

Effects of computer animation instructional package on students' achievement in practical biology

Abdulrasaq Hamzat*, Citadel Academy, no. 8 Jockey Street, Ilorin, 240242 Nigeria

Ganiyu Bello, Department of Science Education, Faculty of Education, University of Ilorin, Ilorin, 240103 Nigeria

Isaac Olakanmi Abimbola, Department of Science Education, Faculty of Education, University of Ilorin, Ilorin, 240103 Nigeria

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Abstract

This study examined the effects of computer animation instructional package on secondary school students' achievement in practical biology in Ilorin, Nigeria. The study adopted a pre-test, post-test, control group, non-randomised and non-equivalent quasi-experimental design, with a 2x2x3 factorial design. Two intact classes from two secondary schools were purposively sampled. The instruments used were Biology Practical Achievement Test (BPAT) for data gathering and Computer Animation Instructional Package (CAIP) as the treatment instrument. The reliability coefficient of BPAT was determined using the Pearson Product Moment Correlation and was found to be 0.91. Two research questions and two hypotheses were formulated in the study. The hypotheses were tested with t-test statistics at a significance level of 0.05. The study concluded that CAIP significantly improved students' achievement in practical biology. The researchers recommend that biology teachers should employ computer animation instructional packages to teach the practical aspects of photosynthesis among other biology topics.

Keywords: Achievement, computer animation, practical biology, secondary school.

* ADDRESS FOR CORRESPONDENCE: **Abdulrasaq, Hamzat**, Citadel Academy, no. 8 Jockey Street, Ilorin, 240242 Nigeria. *E-mail address*: hamzatabdulrasaq@gmail.com / Tel.: +2347066479855

1. Introduction

Biology is a fundamental part of science taught at the secondary school level in Nigeria. It centres on the understanding of life, and includes the study of plants and animals. Basically, it studies the function, structure, evolution, taxonomy, growth and distribution of living organisms. Biology is essential because it informs about the natural world around us (Umar, 2011). It is a science subject taught through theory and practical components. Practical activities in biology provide the chance for students to execute scientific processes in the laboratory and outside the laboratory, which is different from the theoretical learning of science.

Biology is undoubtedly an essential discipline. Its application could help to provide answers to some challenging issues of our time, most especially the challenges of population explosion, human impacts on ecosystems and climate change (Kim & Diong, 2012). Practical work is a crucial and important feature of science-oriented subjects. Many science teachers believe that a student's participation in practical work leads to better learning, because real learning is achieved when a person comes up with the meaning of things they stumble upon on their own. Despite this importance, most science teachers in Nigeria lay emphasis on the theoretical aspects of science and expose science students to few or no practical activities. Therefore, many students see science as abstract and irrelevant to their lives due to the lack of laboratory practical lessons (Kolawole & Oginni, 2009). The West African Examination Council (WAEC) Chief Examiners' Report (2015) on May/June & Nov/Dec [WASSCE] biology practical from 2009 to 2013 showed inconsistency in the performance of students in biology practical. There were marginal improvements in the performance, but generally, the students' performance in biology practical is unsatisfactory. Several studies have made known the factors responsible for ineffective teaching and learning as well as poor enrolment of students in biology. The factors include lack of exposure to practical work, lack of qualified teachers, ineffective use of teaching methods and inadequacy of computers (Ahmed & Abimbola, 2011; Akinfe, Olofinniyi & Fashiku, 2012; Auwalu, Mohd & Muhammad, 2014; Kareem, 2003; Nzelum, 2010).

The factors that serve as hindrances to the learning of biology have prompted researchers to conduct research on ways to enhance effective learning of biology practical in secondary schools. Some of the substitute methods of teaching practical biology, especially as a result of the dearth of practical materials or when the teacher is not physically present, are virtual biology laboratory, animation and biology simulation experiments. These are examples of relevant ICTs tools that may be utilised to enhance teaching and learning of practical biology. Animation refers to a computerised simulation of processes using images to structure a synthetic motion picture and adding printed text, charts, maps, static graphics and self-motivated graphics (Clark & Mayer, 2003). When used essentially as a form of entertainment, an animation can be a cartoon, but in this study, we focused on the potential of animation as an educational tool. Different categories of images with text have diverse functions in creating mental models as a replacement for simply receiving knowledge. Animation that combines audio and visual features may help in the course of encoding information, storing it into lasting memory and the recovery process (Paivio, 1986). Animations facilitate descriptive and procedural learning with an assurance of enhanced performance when applied for instructions over contemporary means (Mayer, 2001).

