Technology Instructional Package Mediated Instruction and Senior Secondary School Students' Academic Performance in Biology Concepts

[1] Science Education Department
Federal University of Technology
Minna, Nigeria
yaki.akawo@yahoo.com

[2] Science Education Department
Federal University of Technology
Minna, Nigeria

Yaki, Akawo Angwal [1], Babagana, Mohammed [2]

ABSTRACT

The paper examined the effects of a Technological Instructional Package (TIP) on secondary school students' performance in biology. The study adopted a pre-test, post-test experimental control group design. The sample size of the study was 80 students from Minna metropolis, Niger state, Nigeria; the samples were randomly assigned into treatment group 40 (male = 18 and female = 22) and control 40 (male = 20, female = 20). The researcher developed package was validated by experts. The data collection instrument was a Biology Achievement Test which yielded a reliability coefficient of .74. The treatment group was taught with TIP while the control group was taught with traditional teaching methods. The data obtained were analyzed using split-plot Analysis of Variance (SPANOVA) and t-test. The results of data analysis revealed there was an interaction effect, treatment was effective in significantly improving students' performance in the experimental group than the control group ($F(1.78) = 29.89$, $p < .05$) in the main effects. The TIP was found to be gender friendly ($t = 3.93$, $df = 38$, $p > 0.05$). Based on the finding, it was recommended that teachers should be trained and encouraged to employ technological resources in their classroom practices.

Keywords: *Technology Instructional package, Performance, Ecology and Gender*

INTRODUCTION

The Organisation of Economic Cooperation and Development (OECD) reported that differences in achievement and reasoning abilities of students in mathematics, science and reading account for the differences in economic growth among OECD countries (OECD, 2010). Hence, achievement in science, mathematics and engineering is relevant to the economic growth as well as competition in the global economy because human resource development will influence economic development (Hanushek & Wößmann, 2008). Therefore, implementing better ways of teaching and learning science is more important now than ever before in the era of the knowledge based economy. Science teaching in Nigeria is bedevilled with a lot of ills and manifested in the dwindling performance of secondary school students' performance in science and mathematics.

The 2015 West African Examinations Council (WAEC) has released the Senior Secondary School Certificate Examination (WASSCE) results. The total number of candidates sitting for the examination was 1,593,442. Only 38.68 percent of the total number obtained five (5) credits including mathematics and English; this implies that only 38.68 qualify for admissions into the nation's universities and other higher institutions since admission into Nigerian universities and other higher institutions requires five (5) credits

and above, including Mathematics and English. Therefore, 61.32% are ineligible for admission into Nigerian higher learning institutions. The performance is not encouraging because it is far below average, although it is a slight increase over the 2014 results where only 31.28% obtained five credits including mathematics and English (Nnaike, 2015).

Literature has reported the causes for this dismal performance to include: traditional teacher centered instructional methods, poor learning environment including crowded classrooms, lack of laboratories and resistance to employ innovative strategies just to mention a few (Ezenwa, 2005; Gambari, Yaki, Gana, & Ughovwa, 2013; Ndagi, 2014; Umar, 2011). Therefore, for Nigeria as a nation to be an active player in the dynamics of the 21st century economy, the nation must employ better instructional strategies and resources. One of such instructional resource is the use of a learner-centered technology learning package because the present learners are digital natives who are used to technological devices.

Students have learning difficulties in science subjects and ecology is one of the concepts they find difficult. The West African Examinations Council (WAEC) Chief Examiners Report revealed that only a few candidates attempted questions on ecology and they exhibited a poor understanding of ecological concepts (West African Examinations Council, 2007). In view of the foregoing, the observed classroom practices have not been effective in Nigeria and that is seen clearly in the dwindling performance of students in science. While the expected is for learners to acquire science knowledge and skills because most science, technology, engineering and mathematics job opportunities in the 21st century require some science skills and knowledge. Therefore a gap is established between the observed classroom practices and the expected demand in the global market, which this study will attempt to fill using a Technology Instructional Package.

The Technology Instructional Package is a multimedia package made up of visual text, verbal narration supplemented by simulation or animation. Instructional materials such as a Technology Instructional Package (TIP) which is supported by text, sound and animation has the potential to enhance learning. The more the students' senses are stimulated in the learning process the better the students' understanding. It is reported that learning is achieved mainly from seeing (83%), hearing (11%), smelling (3.5%), touching (1.5%) and tasting (1%) (Demirel, 2004, in Izzet & Ozkan, 2008). The package will enable learners to proceed at their own pace. It is interactive so students are active participants in the learning process. Students can only proceed after mastering a given concept before proceeding to another one. Another package feature is to provide remediation where learners encounter difficulties. It is portable so students can download it into their phones, laptops, tablets and other devices for repeated viewing after the lesson; therefore it is not limited to the computer alone. Hence the name Technology Instructional Package (TIP).

