



EFFECTS OF A COMPUTER-ASSISTED INSTRUCTIONAL PACKAGE ON LEARNING ACHIEVEMENT OF CELLULAR RESPIRATION AMONG SENIOR SECONDARY SCHOOL STUDENTS IN IBADAN, NIGERIA.

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Abstract

This study investigated the effects of Computer-Assisted Instructional Package [(CAIP) (a special CAI package for this research)] on students' achievement

Keywords

Computer-Assisted Instruction, Conventional Method of Instruction, Cellular respiration, Academic Achievement, Gender.

INTRODUCTION

The relevance of biology in day-to-day human activities is unlimited. However, it is unpleasant that students performance at secondary's school level of education in this subject is not encouraging, and this has been an issue of great concern to stakeholders in education (Akinfe, Olofinniyi, & Fashiku, 2012). Abimbola (2013) observed that the performance level for the individual science subjects did not show any significant rise for more than twenty-year period between 1991 and 2011 except occasionally for chemistry and physics, which were above 50%. Candidates' performance in

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in cellular respiration and the influence of gender when exposed to Computer-Assisted Instructional Package (CAIP). A quasi-experimental, pre-test, post-test, and control group, involving a 2x2 design was adopted for the study. Two research hypotheses were formulated and tested. Four intact classes, involving 107 Senior School one (SS1) students (48 males and 59 females) from two public and private secondary schools, were purposively sampled in Ibadan, Oyo State, Nigeria. A CAIP and an Achievement Test on Cellular Respiration (ATCR) were used for data collection, after due validation with a reliability co-efficient of 0.84. t-test and ANCOVA were used to analyse the data collected. The findings of the study were that: (i) the achievement of the SS1 students exposed to CAIP on cellular respiration and those taught with Conventional Method of Instruction (CMI) indicated a significant difference, in favour of students taught with CAIP, $F(1, 104) = 133.22$, $p < 0.05$; (ii) no significant difference existed in the achievement of the students, based on gender; it can be concluded that for effective teaching - learning process to take place, Senior Secondary School students may benefit a great deal from the use of Computer-Assisted Instruction (CAI). The study recommended, that CAIP should be made available for teachers' and students' use in our secondary schools.

biology over these years has never been up to 50%, perhaps because non-science students used to register for biology as a core science subject. However, Odekunle (2018) posited that there was a slight improvement in biology examinations results in the year 2013 to 2016 with a 50% and above credit pass which, is contrary to the existing results' history. This sudden improvement might be associated with improved teaching strategies from the teachers and other factors. Such an improvement might be sustained since biology subject is no longer offered by non-science students, resulting to fewer science students to take part in biology examinations (Table 1).

Candidates' Performance in May/June Senior School Certificate Examinations in Biology, Chemistry and Physics in Nigeria from 2007-2016

YEAR	TOTAL SAT	CREDITS PASSES	%	TOTAL SAT	CREDITS PASSES	%	TOTAL SAT	CREDITS PASSES	%
2007	1,238,163	413,211	33.37	422,681	194,284	45.92	218,593	180,797	43.24
2008	1,259,964	427,644	33.94	418,423	185,949	44.47	415,113	200,345	48.38
2009	1,903,552	644,733	33.87	422,091	194,035	45.97	429,174	186,940	43.56
2010	1,300,418	427,644	33.90	465,643	236,059	50.70	463,755	237,756	51.30
2011	1,505,199	579,432	38.50	565,692	280,250	49.54	563,161	360,096	63.94
2012	1,646,150	587,044	35.66	627,302	270,570	43.13	624,658	429,415	68.74
2013	1,648,363	854,743	51.73	539,296	143,218	72.34	637,023	297,988	46.77
2014	1,365,384	766,971	56.17	636,268	397,649	62.49	635,729	386,270	60.76
2015	1,390,234	798,246	57.42	680,357	412,323	60.60	684,124	410,543	60.01
2016	1,200,367	740,345	61.68	706,873	408,122	57.74	705,125	415,655	58.95
		Biology			Chemistry			Physics	

Sources: The West African Examinations Council (WAEC). Adapted from Abimbola (2013), Olorundare (2014) & WAEC, Yaba Office (2017).