Animation package has been exploited in science fields to assist students in the understanding of difficult topics (Abidoeye & Omotunde, 2015; Adegbija & Falode, 2014; Akpoghol, Ezeudu, Adzape & Otor, 2016; Ayotola & Abiodun, 2010; Gambari, Falode & Adegbenro, 2014; Salisu, 2015; Yisa & Ojiaku, 2016). Ayotola and Abiodun (2010) carried out a study on computer animation in biology. The independent variables are the teaching strategy at two levels (use of computer animation and conventional teaching method): the mental ability at two levels (high and low) and gender (male and female). Biology content pre-test was exploited as a covariate. Topics on genetics were grouped into a six-week learning package. Biology Achievement Test and Mental Ability Test were the research instruments. The findings highlighted the significant effect of computer animation on the achievement of students. Akpoghol, Ezeudu, Adzape and Otor (2016) also carried out a study on computer

animation in electrochemistry. Electrochemistry Achievement Test was the research instrument. The findings indicated that learners taught with lecture methods with music had higher achievement scores than the corresponding learners taught with lecture methods with computer animation. Gambari, Falode and Adegbenro (2014) explored computer animation in geometry in their study. The results showed that learners taught with computer animation had better post-test and retention scores than the corresponding learners taught with other methods. Moreover, Salisu (2015) conducted a study on computer animation in weather concepts. The instruments were Weather Concepts Interest Questionnaire and Weather Concepts Achievements Test. The study observed that with respect to teaching geography, students exposed to animated-media strategy performed better than the corresponding students taught with lecture method. In addition, Abidoeye and Omotunde (2015) examined the use of computer animation in geography. The findings revealed that students taught geography using computer animation package had better achievement than those taught geography without the package. Lastly, Westhoff, Bergman, and Carroll (2010) conducted a study on the effects of computer animations on high-school students' performance and engagement in biology. Seventy-nine (79) biology students from an urban high school were involved in a three-week study. Pre-test, post-test and retention test were given for assessment. This research observed that computer animations accompanied by conventional teaching enhance the performance of biology students in high school. Hence, there is need for more studies on the effects of animation package on students' performance in practical biology.

Gender influence on science teaching and learning in Nigeria has been worrisome to many researchers. There is no agreement in the views of researchers on the performance level of female and male learners in Nigeria. Some studies revealed that female students performed less than males in science (Njoku, 2000; Onasanya, Fakomogbon, Shehu & Soetan, 2010). However, some other studies showed no substantial difference in the performance of females and males in science (Achuonye, 2011; Yusuf & Afolabi, 2010). Since there is no agreement on the performance of female and male students when taught ICT, it is necessary for researchers to bridge this gap emanating from the previous studies.

1.1. Statement of the problem

The problem of students' performance has been the focus of many researchers in the biology education field. This is because of the poor performance by biology students at the secondary school level. The reasons adduced by researchers for the dwindling performance of students in biology include lack of exposure to practical lessons, inadequately qualified teachers, irregularities of attendance to lessons by the teachers, abstractness of biology and lack of understanding of certain biological concepts and terminologies on the students' part. In addition, insufficient library and laboratory facilities, inadequacy of computers in schools and overpopulation of students are other identified factors (Ahmed & Abimbola, 2011; Auwalu, Mohd & Muhammad, 2014; Kareem, 2003; Nzelum, 2010).

As revealed by many studies, most of the problems encountered by students studying biology are from practical biology. Specifically, WAEC Chief Examiners' report (2015) revealed that the performance of biology students in practical biology is on the decline, and the bases for the decline are the short supply of biology laboratory equipment and the deficiency in practical activities. For these reasons, this study determined the effects of computer animation instructional package on secondary school students' achievement in practical biology in Ilorin, Nigeria.

1.2. Purpose of the study

The major purpose of this study is to investigate the effects of computer animation instructional package on secondary school students' achievement in practical biology in Ilorin. Specifically, the study determined the following:

1. The effects of the use of computer animation instructional package on secondary school students' achievement in practical biology.
2. The influence of gender on students' achievement in practical biology when exposed to the computer animation instructional package.

1.3. Research questions

Attempt was made in this study to provide answers to the following questions:

1. Is there a difference between the mean scores of biology students exposed to computer animation instructional package and those who were not exposed to computer animation instructional package when taught practical biology?
2. Is there any difference between the achievements of female and male students taught practical biology using computer animation instructional package?