Empirical evidence of the effects of technology instructional package reveals that students taught with it perform better than their counterparts taught with traditional teaching method. For instance, Izzet and Ozkan (2008) in physics topic compared the effects of Computer Assisted Instructional (CAI) strategy and traditional method of teaching; their findings revealed that the students taught with CAI perform better than those taught with traditional instruction (Izzet & Ozkan, 2008). Similarly, other researchers found similar result (Satyaprakasha & Sudhanshu, 2014; Serin, 2011). On the contrary, Cetin (2007) found that the group taught with traditional teaching method performs better than the treatment group taught using CAI.

Gender is an important variable that has been linked to academic performance in most parts of the world because of the culturally perceived role of males and females. Literature on gender differences in science abound. The Trends in International Mathematics and Science Study (TIMSS) data on gender of final year students among participating countries internationally revealed that male students perform better than their female counterparts in all participating countries except South Africa (TIMSS, 2007). Some literature reported that there is no gender effect on students' performance in science and mathematics concepts (Satyaprakasha & Sudhanshu, 2014; Umar, 2011). Some researchers reported that male students perform better than their female counterparts in science (Meltem & Serap, 2007).

The objectives of this research include the development and validation of a technology instructional package for teaching ecological concepts, determining the efficacy of the technology learning package in improving learning and understanding of science concepts using gender as a moderating variable.

Research Questions

The research questions to be answered by this study are:

1. Is there any difference in the mean score of students exposed to technology learning package and students taught with conventional method while controlling for the moderating effects of gender?

2. What is the difference in the achievements of male and female students taught Ecological concepts using technological concepts using the technology learning package?

Research Hypotheses

The research hypotheses tested in the study are:

Ho_1: There is no difference in the mean score of students exposed to technology learning package and students taught with conventional method while controlling for the moderating effects of gender

Ho_2: There is no significant gender influence on the performance of students taught ecology using technology learning package.

METHODOLOGY

Quantitative research method was adopted, to be precise, pretest posttest experimental control group design. The independent variable is made up of one treatment and one control and gender (male and female) was investigated.

The population of this study is all senior secondary students in class 1 in Minna metropolis, Niger State, Nigeria. Two secondary schools were selected using stratified random sampling; these schools were coeducational public schools. Using simple random sampling the two schools were assigned to experimental and control groups. Using stratified random sampling technique a total of eighty-two (82) were selected as the sample. The experimental group was made up of forty (40) students (male = 22, female = 18), the control group was made up of 42 students (male = 22, female = 20).

The package was developed on the content of ecology in senior secondary school biology which covers topics such as food chain, food web, ecosystem and local biomes in Nigeria. This TIP is different from other commercial packages because it is developed to culturally suit the Nigerian situation and the biology scheme or module of senior secondary class II in Nigeria.

The TIP was validated by two experts in instructional technology and was used as a treatment instrument for the study while biology achievement test was used as pretest and posttest to collect data. The Biology Achievement Test (BAT) was made up of forty questions adopted from past West African Examinations Council and National Examination Council (NEC). The BAT is made up of two sections; section A solicits demographic information, section B consists of questions where each question has four options (A-D) and students are expected to select one correct answer. The BAT was validated by two senior biology teachers in secondary schools and it yielded a reliability coefficient of .74 using the test-retest method. The pretest was administered at the start of the treatment while posttest was administered after the treatment which lasted six weeks.

The data obtained were analyzed based on the stated hypothesis using split-half analysis of variance.

RESULTS AND DISCUSSIONS

The results are presented in accordance with the stated hypotheses:

Ho_1: Is there any significant difference in the mean score of students exposed to technology learning package and students taught with conventional method

To test this hypothesis split-plot analysis of variance (SPANOVA) was used and the result presented as follows

Table 1 Box Table of Equality of Covariance Matrices

Covariance Matrices[a]	
Box's M	8.192
F	2.655
df1	3
df2	1095120.000
Sig.	.067

Testing of the null hypothesis revealed that the observed covariance matrices of the dependent variables are equal across groups. That is the covariance measure between the independent variables (the control and treatment group) in the pre-test is not significant or different (p = .067).

