ASSESSING THE EFFICACY OF TWO MODES OF COMPUTER ASSISTED INSTRUCTIONAL PACKAGE ON STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN BASIC SCIENCE

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ABSTRACT

This study investigated the efficacy of two modes of Computer Assisted Instruction (CAL) on students' academic achievement and retention in basic science in Aguata education zone of Anambra State. To achieve the purpose of the study, four research questions were posed and four hypotheses were formulated. The study adopted quasi experimental design, specifically, static-group pre-test post-test design. The population for the study comprised 1124 SS2 basic science student in Aguata education zone of Abanbra State purposive sampling technique was used to sample 352 SS 2 basic science used for the study. The sample was obtained using purposive sampling technique. Basic Science Achievement Test (BAST) was used to collect data for the study. The instrument was validated by three experts in Department of Science Education. Content validity of BAST was determined using a well-constructed table of specification. The instrument was trial tested on a sample of 20 basic science students in Nsukka education zone of Enugu State and reliability coefficient of 0.91 was obtained using Kuder-Richardson 20 (KR-20) formula. The data obtained for the study were analyzed using mean and standard deviation to answer the research questions and analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings revealed that computer assisted instruction with animation method was more effective in enhancing students' academic achievement and retention in basic science than computer assisted instruction without animation. There was no significant difference in the mean achievement and retention scores of male and female students in basic science. Thus, it was recommended that basic science teachers should adopt the use of CAL with animation method in their lessons in order to enhance the students' academic achievement and retention in the subject.

KEYWORDS: Basic Science, Computer Assisted Instruction, Gender, Retention, Achievement.

INTRODUCTION

Basic Science is one of the compulsory core science subjects offered by students in senior secondary schools in Nigeria. It is a science that deals with the study of

matter's relation to energy. Basic science, according to Ike (2002), is the study of laws that determine the structure of the universe with reference to matter and energy. The objectives of studying basic science in Nigeria, as stipulated in the New Senior Secondary Basic Science Curriculum (2008), are to: provide basic literacy in basic science for functional living in society; acquire basic concepts and principles of basic science as a preparation for technological application of basic science; and stimulate and enhance creativity.

In spite of the importance and objectives of basic science in Nigerian secondary schools, the results of basic science students in external examinations still remain poor. This poor performance of students in basic science was confirmed by the West African Examination Council's (WAEC) Chief Examiner's report in May/June 2010/2014. According to the Chief Examiner's report (May/June, 2010–2014), the pass rates at credit level recorded for 2010–2014 were 43.19%, 48.26%, 47.83%, 51.27%, and 40.27% in 2010, 2011, 2012, 2013, and 2014.

However, there are several factors responsible for students' poor performance in basic science. These factors, as revealed in the literature, include a poor primary school background (Obioma, 2005), a lack of interest in the subject and concentration in learning (Okereke, 2006), a poor teaching and learning environment (Abakpa & Iji, 2011), and a lack of adequate laboratory apparatus (Adeyemo, 2011). Some researchers, however, attributed the poor performance of students in basic science to poor and effective methods of instruction (Kalijah, 2002; Agommuoh & Nzewi, 2003; Ezeliora, 2004). This is supported by the assertion of Osemwinyen (2009) and Tolu (2009) that poor achievement and retention of students in basic science are a result of poor teaching methods. There is a need, therefore, to focus research on instructional strategies capable of improving students' achievement and retention in basic science since the instructional method adopted by the teacher goes a long way in determining the achievement and retention of students. Such an instruction strategy, as reported in the literature, is computer-assisted instruction (CAL) (Golden, McCrone, Walker, & Rudd, 2006; Yusuf & Afolabi, 2010).

CAL is the process of using computers in teaching and learning processes. Gana (2013) refers to CAL as virtually any kind of computer used in educational settings, including drill and practice, tutorials, and simulation. Simulations foster learning and help students see different aspects of a subject and generalize about it (Akpinar & Ergin, as cited in Tekbiyik & Akdeniz, 2010). According to Isiaka Ezenwa and Anyanwu (2014), CAI as an instructional strategy has proven effective in integrating different types of media and bringing out a better learning outcome in students. The use of CAI has been empirically proven to enhance students' academic achievement, increase interest retention, and reduce the boring and abstract nature of Basic Science (Kuti, 2006; Adegoke, 2010; Gambari, 2010; Adegbija & Falode, 2014; Isiaka, Ezenwa, & Anyanwu, 2014). There is no doubt from empirical studies that CAI improves students' achievement, interest, and retention in Basic Science, but there is no empirical evidence on Basic science to determine if the efficacy of CAI is a result of animation or not since CAI packages can be packaged with or without animation.