1.4. Research hypotheses

The hypotheses generated and tested in this study are as follows:

- Hypotheses 1: There is no significant difference between the achievements of biology students taught practical biology using computer animation instructional package and those taught without the package.
- Hypotheses 2: There is no significant difference between the achievements of female and male students taught practical biology using computer animation instructional package.

2. Research methods

This study adopted an experimental research design of the quasi-experimental type. Specifically, the pre-test, post-test, control group, non-randomised and non-equivalent quasi-experimental design was adopted, using a 2x2x3 factorial design, where the 2x2x3 design represents the following: two groups (experimental and control), two genders (male and female) and three score levels (high, medium and low scorers).

The quasi-experimental design is shown structurally below:

Experimental group: O_1 X O_2

Control group: O_3 O_4

Where O_1 and O_3 are the pre-test for experimental and control groups, respectively, while the post-test for the experimental and the control groups are O_2 and O_4 . X signifies the treatment for the experimental group.

The population of this study includes all senior secondary school students offering biology in Ilorin, Nigeria. However, the target population was senior secondary school biology students in Ilorin. Two co-educational senior secondary schools in Ilorin were purposively selected for the sampling. The purposive sampling of the schools was necessary because the researchers considered schools that had the following facilities, which are paramount to this study: functional computers, a working projector, source of electricity and functional biology laboratory.

The instruments of the study are Biology Practical Achievement Test (BPAT) and Computer Animation Instructional Package (CAIP). The research instrument for data gathering of the students' achievement is BPAT, which was designed by the researchers. BPAT comprises two sections: Section A and B. Section A contains information on the personal bio-data of the senior secondary school one biology students. Section B contains five (5) practical questions on photosynthesis. Specifically, it covers the practical questions on conditions crucial for photosynthesis to take place, such as light and

carbon dioxide. The CAIP on practical experiments on photosynthesis was applied as the treatment instrument for the experimental group.

CAIP is a 2D computer animation written in Macromedia Dreamweaver 8 as the overall platform. Other computer programs employed for the development procedure are Macromedia Flash, Macromedia-Fireworks 8 and Microsoft Word. Macromedia Flash 8 was utilised for texts and graphics; Macromedia Fireworks was also utilised for particular texts and graphics, while Macromedia Flash was utilised for animation. The animation and graphics used for the development of the package were adapted from science4kids.com (www.youtube.com). The researchers designed the package with the help of a senior biology educator (an IT programmer).

The instruments for this study were validated by two biology teachers teaching in senior secondary schools, two lecturers in the Department of Science Education (Biology) and Plant Biology (University of Ilorin) and two computer experts. They helped to determine the face and content validity of the instrument. To establish the reliability of BPAT, test-retest method was used. Scores were then correlated using the Pearson Product Moment Correlation. The reliability coefficient value of the instrument is 0.91.

The researchers personally visited the schools where the study was conducted and officially solicited the permission and assistance of the appropriate authorities in writing. Permission was sought to make use of the school laboratory and employ the students in the study. The researchers also sought the consent of the students' parents by giving the students consent forms to be completed by their parents, indicating permission to partake in the study. Their sincere and maximum cooperation was sought to accomplish reliable data for the study.

The researchers made it clear to the partaking students that their bio-data, contributions and scores would be treated confidentially and were principally for this study only. The researchers carefully took the school's lesson periods and other protocols into consideration to avoid disruption to school activities. Indeed, the treatment took place during the period officially scheduled on the school timetable for biology practical lessons. The consent of the biology teachers (in the participatory schools) was sought for the study. They were required to help, mostly in the aspects of administration and supervision of the pre-test and post-test. The researchers used trained research assistants to administer the treatment to the groups (experimental and control). The study lasted for three weeks. In the first week, the groups (experimental and control) were pre-tested.

The second week was used to expose the experimental group to the computer animation instructional package in practical biology experiments, while the control group underwent regular practical lessons without the package. The experimental group was asked to relate with the treatment without additional explanation from the researchers, the research assistant and their biology teacher. Instructions were specified to both groups, and they were required to follow them strictly while performing the biology practical experiments. The third week was utilised to administer the post-test on the two groups. The post-test lasted for four hours.

The research questions were answered with descriptive statistics (mean and standard deviation), while the hypotheses were tested with t-test statistics at 0.05 level of significance with Statistical Package for Social Science version 20.0.

