the state. The study was delimited to nine (9) purposively selected Niger State owned co-educational secondary schools (three schools each from the three senatorial zones of the State). The study was also delimited to Senior Secondary Two (SS II) students in the selected schools.

Research Methodology

The research design adopted for this study was a Quasi-Experimental design. A Pre test-Post test-Control group design was used. This design enables the researcher to concurrently manipulate the two independent variables (Computer Assisted Concept Mapping and Computer Assisted Analogical Models) to assess the effects of their interactions on the dependent variables (Students' Achievement). The design layout is as shown in table 4.

Multiple Treatment Research Design (3 x 3 x 2).

GROUP	HIGH (1)	AVERAGE (2)	LOW (3)	GENDER
Experimental group1 (CACMIM)	111	112	113	Male 1
	121	122	123	Female 2
Experimental group2 (CAAIM)	211	212	213	Male 1
	221	222	223	Female 2
Control group3 (CM)	311	312	313	Male 1
	321	322	323	Female 2

KEY:

- In 111, 1= Experimental group 1, 1= Male and 1= High academic achievement level
- In 121, 1= Experimental group 1, 2= Female and 1= High academic achievement level
- In 212, 2= Experimental group 2, 1= Male and 2= Average academic achievement level
- In 222, 2= Experimental group 2, 2= Female and 2= Average academic achievement level
- In 313, 3= Control group 3, 1= Male and 3= Low academic achievement level
- In 323, 3= Control group 3, 2= Female and 3= Low academic achievement level

Purposive sampling was used for selecting schools for the study as only few of the secondary schools in Niger state have e-learning facilities. Simple random sampling technique by balloting was used to assign the sampled schools to different experimental and control groups. The target population for this study was all the four thousand, two hundred and thirty four (4,234) year II Senior Secondary (SSII) biology students in Niger State owned co-educational Secondary Schools. A total of thirty (30) SSII students (15 males and 15 females) were selected by simple balloting technique from each school for the study. The experimental group 1 was taught the concept of Metabolism in biology using Computer Assisted Concept Mapping Instructional Model (CACMIM) while experimental group 2 was taught the same concept using Computer Assisted Analogical Instructional Model (CAAIM). Control group on the other hand was taught same concept using Conventional lecture Method.

The two research instruments used for this study were Test instrument and Treatment instruments. Test instrument was a 50-Multiple Choice Test Items on Metabolism (MCTIM) drawn from past question papers of Senior Secondary Certificate Examination (SSCE) 'O' levels conducted by the West Africa Examinations Council (WAEC) and National Examinations Council (NECO). The questions were based on SSII syllabus and specifically on the concept of metabolism and were subjected to further validation by three experts in biology. Each test item had four (4) options (A - D) and only one of them is correct. The pilot test was conducted and students' scores were analyzed using Pearson Product Moment Correlation (r) and reliability coefficient of 0.96 was obtained. The achievement test instrument was administered on both experimental and control groups as pretest and posttest. The students' scripts were marked and their scores analysed.

The treatment instruments were the Computer Assisted Instruction (CAI) packages developed by the researcher with the help of a computer programmer. The two CAI instruments were: (i) Computer

Assisted Concept Mapping Instructional Model (CACMIM) and (ii) Computer Assisted Analogical Instructional Model (CACIM). Lessons in the CAI packages were planned in an organised manner and the learning materials presented sequentially in the following manner: Introduction, presentation of content with pictorial illustrations (animation) and evaluation. There is also a section of text that will enable the students copy notes on the topics being studied. Additionally, there is a self-assessment section at the end of every lesson. This section consists of 10-Multiple Choice Test Items as formative questions. The first five (5) questions are to be answered by the students in the class and the remaining five (5) are assignment questions. Each question has four options (A - D) and only one of them is correct. The students will be informed when his/her answer is correct or wrong using ticks (\checkmark) and (x) respectively. A correct answer is also followed by a voice sound "CORRECT" and a wrong answer is followed by a voice sound "WRONG". Students are scored as they supply answers to the questions and the total score is displayed at the end of each self-assessment section.

Method of Data Collection

The selected students formed an intact class and were used for the purpose of this study. The school biology teachers were trained as research assistants in each school. The researcher used the developed Computer Assisted Instructional Models (CAIM) on the experimental groups but taught the control group personally using conventional method, although, he solicited for the assistance of the school biology teachers particularly during the use of instructional models and administration of pretest and posttest. The contact period for data collection was fourteen (14) weeks.

Method of Data Analysis

The Pretest and Posttest scores of the students were analysed using Statistical Package for Social Science (SPSS) version 16. Significance of the various statistical analyses were determined at 0.05 significant level. The statistics used for analyses were Means, Standard deviation, Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and Scheffes' *post hoc test*.