Yet with this improvement in biology examinations performance, West African Examinations Council Chief Examiners' report showed the following development;

there is a wide gap in knowledge of students in cellular respiration, candidates were unable to tabulate correctly the differences between gaseous exchange and aerobic respiration, and candidates could not outline the activities that can result in oxygen debt (WAEC, 2003; 2010 & 2013).

Yap (2016) posited that conventional method of teaching does not motivate students, as a result, they lose interest in the subject. This is more often seen in science subjects in general, and biology in particular. Ramanjeet, Sushama, and Anil (2012) have identified poor teaching strategies as one of the major reasons for undesirable performance of students in sciences. As a result of this, the use of information and communications technology (ICT), such as Computer-Assisted Instruction (CAI) is becoming a channel that brings solution to difficulties associated with teaching-learning process.

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Computer-Assisted Instruction (CAI) is an interactive instructional technique whereby a computer is used to present the instructional material and evaluate the learning that takes place (Pepple, 2015). The potential benefits of Computer-Assisted Instruction (CAI) cannot be underrated in this contemporary world of teaching, learning and research. There is a plethora of established findings on the instructional value and relevance of the computer, particularly in advanced countries such as the United Kingdom, United States of America, Japan and others. There are now several CAI packages on a reasonable number of subjects. Researchers, such as Yusuf and Afolabi (2010); Ramanjeet, Sushama, and Anil (2012); Yap (2016), acclaimed that students exposed to individualized computer instructional package might have better results over others.

Previous studies suggested that relative traditional teaching and the use of CAI can give rise to gender inequalities in classroom interaction and achievement (Ramanjeet et al., 2012). Ramanjeet, Sushama, and Anil (2012) are of the opinion that boys often monopolize the computer in CAI setting and they feel more comfortable than girls with using computers. Previous studies revealed that male students performed better than females in Physics, Chemistry, and Biology (Yusuf & Afolabi, 2010). Anyamene, Nwokolo, Anyachebelu, and Anemelu (2012), worked on the influence of gender on the academic performance of students. The study found out that performance of male and female taught using CAI package indicated no significant difference. The finding agrees with Pepple (2015), posited that there is chance of learning irrespective of gender when exposed to CAI, but the females should be encouraged in the usage of computers.

Cellular respiration has been proven to be a difficult biological concept (Teaching the Sciences for Optimum Learning Outcomes 2012; Fadipe, 2011 & WAEC Chief Examiners Report 2003, 2006, 2013 & 2010) This indicated that the level of students understanding in cellular respiration was very low. Researchers, such as Yusuf and Afolabi (2010); Ramanjeet, et al. (2012); Yap (2016), claimed that students exposed to individualized computer instructional package might have better results over others. However, limited number of empirical studies exist in Nigeria regarding the use of CAI in cellular respiration. Thus, much remains to be empirically

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studied which include, the effects of CAI in cellular respiration in relation to the gender and academic achievement of the students in Nigeria, these were the focus of this research work.

Purpose of the Study

The study investigated effects of the use of a computer-assisted instructional package on students' achievement in cellular respiration. Specifically, the study examined the:

1. difference between achievement in cellular respiration of the Senior Secondary School students exposed to computer-assisted instruction (CAI) and those exposed to the conventional method of instruction(CMI).
2. influence of gender on Senior Secondary School students' achievement in cellular respiration, when exposed to computer-assisted instruction and conventional method of instruction.

Research Questions

The following research questions were answered in this study:

1. Is there any difference in the achievement of Senior Secondary School students taught cellular respiration when exposed differently to Computer-Assisted Instruction (CAI) and Conventional Method of Instruction (CMI)?
2. Is there any difference in the achievement of Senior Secondary School students taught cellular respiration when exposed differently to CAI and CMI based on gender?

Research Hypotheses

The following hypotheses were tested in this study:

H0₁: There is no significant difference between the achievement of Senior Secondary School students taught cellular respiration when exposed to Computer-Assisted Instruction (CAI) and Conventional Method of Instruction (CMI).

H0₂: There is no significant difference between the achievement of male and female Senior Secondary School students taught cellular respiration

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when exposed to Computer-Assisted Instruction (CAI) and Conventional Method of Instruction (CMI).

RESEARCH METHODOLOGY

The methodology used in this study were discussed under the following sub-headings; research design, sample and sampling method, research instruments, procedure for data collection.

Research Design

This study adopted a pretest- posttest, control group, quasi – experimental design. The research design is a 2x2 factorial design. Where the 2x2 represents 2 research groups {experimental group(computer- assisted instruction) and control group (conventional method of instruction)} and 2 levels of gender (male and female).