3. Results

3.1. Research question

Is there a difference between the mean scores of biology students introduced to computer animation instructional package and those who were not introduced to computer animation instructional package when taught practical biology?

Table 1 reveals that the students in the experimental group who were exposed to the package had higher achievement than the students in the control group who were taught without the package. This was deduced from the pre-test mean scores (14.67 and 13.56) and the post-test mean scores (27.43 and 22.94) obtained by the experimental and control groups, respectively. Moreover, the mean gain scores of 12.76 and 9.38 were obtained by the experimental and control groups, respectively. This shows that the mean gain score of the experimental group was higher than that of the control group with a difference of 3.41, in support of the experimental group. Hence, the students in the experimental group benefitted more than the students in the control group.

Table 1. Descriptive statistics of the experimental and control groups

Variable	N	Pre-test		Post-test		Mean gain score
		M	SD	M	SD	
Experimental	30	14.67	6.28	27.43	8.27	12.76
Control	32	13.56	3.08	22.94	4.44	9.35

3.2. Hypothesis

There is no significant difference between the achievements of biology students taught practical biology using computer animation instructional package and those taught without the package.

Table 2 discloses the t-test analysis of the mean scores of biology students in the experimental and control groups. The table reveals that the calculated t-value ($t_{(47.43)} = 1.62, p < 0.05$) was significant at 0.05 alpha level. This indicates that students who were taught practical biology with the package had significantly improved performance than those taught without the package. Thus, the hypothesis was rejected.

Table 2. t-test analysis of the significance of the difference between the achievements of the experimental and control groups

Variable	N	M	SD	Df	T	Sig. (2-tailed)
Experimental	30	11.50	8.01	47.43	1.62	0.00
Control	32	8.75	4.90			

$P < 0.05$

3.3. Research question

Is there any difference between the achievements of female and male students taught practical biology using computer animation instructional package?

Table 3 discloses that the achievement of female students who were introduced to the package was higher than that of male students exposed to the same package. The evidence to support this is seen in the mean gain scores of 14.15 and 11.10 obtained by the female and male students, respectively. This shows that the female students' mean gain score was higher than that of the male students with a difference of 3.05, in support of the female students. This means that the female students had more advantage than the male students.

Table 3. Descriptive statistics of the difference between the achievements of female and male students in the experimental group

Variable	N	Pre-test		Post-test		Mean gain score
		M	SD	M	SD	
Male	10	13.30	2.41	24.40	6.70	11.10
Female	20	14.80	6.72	28.95	8.75	14.15

3.4. Hypothesis

There is no significant difference between the achievements of female and male students taught practical biology using computer animation instructional package.

Table 4 unveils the t-test analysis of achievements scores of female and male biology students in the experimental group. The table reveals that the calculated t-value ($t_{(28)} = -0.78, p > 0.05$) was not significant at 0.05 alpha level. This indicates no significant difference between the achievements of female and male students taught practical biology with the package. For this reason, the hypothesis was not rejected.

Table 4. T-test analysis of the significance of the difference between the achievements of female and male students in the experimental group

Variable	N	M	SD	Df	T	Sig. (2-tailed)
Male	10	11.10	6.37	28	-0.78	0.44
Female	20	14.15	8.99			

$P > 0.05$

3.5. Summary of major findings

1. The experimental group had a higher mean gain score than the control group, with a difference of 3.41 in support of the experimental group.
2. The students who were taught practical biology with the package had significantly improved performance than those taught without the package.
3. The female students' mean gain score was higher than that of the male students, with a difference of 3.05 in support of the female students.
4. There was no significant difference between the achievements of female and male students taught practical biology with the package.

4. Discussion

The major finding of this study indicated that CAIP significantly improved students' achievement; it thus corroborates the findings of similar studies (Abidoye & Omotunde, 2015; Ayotola & Abiodun, 2010; Gambari et al., 2014; Salisu, 2015) involving Nigerian secondary schools students. This finding demonstrates that animation provides the opportunity for students to acquire practical laboratory skills visually, exactly like an actual experiment. It suggests that animation serves as a cognitive bridge required by the learners to formulate technical skills for biology practical activities. Also, the finding is compatible with the assertion of Paivio (1986), who stated that the multimedia nature of animation promotes the processes of encoding, storage and recovery of information from lasting memory. These cognitive processes are not readily enhanced through traditional biology practical lessons, where the teacher merely demonstrates or presents verbal/written instructions on practical activities for students to undertake.