Results

Pretest Analysis

Table 4: Analysis of Variance (ANOVA) of Pretest Result of Experimental and Control Groups

Group	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	434.467	2	217.233	5.568*	.004
Within Groups	10416.900	267	39.015		
Total	10851.367	269			

*Significant at $p < 0.05$

Table 4 shows the students pretest results of Experimental and Control groups. The ANOVA result is significant at $P = 0.004$, ($P < 0.05$). The result revealed that there was a significant difference on the pretest scores of the students. This result therefore indicates that, the three groups were not equivalent in terms of their prior knowledge on the concept of metabolism before the treatment.

Hypothesis (H_{01})

H_{01} , There is no significant difference in the mean achievement scores of students taught the concept of metabolism in biology with Computer Assisted Concept Mapping and Analogical Instructional Model and those taught with Conventional lecture method

Table 5: Analysis of Covariance (ANCOVA) Results of Achievement Scores of Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9250.880	3	3083.627	902.770	.000
Intercept	5988.428	1	5988.428	1753.187	.000
Pretest	8441.992	1	8441.992	2471.499	.061
Group	1918.057	2	959.028	280.768	.000
Error	908.586	266	3.416		
Total	668464.000	270			
Corrected Total	10159.467	269			

Table 5 shows the ANCOVA results of achievement of groups taught the concept of metabolism in biology with Computer Assisted Concept Mapping Instructional Model, Computer Assisted Analogical Instructional Model and Conventional method. The ANCOVA result is significant at $P = 0.000$, ($P < 0.05$). This means that there was a significant difference in the mean achievement scores of students taught the concept of metabolism in biology with Computer Assisted Concept Mapping and Analogical Instructional Model and those taught with Conventional lecture method. Since a significant difference was observed, Scheffe analysis was then conducted to find where the significant difference actually existed among the three groups as shown in table below.

Table 6: Scheffe Analysis of Achievement Scores of Experimental and Control Group Students

Multiple Comparisons

(I) 1, 2 & 3	(J) 1, 2 & 3	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.222	.882	.969	-2.39	1.95
	3	3.556*	.882	.000	1.38	5.73
2	1	.222	.882	.969	-1.95	2.39
	3	3.778*	.882	.000	1.61	5.95
3	1	-3.556*	.882	.000	-5.73	-1.38
	2	-3.778*	.882	.000	-5.95	-1.61

*. The mean difference is significant at the 0.05 level.

KEY:

1 = EXPERIMENTAL GROUP ONE, 2 = EXPERIMENTAL GROUP TWO AND 3 = CONTROL GROUP

From table 6, Scheffe result indicated a significant mean difference of 3.56 and a high upper boundary of 5.73 between experimental group 1 and control group as against low mean difference of -222 and lower upper boundary of 1.95 at 95% confidence level between experimental groups 1 and 2. This is an indication that there was a significant difference between experimental group 1 and control group but there was no significant difference between experimental groups 1 and 2. Scheffe result also indicated a significant mean difference of 3.78 and a high upper boundary of 5.95 between experimental group 2 and control group. This is an indication that there was a significant difference between experimental group 1 and control group on one hand and experimental group 2 and control group on the other, but there was no significant difference between experimental groups 2 and 1. Hence the research hypothesis that there is no significant difference in the achievement mean scores of students taught the concept of metabolism in biology with Computer Assisted Concept Mapping and Analogical Instructional Model and those taught with Conventional method was therefore rejected. There is therefore a significant difference between experimental and control groups favouring experimental group 2 with higher mean gain of 22.94.

The above results indicated that, the two research instruments were very effective. These findings are in line with the findings of Tabassum (2004), Etukudo (2009); Yusuf & Afolabi (2010) and Ramatu (2014) who reported that students exposed to Computer Assisted Instruction (CAI) achieved better than their counterparts exposed to the Conventional instructional strategy. Okoye (2012) also reported that students taught using CAI performed significantly better than those taught conventionally. Olikeze (1999); Wongsatit (2001); (Basturk, 2005); Ifeakor (2005); Akour (2006); Chien-hsun (2006); (Mudasiru, et al., 2010); Okoye (2012) worked on the effects of Computer Assisted Instruction (CAI) on science students' achievement and retention and all reported that the experimental group students upon which CAI was used performed significantly better than the control group.

Discussion of Finding

The results reveal that, the experimental groups 1 and 2 treated with Computer Assisted Concept Mapping Instructional Model (CACMIM) and Computer Assisted Analogical Instructional Model (CAAIM) respectively achieved higher than the control group treated with Conventional lecture method. This result indicated that, the two research instruments were very effective. This finding is in line with the findings of Tabassum (2004), Etukudo (2009), Yusuf & Afolabi (2010) and Gimba (2014) who reported that students exposed to Computer Assisted Instruction (CAI) achieved better than their counterparts exposed to the Conventional instructional strategy. Okoye (2012) also reported that students taught using CAI performed significantly better than those taught conventionally. Olikeze (1999), Wongsatit (2001), (Basturk, 2005), Ifeakor (2005), Akour (2006), Chien-hsun (2006), (Mudasiru, et al., 2010) and Okoye (2012) worked on the effects of Computer Assisted Instruction (CAI) on science students' achievement and retention and all reported that the experimental group students treated with CAI performed significantly better than the control group.