Sample and Sampling Method

The population for the study was all biology Senior Secondary School I students in Ibadan, Oyo State, Nigeria. Four Senior Secondary Schools that satisfied the following criteria: functioning computer laboratories; computer literate students; easy access to students without choking timetable issues; co-educational school; prompt approval of the consent form and good SSCE (WAEC and NECO) tracking results of five years, were purposively selected for the study. This is because a research on CAI must necessarily be conducted in schools where computers are available for the students' use. Two schools each were selected as the experimental group and the control group. The sample for the experimental and control groups was made up of an intact class of SS one (Science class that offered biology) each from the selected private and public schools with the total population of one hundred and ten (110) students which was made up of 49 males and 61 females.

Research Instruments

The instruments for this research were:

1. Computer-Assisted Instructional Package (CAIP)
2. Achievement Test on Cellular Respiration (ATCR)

Computer-Assisted Instructional Package (CAIP): The treatment instrument, Computer-Assisted Instructional Package (CAIP) on cellular respiration is a self tutoring instructional interactive package developed with Microsoft visual basic.net, which contains images, video, and animations that added better description to the texts, while quiz maker software was used to develop the formative and summative evaluations. CAIP contained lessons on cellular respiration as it was described in the new biology curriculum, sub-topics to be covered in the package included; definition of respiration, types of cellular respiration, fermentation, uses of anaerobic respiration in industries, comparison between aerobic and anaerobic respiration, i.e., similarities and differences, glycolysis, Krebs cycle, functions of ATP.

CAIP was used to teach the experimental group and the control group was taught traditionally.

Achievement Test on Cellular Respiration (ATCR): The test instrument was the researcher designed test instrument containing multiple-choice objective test with four options. The test items used were patterned after the past questions of different examinations bodies such as: West African Examinations Council (WAEC), National Examinations Council (NECO) and Joint Admissions and Matriculation Board (JAMB) and researcher's self developed questions on cellular respiration. The test contents were based on a Table of Specification covering the six levels of the cognitive domain of learning. CAIP and ATCR undergone face and content validation, ATCR had a reliability co-efficient of 0.84, determined using Cronbach's alpha method.

Procedure for Data Collection

Consent of the schools, students and students' parents that participated in the study was sought to meet the ethical requirement in research. The co-operation of the biology teachers and computer laboratory manager (experimental school) was sought for, and they served as research assistants and had one day training on the Computer-Assisted Instructional Package (CAIP); how it works and the installation process.

Both the experimental and control groups with a total population of

110 students made up of 49 males and 61 females were subjected to Achievement Test on Cellular Respiration (ATCR) as pre-test. Then, the students in the experimental group were individually exposed to CAI, which was installed on the desktop and laptop computers by the researcher and research assistants. The students in the experimental group were introduced to the CAI format to make them familiar with the navigation buttons and use the package independently, while their biology teacher and computer laboratory manager were on ground to guide and assist students with difficulties. The control group students were exposed to the conventional method of instruction on the same content used for the experimental group. They were taught in traditional classrooms format. The treatment for both groups lasted for four weeks (first week for the research assistants and students training, installation of the package and pretest, second week for collation of the students previous terminal scores in biology, third week for treatment and the fourth week for the posttest). After the treatments, the two groups were exposed to Achievement Test on Cellular Respiration (ATCR) as posttest, out of the 110 students who took the pretest, only 107 students (48 males and 59 females) took the posttest Achievement test.

RESULTS

Analysis of Covariance (ANCOVA) and *t*-test were used to analyse the data collected.

Hypothesis 1: There is no significant difference between the achievement of Senior Secondary School students taught cellular respiration when exposed to Computer-Assisted Instruction (CAI) and Conventional Method of Instruction (CMI).

The ANCOVA analysis of the data for the treatment, experimental (CAI) and control (CMI) in Table 2 reveals that there were significant difference in the achievement of Senior Secondary School Students' exposed to CAI and those exposed to CMI because the significant probability (0.000) obtained at $F(1, 104) = 133.22$ at $p < 0.05$, the null hypothesis which states that there is no significant difference between the achievement of Senior Secondary School students taught cellular respiration when exposed to computer

assisted Instruction and those exposed to traditional Instruction is rejected.