This study also showed no gender difference in students' achievement when taught practical biology using computer animation instructional package. This result is in agreement with the findings of Adegbija and Falode (2014), Ayotola and Abiodun (2010), Akpoghol et al. (2016), Gambari et al.

(2014), and Salisu (2015) who ascertained no considerable difference in the achievements of female and male students taught science using computer animation. The result implies that computer animation instruction is gender friendly; thus, its usage is applicable in coeducational institutions or mixed-gender classroom.

The results of this study provided a clear indication that students can acquire biology practical skills through the utilisation of CAIP; hence, it is relevant as a substitute for actual practical biology lessons in the dearth of passable laboratory facilities or large student populations. Curriculum overcrowding is a foremost challenge in Nigerian secondary schools; in addition, the biology syllabus is very vast. Consequently, teachers hardly cover the syllabus before the final examination. Only three lessons of 40-minutes duration per week is usually allocated to biology on the school timetable as noted by Bello (2016). It is apparent that the utilisation of CAIP becomes a necessity in this situation.

5. Conclusion

Based on the major findings of this study, the researchers concluded that the utilisation of animation instructional package is efficient for teaching biology practical and significantly improved the achievement of students in practical biology on photosynthesis. It was also concluded that students' gender had no considerable influence on the achievement in practical biology on photosynthesis. Computer animation instructional packages can, therefore, be utilised to develop practical biology proficiencies and improve the achievement of students in practical biology despite their gender.

6. Recommendations

According to the findings, the following recommendations are put forward:

- (i) Biology teachers are encouraged to use CAIP to teach the practical aspects of photosynthesis, among other biology topics.
- (ii) Teachers should encourage students to get themselves familiar with the use of animation packages as a learning tool, by making use of the varieties of animation packages that abound on the Internet.
- (iii) The researchers used purposive sampling technique to select the sample schools, because most secondary schools in Ilorin lack the necessary facilities for use of animation packages. Hence, the proprietors of schools should endeavour to provide standard ICT facilities that will bring about effective utilisation of computer animation packages in schools.
- (iv) Curriculum planners should include the use of computer animation instructional package as an essential instructional method for teaching practical biology in senior secondary schools in Nigeria.
- (v) Teacher education institutions should integrate ICT courses, such as computer animation, into biology teachers' education programme.
- (vi) Regular professional development programmes should be organised for biology teachers by the Science Teachers Association of Nigeria and other major stakeholders in science education to enable biology teachers update their pedagogic skills.

References

- Abidoye, J. A., & Omotunde, C. T. (2015). Effects of computer animation package on senior secondary school students' academic achievement in geography in Ondo state, Nigeria. *Journal of teaching and teacher education*, 3(2). ISSN: 2210-1578.
- Achuonye, K. A. (2011). Using computer in science class: the interactive effect of gender. *Journal of African Studies and Development*, 3(7), 131–134.

Hamzat, A., Bello, G. & Abimbola, I. O. (2017). Effects of computer animation instructional package on students' achievement in practical biology. *Cypriot Journal of Educational Science*. 12(4), 218–227

