

Effect of Computer Simulation and Jigsaw Technique in Teaching Reproductive System in Human in Senior Secondary Schools Minna Metropolis, Niger State

BABAGANA, M. YAKI, A. A. IDRIS, U.S.B.

Department of Science Education, Federal University of Technology, Minna, Nigeria

Abstract

The conventional method of teaching is most common in Nigeria and researchers have shown that this method has led to poor performance of students in Biology and in other subjects. Researchers have been able to ascertain that students will learn best when they participate in the teaching-learning process. This study examined the effects of Computer simulation and jigsaw technique on the performance of senior secondary school students in Biology in Minna metropolis, Niger state. The study also investigated gender differences in the performance of Male and Female students in Biology. The sample used consists of seventy-eight (78) Senior Secondary (SSII) Biology students. Twenty-six (26) students consisting of thirteen (13) males and thirteen (13) females were randomly selected from each school. The schools were randomly assigned to Experimental group 1, Experimental group 2 and Control group. Experimental group 1 (n=26) was treated with jigsaw technique, experimental group 2 (n=26) was treated with computer simulation, while the control group (n=26) was treated with convectional teaching method. Quasi-experimental design employing pre-test, treatment and post-test was adopted. The test instrument used for the study was a twenty (20) multiple-choice Biology Achievement Test (BAT) questions. The test had a reliability index of 0.72 determined using split- half reliability approach. The data collected were analyzed using Analysis of Variance (ANOVA), t-test, mean, standard deviation and mean gains. Three null hypotheses were tested at 0.05 level of significance. Treatments used had significant effects on students' Post-test achievement score. Students exposed to Computer simulation and jigsaw technique performed better than their counterparts who were taught with conventional teaching method ($F=8.811$, $df=2$, 75 $P<0.05$). There was no significant difference in the performance of the Male and Female students taught with both Computer simulation and jigsaw technique. Based on the findings, it was recommended, among others, that biology teachers should adopt computer simulation technique and jigsaw technique in teaching Biology concepts in view of its high facilitative effect on students' performance

Introduction

Science is a major tool of the ideology currently driving the world economy, namely that of the free market system, continual growth and the pursuit of personal wealth. On the other hand, science is increasingly being called on to produce knowledge and technology that promote environmentally sustainable, people-oriented development long-term management of resources. Advances in science and its resulting technologies, such as global communication, satellite images of Earth, together with the popular fascination with dinosaurs etc., have irrevocably expanded the space and time scales with which people at many levels of society now view their world. Science is largely responsible for a growing public awareness that people share the planet with all other living creatures, that the environment which supports all life is subject to change, and that human activities are present, science has been used mainly as a tool for economic expansion and military power for the wealthier segments of the human race. It is now clear that the current consumption of natural resources and increasing stresses on the regional and local environment cannot continue indefinitely without breakdown of the natural support systems that make present civilizations possible. Science, which helped to bring about this situation, now has an over-riding responsibility to help societies make a transition from an obsession with growth to achievement of a dynamically stable and sustainable ecological and economic system. Kananaskis Village, Alberta (Canada), November 1998.

Science comprises a wide variety of fields from the study of different branches of science. The branches of science in the fields of academic which comprises of three (3) science subject which are chemistry, physics and biology. Biology is the only branch of science that deals with the study of life. Biology is the study of living organisms, their organization and their functions and biology is a large part of the way our environment evolved from simple organisms and is intimately part of our environment. Biology is a very broad field, covering the minute workings of chemical machines inside our cells, to broad scale concepts of ecosystems and global climate change. Biologists study subjects which range from intimate details of the human brain, the composition of our genes, and even the functioning of our reproductive system to the building blocks of the simplest organisms on earth. Steve (2006.) The study of biology aims at providing the learner with the necessary knowledge with which to control or change the environment for the benefit of an individual, family or community. In spite of the importance of biology, the performance of students in leaning and mastering biology concept in secondary schools is very poor. The performance of biology in secondary school from the year 2010 has been below 50%. In 2010 only 24.16% passed,

in 2011 only 36.07% passed while in 2012 only 37.97% passed in west Africa an examination casual (WAEC)

Lucas Mwirigi (2011) gave some reason why student perform poorly in biology; lack of students retention and application of concept, methodology of teaching, lack of detailed instructional materials. Biology as a science subject requires both a well detailed theoretical and practical work to make it easily understood by the students.