Table 2 Descriptive Statistics of the Treatment and Control Group

	Treatment & Control	Mean	Std. Deviation	N
Pre-test	Treatment	22.1250	4.65302	40
	Control	23.5000	3.61620	40
	Total	22.8125	4.19793	80
Post-test	Treatment	60.0000	11.43544	40
	Control	44.6250	7.71175	40
	Total	52.3125	12.40008	80

The descriptive statistics revealed that before the treatment the mean score of the Treatment and Control group was 22.13 and 23.50 respectively. After the treatment the mean of the experimental group rose significantly to 60.00 while the control group mean was 44.62. The treatment group has a higher mean score than the control group after the treatment.

Table 3 Test of Within Group Effects

Source		Type III Sum of Squares	df	Mean Square	*F*	Sig.
Pre-Posttest	Sphericity Assumed	34810.000	1	34810.000	741.979	.000
	Greenhouse-Geisser	34810.000	1.000	34810.000	741.979	.000
	Huynh-Feldt	34810.000	1.000	34810.000	741.979	.000
	Lower-bound	34810.000	1.000	34810.000	741.979	.000
Pre-postest * Group	Sphericity Assumed	2805.625	1	2805.625	59.802	.000
	Greenhouse-Geisser	2805.625	1.000	2805.625	59.802	.000
	Huynh-Feldt	2805.625	1.000	2805.625	59.802	.000
	Lower-bound	2805.625	1.000	2805.625	59.802	.000
Error (pre-posttest)	Sphericity Assumed	3659.375	78	46.915		
	Greenhouse-Geisser	3659.375	78.000	46.915		
	Huynh-Feldt	3659.375	78.000	46.915		
	Lower-bound	3659.375	78.000	46.915		

Table 3 shows the test of within group effects; there is a significant effect between the pre and post-tests within the groups $F = 741.979.000$, $p = 0.001$. But the most important aspect of the analysis is the pre and post-tests by group interaction effects (Pre-posttest * Group), the result yielded a significant interaction effect between pre-test and post-tests with $F = 59.802.00$, $p < .05$. Therefore the main effect of treatment is significant. Note the result of Sphericity test is not reported because only two groups are involved.

The significant interaction effects can be seen clearly illustrated in the graph of the profile plots which indicates the students' scores in biology for the treatment group increased significantly from pre-test to post-tests

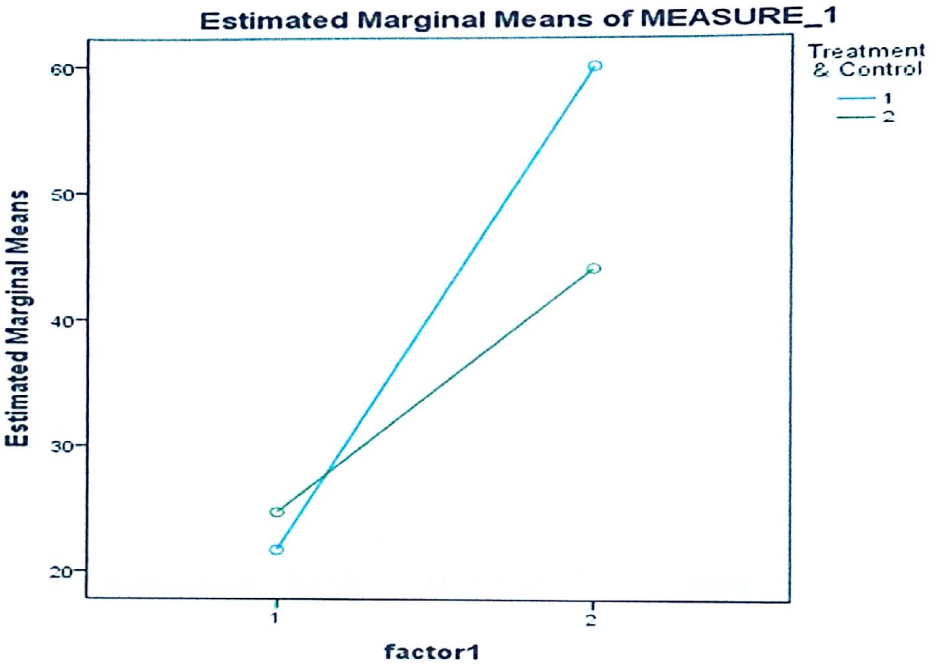

Figure 1. **Interaction effects to show treatment was effective.**

Hence, the null hypothesis one is rejected and it is concluded that the treatment with technology learning package is significantly effective in improving students' performance in science.