Table 2. ANCOVA showing difference in the Achievement of Senior Secondary School Biology Students when exposed to Computer-assisted Instruction and Conventional Method of Instruction

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected model	18709.43 ^a	2	9354.71	99.17	.000
Intercept	25868.30	1	25868.30	274.24	.000
Pretest	2741.96	1	2741.96	29.07	.000
Treatment	12566.04	1	12566.04	133.22	.000**
Error	9810.05	104	94.328		
Total	338160.00	107			
Corrected Total	28519.48	106			

**denotes F is significant at p value < 0.05

Hypothesis 2: There is no significant difference between the achievement of male and female Senior Secondary School students taught cellular respiration when exposed to Computer-Assisted Instruction (CAI) and Conventional Method of Instruction (CMI).

Table 3 reveals that there was no significant difference in the achievement of male and female Senior Secondary School students taught cellular respiration when exposed differently to CAI with $F_{(1,40)} = 0.43$, $p > 0.05$ and CMI with $F_{(1,61)} = 0.23$, $p > 0.05$, the hypothesis is therefore not rejected, which means that there was no significant difference in the achievement of male and female Senior Secondary School students taught cellular respiration when exposed to Computer-Assisted Instruction (CAI) and Conventional Method of Instruction (CMI).

Furthermore, *t*-test statistical result in Table 4 shows that, there was a significant difference in the achievement of the male students exposed to CAI and CMI, respectively with *t*-value of 6.06, $p < 0.05$, also there was a significant difference in the achievement of the female students exposed to CAI and CMI, respectively with *t*-value of 10.89, $p < 0.05$

Table 3

ANCOVA Showing Difference in Achievement of Male and Female Senior Secondary School Students taught Cellular Respiration when Exposed to CAI and CMI

Treatments	Source	Type III sum of squares	df	Mean square	F-value	Sig.
CAI(EXPERIMENTAL)	Corrected model	3452.29 ^a	2	1726.15	18.745	.000
	Intercept	12976.14	1	12976.14	140.94	.000
	Pretest	3069.96	1	3069.96	33.34	.000
	Gender	39.70	1	39.70	0.43	.52 ^{NS}
	Error	3682.78	40	92.07		
	Total	210068.00	43			
CMI(CONTROL)	Corrected total	7135.07	42			
	Corrected model	240.41 ^a	2	120.21	1.42	.25
	Intercept	12028.58	1	12028.58	141.74	.00
	Pretest	236.22	1	236.22	2.78	.10
	Gender	19.91	1	19.91	0.23	*.63 ^{NS}
	Error	5176.53	61	84.86		
Total	128092.00	64				
	Corrected total	5416.94	63			

NS denotes F is not significant at p value < 0.05

Furthermore, *t*-test statistical result in Table 4 shows that, there was a significant difference in the achievement of the male students exposed to CAI and CMI, respectively with *t*-value of 6.06, *p*<0.05, also there was a significant difference in the achievement of the female students exposed to CAI and CMI, respectively with *t*-value of 10.89, *p*<0.05

Table 4. *The t-test analysis of the Difference in Achievement of Male and Female Senior Secondary School Students taught Cellular Respiration when Exposed to CAI and CMI*

Gender	Group	N	$\bar{x} \pm SD$ (%)	Df	<i>t</i>	Sig
Male	CAI	20	65.50 ± 3.81			

	CMI	28	44.07 ±10.69	46	6.06	0.00
Female	CAI	28	44.07 ±10.69			
	CMI	36	43.56 ± 8.16	62	10.69	0.00

SUMMARY OF MAJOR FINDINGS

The major findings of the study as obtained from the data analyzed are summarized as follow:

1. Senior Secondary School students exposed to CAI achieved significantly better than those exposed to CMI
2. There is no significant difference in the achievement of male and female students taught using CAI or CMI

DISCUSSION OF FINDINGS

1. Findings on the Effects of Instructional Strategy on the Achievement of Senior Secondary School Students Taught Cellular Respiration.

The result of the Analysis of Covariance on the achievement of Senior Secondary School students exposed to Computer-Assisted Instructional via Computer-Assisted Instructional Package on cellular respiration and those taught with Conventional Method of Instruction indicated a significant difference in favour of students taught with CAI (experimental group). This implies that exposing students to CAI as an instructional strategy helps them to understand and comprehend cellular respiration easily more than those exposed to CMI. This positive result of CAI from the students may be associated with the general characteristics of CAI, such as: one-to-one interaction; self pacing; individual attention; self directed learning; great motivation and instantaneous response.