- Adegbija, M. V., & Falode, C. O. (2014). Effects of animation-based CamStudio physics instruction on secondary school students' performance in Minna, Nigeria. *European Scientific Journal*, 10(13).
- Ahmed, M. A., & Abimbola, I. O. (2011). Influence of teaching experience and school location on biology teachers' rating of the difficulty levels of nutrition concepts in Ilorin, Nigeria. *Jostmed*, 2(7), 52–61.
- Akinfe, Z., Olofinniyi, O. E., & Fashiku, C. O. (2012). Teachers' quality as correlates of students academic performance in biology in secondary schools of Ondo state, Nigeria. *Online Journal of Educational Research*, 1(6), 108–114.
- Akpoghol, T. V., Ezeudu, F. O., Adzape, J. N., & Otor, E. E. (2016). Effects of lecture method supplemented with music and computer animation on senior secondary school students' academic achievement in electrochemistry. *Journal of Education and Practice*. 7(4). ISSN: 2222-1735 (Paper). ISSN: 2222-288X (Online).
- Auwalu, R. A., Mohd, E. T., & Muhammad, B. G. (2014). Academic achievement in biology with suggested solutions in selected secondary schools in Kano state, Nigeria. *International Journal of Education and Research*, 2(11). ISSN: 2201-6740.
- Ayotola, A., & Abiodun, S. (2010). Computer animation and the academic achievement of Nigerian senior secondary school students in biology. *Journal of the Research Center for Education Technology (RCET)*, 6(2), 148–161.
- Bello, G. (2016). Critical examination of examination of the school certificate syllabus in biology. In I. O. Abimbola, A. S. Olorundare, M. O. Fajemidagba, E. O. Omosewo, S. A. Onasanya, M. O. Fakomogbon and N. A. Adedokun-Shitu (Eds.), *Methods of teaching science, basic technology, and computer studies* (pp. 70–74). Ilorin, Nigeria: Haytee Press and Publishing.
- Clark, R. C. & Mayer, R. E. (2003). *E-learning and the science of instruction*. San Francisco, CA: John Wiley & Sons.
- Gambari, A. I., Falode, C. O., & Adegbenro, D. A. (2014). The effectiveness of computer animation and geometrical instructional model on mathematics achievement and retention among junior secondary school students. *European Journal of Science and Mathematics Education*, 2(2), 127–146.
- Kareem, L. O. (2003). *Effects of audio-graphic self-instructional packages on senior secondary school students' performance in biology in Ilorin, Nigeria* (Unpublished doctoral thesis of Science Education). University of Ilorin, Ilorin, Nigeria.
- Kim, M., & Diong, C. H. (Eds.). (2012). *Biology education for social and sustainable development*. Rotterdam, Netherlands: Sense Publishers.
- Kolawole, E. B., & Oginni, O. I. (2009). The effectiveness of laboratory method of teaching on students' performance in senior secondary school mathematics ABACUS. *The Journal Mathematic Association of Nigeria*, 1(34), 120–125.
- Mayer, R. E. (2001). *Multimedia learning*. New York, NY: Cambridge University Press.
- Njoku, Z. C. (2000). *Gender and acquisition of science process skills among secondary school students: implication for science and teaching*. 42nd Annual Conference Proceeding of STAN.
- Nzelum, V. N. (2010). Mechanism of transmission of information along a Neuron: a practical approach to a reflex action. Paper presented at STAN biology panel workshop, model Girls Secondary School. Rumeme, Port-Harcourt, River State, Nigeria.
- Onasanya, S. A., Fakomogbon, M. A., Shehu, R. A., & Soetan, A. K. (2010). Learning information and communications technology skills and the subject context of introductory technology learning in Nigeria. *Journal of Artificial Intelligence*, 3, 59–66.
- Onasanya, S. A., & Omosewo, E. O. (2011). Effect of improvised and standard instructional materials on secondary school students' academic performance in physics in Ilorin, Nigeria. *Singapore Journal of Scientific Research*, 1, 68–76.
- Paivio, A. (1986). *Mental representations: a dual coding approach*. New York, NY: Oxford University Press.
- Salisu, A. (2015). *Impact of animated-media strategy on achievement, retention and interest among secondary school geography students in weather concepts, Kastina State, Nigeria* (Unpublished Masters thesis of Department of Science Education). Ahmadu Bello University, Zaria, Nigeria.
- Umar, A. A. (2011). Effects of biology practical activities on students' process skill acquisition in Minna, Niger State, Nigeria. *Jostmed*, 7(2), 118–126.

Hamzat, A., Bello, G. & Abimbola, I. O. (2017). Effects of computer animation instructional package on students' achievement in practical biology. *Cypriot Journal of Educational Science*. 12(4), 218–227

West African Examinations Council Chief Examiners Report. (2015). *Biology paper 1 practical, May/June 2011, 2012 and 2013*. Retrieved from www.waeconline.org.ng/e-learning/biology

West African Examinations Council Chief Examiners Report. (2015). *Biology paper 3 practical, Nov/Dec 2009, 2010, 2011, 2012 and 2013*. Retrieved from www.waeconline.org.ng/e-learning/biology

Wiess, R. E., Knowlton, D. S., & Morrison, G. R. (2002). Principles for using animation in computer-based instruction: theoretical heuristics for effective design. *The computer in Human Behaviour*, 18, 465–477.

Yisa, N. C., & Ojiaku, F. C. (2016). Effectiveness of computer animation on a progressive learning achievement of secondary school biology students in Niger state, Nigeria. *International journal of education and evaluation*, 2(4). ISSN: 2489-0073.

Yusuf, M. O., & Afolabi, A. O. (2010). Effects of computer-assisted instruction (CAI) on secondary school students' performance in biology. *The online Journal of Educational Technology*, 62–69.