This study centers on the effect of two (2) modes of teaching which is comparing the use of computer simulation and jigsaw (a type of cooperative learning) in teaching biology. (Reproductive system in human)

Computer is a device which can be used to present instructional events that are designed, developed and produced for individualized learning situation (Onasanya, 2002). The application of computer technology in a classroom has a significant role in enhancing teaching and learning. Computer assisted instruction (CIA) software is the upliftment of frontier knowledge of science. It is a self learning technique involving interaction of the student with programmed instructional material. Simulation is type of computer assisted instruction (CIA). Computer-Assisted-Instruction (CAI) is the use of computer systems as learning tools. These include tutorials, drill and practice, games, simulation; discovery and problem-solving programmed software packages which incorporate many other factors of instruction to accommodate the different learning styles of the learners. Computer programmed lessons, which allow the learners to interact with the computer in such a way that a specific concept is learnt and mastered as thoroughly as when a teacher does the teaching, or even much more efficient and faster, are now available on easy to install software (Ayodele, 2001; Zhang, 2007).

Computer simulation is a comprehensive method for studying systems. In this broader sense of the term, it refers to an entire process. This process includes choosing a model; finding a way of implementing that model in a form that can be run on a computer; calculating the output of the algorithm; and visualizing and studying the resultant data. The method includes this entire process used to make inferences about the target system that one tries to model as well as the procedures used to sanction those inferences. This is more or less the definition of computer simulation studies in Winsberg 2003. In recent years, extensive research has been conducted in the computer simulation field in order to simulate various systems and behaviors in different disciplines (Anthony et al., 2004). At the same time, a variety of design principles and approaches for computer simulation have evolved.

The second mode is jigsaw technique which is a type of cooperative learning.

The jigsaw technique was invented by a social psychologist named Elliot Aronson in 1971. It was originally designed to break down stereotypes and prejudice among classmates. Contemporary research illustrates examples that help to see how you can break down a subject into parts for a jigsaw project According to Aronson (2005), the teacher chooses a main theme and several subtopics about that theme. Students are broken up into heterogeneous groups of 4 or 5, known as the home groups. Each student in the group becomes an expert on one of the subtopics by discussing their topic of expertise with members of other groups who had the same subtopic. The students then go back to their home groups, and help the other group members become informed about their topic. They teach their group their acquired knowledge and learn the main theme information from their peers. This is followed by an assessment which is given to students individually. This quiz allows for individual accountability.

Once teachers have recognized gender-biased behaviors, they need to be provided with resources to help them change. In their study focusing on how the effects of a gender resource model would affect gender-biased teaching behaviors, Jones, Evans, Burns, and Campbell (2000) provided teachers with a self-directed module aimed at reducing gender bias in the classroom. The module contained research on gender equity in the classroom, specific activities to reduce stereotypical thinking in students, and self-evaluation worksheets for teachers

The interest of this present study is to investigate the effect of computer simulation and jigsaw (a type of cooperative learning) on the performances of secondary school biology.

Statement of the problem

The poor performance of students in biology especially at senior school certificate examination (SSCE) in Nigeria has call for attention. The statistical data of performances of biology students according to WAEC chief examiner report shown that since from the year 2010 the performance has been below 50%. In the year 2010 the performance was 24.16%, in the year 2011 the performance was 36.07%, and in the year 2012 the performance was 37.97%. Lucas (2011) gave some reasons such as lack of students retention and application of concepts, methodology of teaching and lack of detailed instructional materials, why students perform poorly in Biology. These have great implication on students performance. Research reports (Njoku, 2004) on the status of science education in schools in Nigeria show that science classroom activities are still dominated by teacher-centered methods, such as lecture and teacher demonstration methods, which have been found to be ineffective in promoting science learning at the primary and secondary school levels. The resultant effect has been students' persistent poor performances in science. In order to overcome these problems of poor performance in biology as a science subject, hence, there is need for the use of computer simulation and jigsaw technique of cooperative learning in teaching biology.

Purpose of the study

The purpose of this study is to compare the effect of computer simulation and jigsaw technique in teaching biology (reproductive system in human) in senior secondary schools in Minna Metropolis, Niger state.

To use a cooperative learning method (jigsaw) in teaching reproductive system in human and their functions.

To determine the effect of cooperative learning (jigsaw) on the performance of biology students in senior secondary schools.