The finding is in agreement with the earlier findings of Ramanjeet, Sushama and Anil (2012), Yusuf and Afolabi (2010), and Ali (2005), whose studies were directly on Biology. Similarly, the findings agree with the studies of Alasoluyi (2015) in economics, Oyelekan and Olorundare (2009) in chemistry, Ogundoju, Bayo-Lebi and Asunbiaro (2014) in Physics, Fakomogbon, Adetayo, Oyebode and Eruwa (2014), in Mathematics, Atif (2014) in statistics, David and

Shane (2014) in language education. (Thus, it can be confirmed that CAI has been effective in enhancing student's academic achievement, not only in Biology but other subject than conventional method of instruction. However, this finding contradicts the conclusion of Adeyemi (2012) and Owusu, Monney, Appiah & Wilmot (2010) that students instructed with the conventional approach performed better than those instructed by the CAI. This conclusion might account for the effective usage of instructional techniques employed by the teacher, since CMI is a combination instructional methodologies that teacher uses in the classroom.

2. Findings on the Influence of Gender on the Achievement of Senior Secondary School Students Taught Cellular Respiration.

The result of analysis of co-variance revealed that there was no significant difference in the achievement of male and female Senior Secondary School students exposed to CAI, though the female students had a greater mean gain score than the male but the difference was not statistically significant enough to show that the difference was caused by the treatment of the study. The higher mean gain score achieved by the female students might be attributed to their curiosity and interest to break male monopolization and dominances of computer gadgets. The findings showed that both genders had a higher achievement when taught with CAI. This implies that neither the male nor female students achieved differently from one another. These findings are in agreement with earlier findings of Ramanjeet, Sushama and Anil (2012), Yusuf and Afolabi (2010). Also, the findings are in line with the submission of Oludipe (2012) and Bello (1990) on gender and achievement in Basic Science and Biology. The findings support the conclusions of Fakomogbon, Adetayo, Oyebode and Enuwa (2014) on effect of computer assisted instructional package on the performance of students in Mathematics that male and female students performed equally well.

The findings also agreed with Ash (2004) conclusion on the effects of computer assisted instruction on middle school mathematics achievement. The findings established the findings of Bello and Abimbola (1997) who found out that gender was not a determining factor in concept mapping ability in evolution.

However, the findings contradict the submissions of Achuonye and Olele (2009), which indicated male dominance in computer usage. Thus, it can be inferred from the findings that the use of Computer-Assisted Instruction enhances the achievement of both male and female Senior Secondary School students and CAI is not gender biased.

CONCLUSION

WAEC Chief Examiners' Reports (2013) reported that cellular respiration questions were not popular in theoretical section and not many candidates attempted it. In an attempt to solve and reduce the level of poor performance in biology, this study was conducted to find out the effect of computer-assisted instructional package on Senior Secondary School students achievement in cellular respiration in Ibadan, Nigeria.

The result of this study showed that those students exposed to Computer-Assisted Instruction achieved significantly higher than those taught with Conventional Method of Instruction.

The result concluded that female students had a greater mean gain score than male students but the difference was not statistically significant, whereas, both sexes had higher achievement when taught with CAI. This implies that CAI is not gender selective; it enhanced the achievement of all students. From the results and findings obtained in this study, it can be concluded that for effective teaching – learning process to take place, Senior Secondary School students may benefit a great deal from the use Computer-Assisted Instruction (CAI).

RECOMMENDATIONS

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

1. The use of CAI has been found to be an effective instructional strategy and therefore should be adopted for effective teaching-learning of science subjects, most especially biology at secondary levels of education. Unlike Conventional Method of Instructions, CAI permits students to learn at their pace with full mastery of contents and knowledge. Evaluation and instant feedback results enable the students to measure their level of understanding of certain concepts in CAI.
2. Students should be continuously guided and monitored while using CAI to avoid distraction and other application that can distract the students while using CAI should be disabled for effective concentration on the real content.
3. Biology teachers need to equip themselves with ICT knowledge to adapt to present day teaching-learning classrooms challenges and update themselves through conferences, seminars, workshop and personal efforts that will enhance their methods of instruction delivery and computer usage most especially on CAI.

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