Animation refers to the computerized simulation of processes using images to form a synthetic motion picture (Zahra, 2016). The author further opined that it is a

process of putting still images together in a sequence so they will appear one after the other, creating the illusion of movement. There is therefore a need to investigate the effectiveness of the two modes of CAI (with and without animation) on students' achievement and retention in Basic Science as well as the influence of gender.

RESEARCH QUESTIONS

The following research questions were posed to guide the conduct of the study:

1. What are the mean achievement scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation?
2. What is the influence of gender on students' mean achievement scores in Basic Science?
3. What are the mean retention scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation?
4. What is the influence of gender on students' mean retention scores in Basic Science?

HYPOTHESES

The following hypotheses were formulated and tested at the 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation.
2. There is no significant difference in the mean achievement scores of male and female students in Basic Science.
3. There is no significant difference in the mean retention scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation.
4. There is no significant difference in the mean retention scores of male and female students in Basic Science.

METHODS

The study adopted a quasi-experimental research design. Specifically, non-equivalent control group research design The population of the study comprised all SS 2 students in the Aguata Education Zone of Anabra State. A sample of 352 SS2 Basic Science students was used for the study. The sample was obtained using purposive sampling techniques. The instrument used for the data collection was the Basic Science Achievement Test (BSAT), developed by the researchers. A test blueprint or table of specifications was used in preparing the test, which was based on the six levels of cognitive domains of Bloom's taxonomy of education to ensure proper content coverage. The test contains forty items (questions) with four options ranging from A to D, from which the students are expected to select the answer that best answers the question. The instrument developed was face-validated by three experts drawn from the Departments of Science Education (Measurement and Evaluation and Basic Science Units), and a table of specifications was used to ascertain the content validity of the

instrument. The reliability of the instrument was established by administering 20 copies of the instrument to 25 SS 2 Basic Science students in the Nsukka Education Zone of Enugu State who were not part of the study but shared the same characteristics as the students under investigation. The reliability coefficient of 0.91 was obtained using the Kuder-Richarson 20 (KR-20) formula. The instrument for the collection of relevant data was administered to Basic Science students in the sampled schools before the commencement of the experiment, which serves as the pretest score. After the pretest, the actual experiment commenced, which started with the training of the basic science teachers who were used for the study. The subjects were randomly assigned to two groups (computer-assisted instruction with animation and without animation). Mean and standard deviation were used in answering all the research questions, while analysis of covariance (ANCOVA) was used in testing the formulated hypotheses at the 0.05 level of significance.

RESULTS

Research Question One: What are the mean achievement scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation?

Table 1: Mean achievement scores and standard deviation of students taught Basic science using a computer-assisted instructional package with animation and without animation

Two Modes of Computer Assisted Instruction (CAI)	N	Pre-test		Post-test		Gain Score
		Mean	Std. Dev.	Mean	Std. Dev.	
CAI (with animation)	168	18.67	55.67	25.54	5.95	6.87
CAI (without animation)	184	17.84	5.42	23.03	8.24	5.19

The result in Table 1 shows the mean achievement scores of students exposed to two modes of computer-assisted instruction (CAI) (with and without animation). From the table, mean achievement scores of 18.67 and 17.84 with standard deviations of 5.67 and 5.42 were recorded for both CAI with and without animation, respectively, at the pretest. However, at the post-test, mean achievement scores of 25.54 and 23.03 with standard deviations of 5.95 and 8.24 were recorded for both CAI with and without animation, respectively. Moreover, mean gain scores of 6.87 and 5.19 were recorded for the two groups (CAI with and without animation), meaning that CAI with animation may be more effective compared to CAI without animation in enhancing the academic achievement of students in Basic Science.

Research Question Two: What is the influence of gender on students' mean achievement scores in Basic Science?

Table 2: Mean and standard deviation of male and female students in the Basic Science Achievement Test (BSAT)

Gender	N	Mean	Post-test Standard Deviation	Gain Score
Males	183	24.54	7.80	0.66
Females	169	23.88	6.80	

From the result of the analysis in Table 22, male students obtained a mean achievement score of 24.54 and a standard deviation of 7.80, while their female counterparts had a mean achievement score of 23.88 and a standard deviation of 6.80. Therefore, male students had a higher achievement mean score than female students at the post-test. This can be seen from the slight difference of.66 between the two posttest achievement mean scores. Therefore, gender may influence students' achievement in Basic Science.

Research Question Three: What are the mean retention scores of students taught Basic Science using a computer-assisted instruction package with animation and those taught without animation?