To determine if the use of computer simulation in teaching is more effective than the use of conventional teaching method of teaching

To determine if the use of jigsaw technique in teaching is more effective than the use of conventional teaching method

To determine if the use of computer simulation and jigsaw technique have any effect on the student's gender.

Hypotheses

The following null hypotheses (HO) were formulated to guide the study and were tested at 0.05 level of significance

HO1. There is no significance difference between students taught with computer simulation, jigsaw technique and conventional teaching method

HO2. There is no significant difference between male and female students taught using computer simulation method

HO3. There is no significant difference between male and female students taught using jigsaw technique

Material and Methods

The research is quasi- experimental design research, using pretest-posttest experimental and control group. This design was for validation of computer simulation package and validation of cooperative learning (jigsaw) method of teaching. This design was adopted because the groups involved have a common variable (achievement and gender). The target population of this study was made up of senior secondary school student's II (SS2) in Minna metropolis, Niger state. Three (3) private schools were selected for this study.

The sample size for the study comprised of 78 students 39 male and 39 female students obtained from 3 senior secondary schools used for the study. A simple random sampling technique was used to select three (3) schools from the nineteen senior secondary schools in Minna. Samples of 26 students (13 males and 13 females) in each school was selected. The choice of this stratified random is base on the belief that gender is an important variable that may affect the outcome of the study.

Biology achievement test (BAT) was developed progressively as the topics were taught by the package and the conventional method. Each item was derived from NECO & WAEC past question papers. However, they were based on the levels of cognitive domain.

It was validated by the chief lecturers in educational technology from the Federal University of Technology, Minna. Biology teachers of the three schools under study also validated them for content and criterion validity. The package (CAI) was also validated by team of experts in the department of Mathematics Computer F.U.T, Minna and other computer package analysts

Results

HO1. There is no significance difference between students taught with computer simulation, cooperative learning (jigsaw) teaching method and conventional method of teaching

Table 1: ANOVA Analysis of the Mean Achievement Scores of Experimental 1 Experimental 2 and Control.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2185.256	2	1092.628	8.811	.000
Within Groups	9300.962	75	124.013		
Total	11486.218	77			

*Significant $P < 0.05$

Table 1a: presents the post-test ANOVA results of experimental 1, experimental 2 and control groups. It yielded an F- ratio of 8.811 and a significance value of .000. The result is significant at $P < 0.05$. This indicates that there is statistically significant difference in the performance of Experimental 1, Experimental 2 and Control groups ($F=8.811$, $df=2$, 75 $P < 0.05$), Hence HO_1 which states that is no significant difference in the performance of students is rejected

To determine the direction of the difference, the data were subjected to scheffe's post hoc test or multiple comparisons as shown in table 2.

Table 2: Scheffe’s analysis; this indicated that the observed significant difference was between Experimental 1 and Control as well as Experimental 2 and Control

(I) 1, 2 & 3	(J) 1, 2 & 3	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Jigsaw	CSI	9.231*	3.089	.015	1.52	16.94
	CTM	12.500*	3.089	.001	4.79	20.21
CSI	Jigsaw	-9.231*	3.089	.015	-16.94	-1.52
	CTM	3.269	3.089	.573	-4.44	10.98
CTM	Jigsaw	-12.500*	3.089	.001	-20.21	-4.79
	CSI	-3.269	3.089	.573	-10.98	4.44

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

Scheffe’s analysis on Table 2 indicated that the observed significant difference was between Experimental 1 and Control as well as Experimental 2 and Control. Between Experimental 1 and control the mean difference is 12.500 and P-value of .001 which is significant at 0.05 level. Between Experimental 2 and Control the mean difference is 3.269 and P-value of .573 which is also significant at 0.05 levels. Therefore, Experimental Groups 1 did better than experimental Group 2 and Control group, however, the group that contributed most to making it significant is found between Experimental Group 1 and Control group with a lower boundary of 4.79 and upper boundary of 20.21.

HO2. There is no significant difference between male and female student taught using computer simulation method

Table 3: t-test Analysis on Achievement Scores of Male and Female Students taught with computer simulation.