Conclusion

There was a significant improvement in the students' mean achievement scores on the concept of metabolism in biology as a result of the effects of Computer Assisted Concept Mapping and Analogical Instructional Model

Recommendations

Since the exposure of secondary school students to teaching with the research N instruments has resulted in such a significant improvement in their achievement, the following recommendations were made for the effective utilisation of the instruments:

- (i) The use of Computer Assisted Concept Mapping Instructional Model (CACMIM) and Computer Assisted Analogical Instructional Model (CAAIM) as teaching strategies be adopted by science teachers in secondary schools.
- (ii) Government should organise and sponsor teachers to attend training courses on the use of Computer Assisted Concept Mapping Instructional Model (CACMIM) and Computer Assisted Analogical Instructional Model (CAAIM) as instructional strategies.
- (iii) Science teachers should study and harness appropriate and familiar analogy and concept mapping strategies in their teaching to enhance better understanding and retention of science concepts. This will reduce misconceptions by students.
- (iv) Government should motivate teachers by raising their status and increasing their monthly emolument. This will encourage them to stay in the teaching profession and discharge their duties effectively.
- (v) Authors should use relevant and familiar concept maps and analogies for presenting specific concepts and principles in science textbooks. This will make students' learning more meaningful as the familiar concept maps and analogies in the book will encourage them to read on their own.

References

- Abimbola, I. O. & Mustapha, M. T. (2001). The Use of Analogies in Communicating Difficult Science Concepts to Secondary School Student. *International Journal of Science Education*. 9 (1), 62-71.
- Abu, A. O. (1998). *The Effectiveness of Individualized and Lecture Instruction Methods of Teaching Biology at the Senior Secondary Level of Education*. Unpublished M. Ed Thesis, Ahmadu Bello University, Zaria.

- Abu, A. O. (2000). Resource Utilization in Classroom: The Effect of Learning Activity Package to Teach Biology at the Senior Secondary School Level of Education. *Science Teachers Association of Nigerian, 41st Annual Conference Proceedings*. 103-106.
- Ahmed, M. A. (2008). Influence of personality factors on biology lecturers' assessment of difficulty levels of genetics concepts in Nigerian colleges of education. *Unpublished PhD thesis, University of Ilorin, Ilorin*.
- Akour, M. A. A. (2006). The effects of computer assisted instruction on Jordanian college students' achievements in an introductory computer science course. *Electronic Journal for the Integration of Technology in Education*, 17-24. Retrieved 10th July, 2008 from <http://ejte.isu.edu/volume5/Akour.pdf>.
- Basturk, R. (2005). The effectiveness of computer assisted instruction in teaching introductory statistics. *Journal of Educational Technology and Society*, 8 (2), 170-178. Retrieved 10th July, 2008 from <http://www.ifets.info/journals/8/2/16.pdf>.
- Chien-hsun, T. (2006). A study on integrating information technology into instruction and computer-assisted concept learning in social studies. Retrieved on 26/05/2009 <http://tc.education.pitt.edu/library/SelfEsteem>.
- Egunjobi, A. O. (2002). The efficacy of two computer assisted instructional modes on learners' practical geography achievement at the secondary school level in Ibadan metropolis, Nigeria. Paper delivered at NAEMT conference, 20 - 23 November.
- Esiobu, G. O. (2000). Biology Teachers Awareness and Level of Use of Mental Analogies in Teaching Difficult Concepts in Biology. *Science Teachers Association of Nigeria. 41st Annual Conference Proceedings*, 116-119.
- Erukudo, U. E. (2009). *The Effect of Interactive Basic Program Package on Students' Performance on Graphs of Linear and Quadratic Inequalities*. *ABACUS*, 34 (1) 7 - 18
- Fafunwa, B. A. (1990). *Problems of Science Education in Nigeria*. Kontagora: Unpublished Seminar Paper. 61 - 63.
- Glynn, S. M. (1991). Explaining science concept: A Teaching - With- Analogy (TWA) model. Hillsdale, N. J.; Erlbaum. 219 - 240.
- Glynn, S. M. (1991). *Explaining Science Concepts: A Teaching-With-Analogies Model*. Hillsdale, N. J.: Erlbaum. 219 - 240.
- Ifeakor, A. C. (2005). Effects of commercially produced computer assisted instruction package on students' achievement and interest in secondary school chemistry. *Unpublished Ph.D Dissertation. Nsukka: University of Nigeria*.
- Ijioma, B. C. & Onwukwe, E. O. (2011). Using culturally-based analogical concepts in teaching secondary school science: Model of a lesson plan. *International Journal of Science and Technology Education Research*. 2(1), pp1-5, January.
- Jenks, M. & Springer, J. M. (2002). A view of the research on the efficacy of CAI. *Electronic Journal for the Integration of Technology in Education*, 1 (2), 43 - 58. Retrieved July 15, 2006, from <http://ejte.isu.edu/volumelno27Jenks.pdf>
- Kareem, L. O. (2003). Effects of audio-graphic self - instructional packages on senior secondary school students' performance in biology in Ilorin, Nigeria. *Unpublished Ph. D thesis of the University of Ilorin, Ilorin*.
- Karper, C.; Robinson, E. H. & Casado-Kehoe. M. (2005). Computer assisted instruction and academic achievement in counsellor education. *Journal of Technology in Counseling*, 4 (1). 2007, from http://jtc.colstate.edu/Vol4_1/Kcarper/Karper.htm