Table 3: Mean retention scores and standard deviation of students taught Basic Science using a computer-assisted instruction package with animation and without animation

Two Modes of Computer Assisted Instruction (CAI)	N	Post-test		Retention		Gain Score
		Mean	Std. Dev.	Mean	Std. Dev.	
CAI (with animation)	168	25.54	5.95	32.30	6.37	6.67
CAI (without animation)	184	23.03	8.24	27.83	8.55	4.80

The result of the analysis in Table 3 shows that Basic Science students who were taught CAI with the animation method had a posttest mean score of 255.54 with a standard deviation of 5.95 and a retention mean score of 32.30 with a standard deviation of 6.37, making a mean gain of 6.67. On the other hand, those who were taught using CAI without animation recorded a posttest mean score of 23.03 with a standard deviation of 8.24 and a mean retention score of 27.83 with a standard deviation of 8.55, with a gain score of 4.80. The mean difference between the two groups was 1.87 in favor of students exposed to CAI with animation. The result indicates that CAI with animation aids students' retention in Basic Science.

Research Question Four: What is the influence of gender on students' mean retention scores in Basic Science?

Table 4: Mean and standard deviation of male and female students' retention scores in Basic Science

Gender	N	Mean	Post-test Standard Deviation
Males	183	27.73	7.61
Females	169	30.40	7.52

The result of the analysis in Table 4 shows that male Basic Science students obtained a mean retention score of 27.73 and a standard deviation of 7.61, while female Basic Science students had a mean retention score of 30.40 and a standard deviation of 7.52. Therefore, female students had a higher retention mean score than their male

counterparts. Thus, gender may have an influence on students' retention in Basic Science.

Hypothesis One: There is no significant difference in the mean achievement scores of students taught Basic Science using a computer-assisted package with animation and those taught without animation.

Table 5: Analysis of the covariance of students' achievement mean scores on two modes of computer-assisted instruction

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1655.254[a]	2	827.627	16.758	.000
Intercept	10029.815	1	10029.815	203.087	.000
Pretest	1102.634	1	1102.634	22.326	.000
Method	438.441	1	438.441	8.878	.004
Error	17236.016	349	49.387		
Total	225453.000	352			
Corrected Total	18891.270	351			

a. R Squared = .088 (Adjusted R Squared = .082)

Table 5 shows that teaching method is a significant factor in students' achievement in Basic Science (F = 8.878, P =.004); thus, the null hypothesis was rejected. This is because the probability value of.004 is less than the level of significance set at.05. Therefore, the researchers concluded that there is a significant difference in the mean achievement scores of students in Basic Science when exposed to two modes of computer-assisted instruction (with and without animation) in favor of those taught with animation.

Hypothesis Two: There is no significant difference in the mean achievement scores of male and female students in Basic Science.

Table 6: Analysis of the covariance of the influence of gender on students' achievement in basic science

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1345.731[a]	2	672.866	13.384	.000
Intercept	9196.972	1	9196.972	182.938	.000
Pretest	1307.537	1	1307.537	26.008	.000
Gender	128.918	1	128.918	2.564	.110
Error	17545.539	349	50.274		
Total	225453.000	352			
Corrected Total	18891.270	351			

a. R Squared = .071 (Adjusted R Squared = .066)

Table 6 shows that gender is not a significant factor in students' achievement in Basic Science (F = 2.564, P =.110). This is because the probability value of.110 is greater than the level of significance set at.05. Thus, the null hypothesis was accepted, and researchers concluded that there is a significant difference between the mean achievement scores of males and females in Basic Science.

Hypothesis Three: There is no significant difference in the mean retention scores of students taught Basic Science using a computer-assisted instruction package with animation and those taught without animation.

Table 7: Analysis of the covariance of students' retention mean scores on two modes of concept mapping.

Source	Type III Sum of Squares	df	Mean Square	f	Sig.
Corrected Model	2637.783[a]	2	1318.891	25.516	.000
Intercept	13000.714	1	13000.714	251.522	.000
Pretest	2103.704	1	2103.704	40.700	.000
Method	383.706	1	383.706	7.423	.007
Error	18039.192	349	51.688		
Total	316883.000	352			
Corrected Total	20676.974	351			

a. R Squared = .128 (Adjusted R Squared = .123)

The result of the analysis in Table 7 shows that (F = 7.423, P =.007). Thus, the null hypothesis was rejected since the probability value of.000 is less than the level of significance set at.05, and researchers concluded that there is a significant difference in the mean retention scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation in favor of those taught with animation.

Hypothesis Four: There is no significant difference in the mean retention scores of male and female students in Basic Science.