Variable	N	DF	X	SD	t-value	P	Remark
Male	13	24	63.08	13.156	0.793	0.44	Significant
Female	13		59.23	11.519			

Ns = not significant $p > 0.05$

The table 3: presents the t-test post-test result of male and female students of experimental group 2, the mean scores of the male students was 63.08 and 59.23 for the females. The calculated t-value of 0.793 and p is 0.44 which was not significant at 0.05 level. This indicates that there is statistically no significant difference between the male and female students taught with computer simulation, ($t=0.793, df=24, P=0.44$). Hence, H_{02} was accepted.

HO3. There is no significant difference between male and female student taught using Jigsaw technique

Table 4: t-test Analysis on Achievement Scores of Male and Female Students taught with jigsaw technique.

Variable	N	DF	X	SD	t-value	P	Remark
Male	13	24	71.54	11.252	0.000	1.000	No Significant
Female	13		71.54	11.065			

Ns = not significant $p > 0.05$

The table 4: presents the t-test post-test result of male and female students of experimental group 1, the mean scores of the male students was 71.54 and 71.54 for the females. The calculated t-value of 0.000 and P is 1.000 which was not significant at 0.05 level. This indicates that there is statistically no significant difference between the male and female students taught with jigsaw technique, ($t=0.000, df=24, P=1.000$). Hence, H_{02} was accepted. Therefore, there is no significant difference between male and female students taught with jigsaw technique.

Discussion

The result of the ANOVA analysis on the performance of students taught reproductive system in human in Biology using jigsaw technique and computer simulation revealed that there was significant different in the posttest means score of the experimental1, experimental2 and control group. In other word those students taught using jigsaw technique performs better than those taught using conventional method.

This result is in line with an investigation conducted by Martin Hanze and Roland Berger 2007, the jigsaw approach was compared with traditional teaching strategies in a grade twelve physics class. Their investigation

revealed that there was a great difference in student learning experiences. Students in the jigsaw classroom showed stronger motivation, greater interest, and involvement in the topic

Sami Ali (2001) looked at the effect of using the jigsaw reading technique on the EFL preserves

Teachers' reading anxiety and comprehension. Results showed that the Lower anxiety among the experimental group participants led to their better performance in the Comprehension of the reading passages.

The result of the ANOVA analysis on the performance of students taught reproductive system in human in Biology using jigsaw technique and computer simulation also revealed that there was significant different in the posttest means score of the experimental1, experimental2 and control group. In other word those student taught using computer simulation performs better than those taught using conventional method

This is in line with the investigation carried out by Trundle and Bell (2005) which described students' conceptual understandings about lunar concepts before and after instruction with planetarium simulations. Results indicated that students learned more about moon shapes and sequences, as well as causes of moon phases, by using the computer simulations than by making actual nightly observations and studying nature alone. The ability to make many more observations using the program, the ease of making and testing predictions, and the consistency and accuracy of student measurements contributed to the dramatic improvements in student understanding.

Hypothesis two was retained, signifying that there was no significant difference between male and female students taught using computer simulation. This finding agree with that of A.I. Gambari, A.A. Yaki, T.T. Olowe (2013) there was no significant difference between the mean scores of male and female students taught biology using computer simulation package, implying that the package is gender friendly. This is also in line with Poripo (2008) experimented on the effect of simulation on male and female students' achievement in chemistry in Bayelsa State, Nigeria. The Results showed that the use of simulation method increased the achievement of students in chemistry and male and female students achieve highly with no significant difference in their mean responses.

Hypothesis three was retained, signifying that there was no significant difference between male and female taught using jigsaw technique. In contrary to this finding The Jigsaw Method can have varying affects on males and females. According to a qualitative study of eighth grade students performed by Ghaith and Bouzeinddine (2003), males enjoy cooperative learning more than females. However, females demonstrated more knowledge of the subject material after learning a topic via the Jigsaw Method

Conclusion

Effective and efficient teaching characterized by the use of educational media especially at this lower level of academic pursuit is very paramount. The teaching of the subject therefore should be based on the use of equipment that would arouse the interest of the pupils, above all improving the manipulative and creative skills of the students. Based on the above facts it would be possible to conclude that the use of computer package in the teaching of the subject to the children between the ages of 10 – 16 be done through the use of varieties of media to arouse students interest, activate their academic achievement and developing their intuitive and creative skills. Teaching of the science subjects, biology inclusive, should be made practical rather than being theoretical.

Recommendation

Base on the findings of the study the following recommendations were made.