- Korika, M. U. S. & Ezema, V. I. (2009). Effects of Analogy on the Understanding of the Concept of Osmosis among Secondary School Students in Minna, Niger State, Nigeria. *Nigerian Journal of Technological Research* 4(2), 80-88
- Lagoke, B. A. (1993). *Analogical Linkages from Socio-Cultural Environment and Biological Concept Attainment by Secondary School Students Using a Constructivist Framework*. Unpublished Ph.D. Thesis Ahmadu Bello University, Zaria.
- Madasiru, O. Y. and Adediji, O. A. (2010). Effects of Computer Assisted Instruction (CAI) on secondary school students' performance in biology. *The Turkish Online Journal of Educational Technology (TOJET)*. Retrieved January 15th, 2010 from pit.edu/library/bel/Eastern.
- Mills, R. (2001). A comparison study of the learning effectiveness of computer aided instruction vs classroom lectures. Retrieved December 22, 2007. From: <http://www.concentric.net/~Walwps/thesis/1result.html>.
- Okubokola, P. A. O. (1998). Concept Maps as Instructional Tools for Promoting Meaningful Learning in Biology. *Science Teachers Association of Nigeria Biology Panel Workshop Proceedings, Orogbo*.
- Okoro, C. A. and Etukudo, U. E. (2001). CAI versus Extrinsic motivation based traditional method: It's effect on female genders performance in chemistry. A paper presented at 42nd STAN Conference in Ilorin.
- Okoye, A. C. (2012). Effects of computer assisted instruction on students' acquisition of science process skills and interest in biology. *Unpublished PhD thesis of the University of Nigeria, Nsukka*.
- Olikeru, F. C. (1999). Effect of computer assisted instruction on secondary school students cognitive achievement and interest in biology. *Unpublished Ph.D Dissertation, Nsukka University of Nigeria*.
- Onwukwe, E. O. & Onwukwe, C. M. (2010). Linking Electrolysis and related topics with analogical thinking processes of students using play simulations. In Osioma, I. (2006). Active learning strategies for the science classrooms. *STAN 47th Annual Conference, 13th - 19th August, 2006*.
- Orinla, R. W. (2014). Effects of Computer Assisted Instructional Package on Achievement, Retention and Interest in Set Theory Among Senior Secondary School Students in Niger State. *Unpublished Ph.D thesis of the University of Nigeria, Nsukka*.
- Spencer, D. J. (2004). Engagement with mathematics courseware in traditional and online learning environments: Relationship to motivation, achievement, gender, and gender orientation. Unpublished dissertation submitted to the Faculty of Graduate School of Emory University, in partial fulfillment of the requirement for the degree of Doctor of Philosophy. From: <http://www.diss.emory.edu/ufp/Spencer%20Dissertation2004.pdf>
- Takassum, R. (2004). Effects of Computer Assisted Instruction (CAI) on the Secondary School Students' Achievement in Science. *Unpublished Ph.D Thesis Rawalpindi University of Arid Agriculture*. Retrieved 7th January, 2009 from <http://eprints.gov.pk/1101>
- Takassum, R. (2004). Effects of Computer Assisted Instruction (CAI) on the Secondary School Students' Achievement in Science. *Unpublished Ph.D Thesis Rawalpindi University of Arid Agriculture*. Retrieved 7th January, 2009 from <http://eprints.gov.pk/1101>
- Tauf, M. O. and Afolabi, A. O. (2010). Effects of Computer Assisted Instruction (CAI) on the Secondary School Students' Performance in Biology. *The Turkish Online Journal of Education Technology*. Retrieved January 15th, 2013 from <http://te.education.pit.edu/library/bel/Eastern>
- WAEC, (2000, 2000, 2003, 2004, 2006, 2009, 2010 & 2011). *Chief Examiners' Report*