Table 8: Analysis of covariance of the influence of gender on students' retention in basic Science

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2590.373[a]	2	1295.187	24.992	.000
Intercept	13049.934	1	13049.934	251.812	.000
Pretest	1964.176	1	1964.176	37.901	.000
Gender	336.297	1	336.297	6.489	.081
Error	18086.601	349	51.824		
Total	316883.000	352			
Corrected Total	20676.974	351			

a. R Squared = .125 (Adjusted R Squared = .120)

From the analysis of the results in Table 8, it was observed that gender is not a significant factor in students' retention in Basic Science with respect to two modes of computer-assisted instruction (F = 6.489, P =.081). Thus, the null hypothesis of no significant difference in the mean retention scores of male and female students in Basic Science was accepted since the probability value of.081 is greater than the.05 level of significance. Researchers therefore concluded that there is no significant difference in the mean retention scores of male and female students in Basic Science.

DISCUSSION

The findings of the study in Table 1 show that students exposed to CAI with animation had a higher achievement mean score compared with students exposed to CAI without animation. The achievement difference was further strengthened by the analysis of covariance in Table 5, which showed a significant difference in the mean achievement scores of students taught Basic Science using computer-assisted instructional packages with animation and those taught without animation. This implies that the CAI with animation significantly enhanced students' achievement in Basic Science compared to the CAI without animation. This high achievement may be a result of active and collaborative learning as well as task-based teaching, which CAI provides with the addition of visual digital display technology that simulates moving objects on-screen, which was made possible through the use of animation. This finding is in agreement with the finding of Adebija and Falode (2014), whose finding revealed that students taught Basic Science using the animation-based CamStudio Instructional package performed significantly better than those taught without animation. Also in support was the finding of Isiaka, Ezenwa, and Anyaanwu (2014), who reported significant differences in the post-test mean scores of students taught Solid Geometry using two modes of computer-assisted instructional packages.

The result of the finding in Table 2 showed male students had a higher achievement mean score than their female counterparts. Further analysis in Table 6 using analysis of covariance (ANCOVA) revealed no significant difference in the achievement mean score of male and female students in Basic Science. That showed that the higher mean achievement score accrued to male students as ealier seen in Table 2 was due to chance factor. This result indicated that CAI with the animation method is gender-friendly in enhancing students' academic achievement in Basic Science. This result is in agreement with the finding of Adegbija and Falode (2014), who reported no significant difference between the mean achievement scores of male and female students taught Basic Science using the animation-based CamStudio Basic Science instructional package.

The result of the finding in Table 3 shows that students taught with CAI with animation had higher retention mean scores than those taught with CAI without animation. The finding was further confirmed by the analysis of covariance in Table 7, which showed that students in CAI with animation significantly retained more than students taught using CAI without animation. This indicates that CAI with animation is capable of making students remember concepts taught in Basic Science. This finding is supported by Zahra (2016), who opined that graphically animated contents have the greatest and most positive impact on students as they help them understand Basic Science concepts more easily and in a memorable way. The findings of the study are in accordance with those of Kurumeh, Onah, and Mohammed (2012), whose study revealed that the constructivist teaching approach was more effective in facilitating and improving students' retention. The findings of the study also support the views of Ogbonna (2007) and Eze (2008), who stated that the use of new practical approaches enhances students' retention.

The findings of the study in Table 4 revealed that female students obtained a higher mean retention score than their male counterparts. Further analysis revealed no

significant difference in the mean retention scores of male and female students in Basic Science. This finding shows that CAI as an instructional method helps both male and female students benefit equally from retaining Basic Science content. The findings of the study are in agreement with the findings of Ajai Amoco (2015), whose study reported that male and female students taught algebra using PBL did not significantly differ in their achievement and retention scores. The study is also in line with Ogbaonna (2007), who reported that gender was not statistically significant in students' retention in mathematics.

Conclusion

On the basis of the basic findings of this study, the following conclusions have been drawn:

1. The use of CAI with animation significantly enhances students' academic achievement in Basic Science when compared with CAI without animation.
2. CAI with animation also proved superior to CAI without animation in promoting students' retention in Basic Science.
3. Gender had no significant influence on students' academic achievement and retention in Basic Science. This implies that the superiority of CAI with animation in fostering academic achievement and retention was uniform for both male and female students'.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Basic Science teachers should adopt the use of CAI with the animation method in their lessons in order to enhance the students' academic achievement and retention in the subject.
2. Teacher training institutions should structure and restructure the special methodology course to include CAI with animation. This will enable Basic Science teachers to be adequately trained on the use of CAI with animation.
3. The government in conjunction with other professional associations, should organize workshops, seminars, conferences, and in-service training on a regular basis to train teachers on the use of CAI with animation since the method has been found effective in enhancing students' achievement and retention.
4. Curriculum planners should include the CAI animation method as one of the necessary instructional methods for teaching Basic Science in senior secondary schools in Nigeria.
5. The government should endeavor to supply computers to schools at all levels of education to enable students and teachers to have access to the computers during the teaching and learning process.

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