- Jigsaw technique should be utilized to enhance the quality of education at secondary school level.
- The use of jigsaw technique in teaching should be put into consideration. Students in the jigsaw classroom showed stronger motivation, greater interest, and involvement in the topic as they work together with their mates.
- The use of computer simulation package should also be put into consideration, as it provides diversity of knowledge in Biology and technology as whole
- Computer should be made available in secondary schools
- Teachers should be made to use other teaching strategies rather than only conventional teaching methods.
- Educational technology should be incorporated in teaching education.

References

- Abd El Sami Ali, M. F. (2001). The effect of using jigsaw reading technique on the EFL preserve Teachers' reading anxiety and comprehension, *Journal of Education College*, 3, 1-21
- Açıkgöz, KÜ. (2006). Aktif Öğrenme, 8. Edition, İzmir: Bilis Yay. Association for Educational Communications and Technology Updated June 7, 2001 Theory of Cognitive Developmental
- Ayodele, S. O. (2001) Quality, quantity, production and distribution of teaching resources. In O. Nnoli & ISulaiman (Eds.). *Reassessing the future of education in Nigeria*, pp. 63- 74. Abuja: Education Tax Fund.
- Aronson, E. (2005). *The jigsaw classroom*. Retrieved September 19th, 2005 from <http://www.jigsaw.org>
- Badawi, G. H. (2008). The effect of jigsaw II versus whole class instruction on EFL students' Reading motivation

- and achievement. Unpublished Master of Arts Thesis, American University of Beirut
- Chen, C.-H., & Howard, B. (2010). Effect of Live Simulation on Middle School Students' Attitudes And Learning toward Science. *Educational Technology & Society*, 13 (1), 133– 139.
- Cooperative Learning Techniques Wikipedia. (May 2010)
- Federal Republic of Nigeria (2004). *National policy on education* (4th edition), Lagos: N.E.R.D. Press 45,(2), 300-313
- Goldsim, A.K. (2011). Introduction to what is simulation. (online) Available <http://www.glodsim.com/web/introduction/simulation-> November 12, 2012.
- Ghaith, G. M., Bouzeineddine, A. R. (2003). Relationship between reading attitudes, achievement, and learners' perceptions of their jigsaw cooperative learning experience. *Reading Psychology*, 24, 105-125
- Haaland, M. Hayden & T. Nghi (Eds.), *Reforming Higher Education in Vietnam: Challenges and Priorities* (pp. 65-86). London: Springer. http://dx.doi.org/10.1007/978-90-481-3694-0_5
- Harman, G., & Nguyen, T. N. (2010). Reforming teaching and learning in Vietnam's higher Education system. In G.
- Hänze, M., & Berger, R. (2007). Cooperative learning, motivational effects, and student Characteristics: An experimental study comparing cooperative learning And direct instruction in 12th grade physics classes. *Learning and Instruction*, 17, 29
- Institute of Simulation and Training (IST) (2002). *Types of simulation*. Florida; University of Florida.
- Johnson David W., Johnson Roger T. (June/July 2009). *Educational Researcher*, Volume 38, No 5, p. 365-379 (Reviewed by the Portal Team) Interdependence Theory and Cooperative Learning
- Johnson, D., Johnson, R.& Holubec, E. (1998). *Cooperation in the classroom*. Boston: Allyn and Bacon.
- Jean Piaget (1896-1980) TCD School of Education Contact Keith Johnston Issue 48 / October – December 2004\
- Johnson, D. W., & Johnson, R. T. (2008). Social Interdependence Theory and Cooperative Learning: The Teacher's roll
- Jones, K., Evans, C., Byrd, R., Campbell, K. (2000) Gender equity training and teaching behavior. *Journal of Instructional Psychology*, 27 (3), 173-178
- Gillies R.M, Ashman A & Terwel J. (Eds.), *Teacher's Role in Implementing Cooperative Learning In the Classroom* (pp. 9-37). New York, U.S.A: Springer. http://dx.doi.org/10.1007/978-0-387-70892-8_1
- Kananaskis Village, Alberta (Canada), 1-3 November 1998
- Gambari A.I, Yaki A.A, Olowe T.T (2013) : Khimiya, Volume 22, Issue 5(2013) Khimiya. 22, 649-661
- Lucas Mwirigi, Platinum Author | 23 Articles Joined: March 26, 2011
- Laureate Education, Inc. (Producer). (2008). Cognitive learning theories. [Video webcast]. Retrieved from <http://www.courseurl.com>
- Mexus education pvt.ltd (2011), www.ikenstore.co
- Min, R. (1994). Parallelism in open learning and working environments. *British Journal of Educational Technology*, 25(2), 108-112. Enscheda, April, 10, 2003^
- Min, Bork, Spitzer (2012, 12). Computer Simulation - Advantages and Disadvantages. StudyMode.com.Retrieved12, 2012,from<http://www.studymode.com/essays/Computer-Simulation-Advantages-And-Disadvantages-1316065.html>
- Ministry of Education and Training of Vietnam [MOET] (2009). *Development Strategy from 2009 to year 2020 for the Cause of Industrialization and Modernization of Vietnam*. Hanoi: Vietnamese Government
- Njoku, Z. C. (2004). Fostering the application of science educational research findings in Nigeria Classrooms: Strategies and needs for teachers professional development. In M. A.G. Akale (Ed.). *Proceedings of 45th annual conference of Science Teachers Association Of Nigeria (STAN)*, pp.217-222. Ibadan: HEB Plc
- National Policy on Education (2004)
- Ormrod, J. (2008). *Human Learning* (5th ed.). New Jersey, NY: Pearson Education, Inc.
- O'Neill, T. (2000) Boys' problems don't matter. Report/ Newsmagazine (National Edition), 27 (15), 54-56.
- Perkins, D. V., & Saris, R. N. (2001). "A "Jigsaw Classroom" technique for undergraduate statistics courses". *Teaching of Psychology*, 28, 111-113, Retrieved December 5, 2012, from sagepub.com
- Poripo, J.P. (2008). *Effects of simulation on male and female students' achievement in chemistry State, Nigeria*. Yenagoa, in *Bayelsa* Beylsa State, Nigeria: Izontimi publishers
- Pitler, H., Hubbell, E., Kuhn, M., & Malenoski, K. (2007). *Using technology with classroom instruction that works*. Alexandria, VA: ASCD
- Steve D Evans, Platinum Author | 171 Articles Joined: January 28, 2006
- Simsek Ü. (2007). Çözümler ve Kimyasal Denge Konularında Uygulanan Jigsaw Ve Birlikte.Öğrenme Tekniklerinin Öğrencilerin Maddenin Tanecikli Yapıda Öğrenmeleri Ve Akademik Başarıları Üzerine Etkisi, Yayınlanmamış Doktora Tezi, Atatürk Üniversitesi Fe Bilimleri Enstitüsü, Erzurum
- Slavin, R. E. (2011). Instruction Based on Cooperative Learning. In R. E. Mayer & P. A. Alexander (Eds.), *Handbook of Research on Learning and Instruction* (pp. 344-360). New York: Taylor & Francis