Ho_2: There is no significant gender influence on the performance of students taught using technology learning package. The *t*-test was used to test this hypothesis and the result is presented in Table 4

Table 4 *The t-Test Analysis of Gender Effects on Student Performance in Ecological Concepts*

Variable	N	df	X	*SD*	*t*-value	*p*	Remarks
Male	18	38	56.34	6.52	3.92^{ns}	0.23	Not Significant
Female	22		54.72	8.04			

NS not significant = $p > .05$

Table 4 presents the *t*-test of gender effects of male and female students of the treatment group. The mean of male and female was 56.34 and 54.72 respectively is not significant, with the calculated *t* value of 3.92 ($t = 3.92$, df =38, $p > .05$). Therefore gender has no significant influence on performance of students treated with the technology learning package. Hence, hypothesis two is retained.

DISCUSSION OF RESULTS

The findings of hypothesis one testing revealed that there was interaction effect of treatment, that the treatment was significantly effective in improving student performance in ecological concepts. This finding is in agreement with the results of Izzet and Ozkan (2008) in physics, Serin (2011) in biology as well as Hart (2006) in arts; all reported that technology enhanced learning such as computer animation improves students' performance more than conventional methods. The results of this study contradict the findings of Adeyemi (2012) who reported no significant difference between students taught with computer aided instruction and traditional method. The higher performance by the treatment group in the current study could be attributed probably to the novelty and ability of technology to capture and sustain learners' attention during the learning process.

The results of hypothesis two testing show that gender has no effect on students' academic achievement in the experimental group treated with the technology learning package. In this study, the technology learning package is gender friendly and should be used to reduce the gender gap in achievement.

CONCLUSION

There is a gap in students' performance in science all over the world and specifically in Nigeria that needs to be filled. Technology learning packages as an instructional resource will help in bridging the gap. In this study it can be seen that the technology learning package has the potential to improve students' performance in science and is gender friendly. It is recommended that teachers should be trained and encouraged to employ technological resources in their classroom practices.

REFERENCES

Adeyemi, B. A. (2012). Effects of Computer Assisted Instruction (CAI) on students' achievement in social studies in Osun State, Nigeria. *Mediterranean Journal of Social Sciences, 3*(2), 269-277.

Cetin, U. (2007). *A comparison of traditional teaching and the computer assisted education software based on ARCS motivation model in accordance with students' achievements and permanence of learning.* (Unpublished Master's thesis, University of Gazi, Ankara, Turkey).

Ezenwa, V. I. (2005). *Concept mapping: A veritable tool in science education*. The seventh inaugural lecture series of the Federal University of Technology Minna.

Gambari, A. I., Yaki, A. A., Gana, E. S., & Ughovwa, Q. E. (2013). Improving secondary school students' achievement and retention in Biology through video-based multimedia instruction. *InSight: A Journal of Scholarly Teaching, 9,* 78-91.

Hanushek, E. A., & Wößmann, L. (2008). Education and economic growth. In P. Peterson, E. Baker & B. McGaw (Eds.), *International encyclopedia of Education* (3rd ed., pp. 245-252). Retrieved from http://edpro.stanford.edu/hanushek/admin/pages/files/uploads/hanushek_woessmann%20%20200 10%20international%20encyclopedia.pdf.

Izzet, K., & Ozkan, O. (2008). The effects of computer assisted instruction on the achievement of students on the instruction of physics topic of 7th grade science course at primary school. *Journal of Applied Sciences, 8*(6), 1067-1072.

Meltem, D., & Serap, T. (2007). Gender differences in academic performance in a large public university in Turkey. *Higher Education, 53,* 255-277. doi: DOI 10.1007/s 10734-005-2464-6

Ndagi, M. U. (2014). WASSCE result: Reflection of a failed system. *Daily Trust Newspaper*.

Nnaike, U. (2015). Nigeria: 38% of students pass May/June WAEC examination. *Thisday*.

Satyaprakasha, C. V., & Sudhanshu, Y. (2014). Effect of multi media teaching on achievement in Biology. *International Journal of Education and Psychological Research (IJEPR), 3*(1).

Serİn, O. (2011). The effects of the computer-based instruction on the achievement and problem solving skills of the science and technology students. *The Turkish Online Journal of Educational Technology, 10*(1), 183-201.

TIMSS. (2007). Summary of gender differences in average mathematics and science achievement. Retrieved from http://timssandpirls.bc.edu/timss1995i/TIMSSPDF/T95_GChapter%201.pdf.

Umar, A. A. (2011). Effects of biology practical activities on students' process skill acquisition in Minna, Niger State, Nigeria. *Journal of Science, Technology, Mathematics and Education, 7*(2), 118-126.

West African Examinations Council. (2007). *May/June, Chief Examiner's Report, Lagos*.