- Smaldino, Sharon E.; Russell; James D.; Heinich, Robert; & Molenda, Michael (2004). *Instructional Media, and Technologies for Learning*, 8th edition. Upper Saddle River, New Jersey: Prentice Hall.
- Simulation (2010). *Encyclopædia Britannica. Encyclopaedia Britannica Ultimate Referen Suite*. Chicago: Encyclopædia Britannica
- Ozgur Ozer TCD Homepage TCD School of Education Contact Keith Johnston Issue 48 / October - December 2004 CONSTRUCTIVISM in Piaget and Vygotsky
- Trundle and Bell (2005) using computer simulation to enhance teaching and learning. *Technology in the secondary science classroom*.
- TYPES Cooperative Learning Wikipedia. (May 2010)
- Tippler, M. N. (2003). *The objectives and creation of a course of simulation*. Michigan: Bostrom Press Lansing.
- Wang, S., & Reeves, T. C. (2007). The effects of a web-based learning environment on students' motivation in a high school earth science course. *Journal of EducatioTechnology Research and Development*, 55 (2), 169-192. <http://dx.doi.org/10.1007/s11423-006-9016-3>
- Winsberg, (2003). "Simulated Experiments: Methodology for a Virtual World," *Philosophy of Science*, 70, 105–125.
- WAEC chief examiner report, 2010, 2011 and 2012.
- Zhang, J. (2007). A cultural looks at information and communication technologies in eastern Education. *Journal of Education Technology Research and Development*, 55 301- 314. <http://dx.doi.org/10.1007/s11423-007-9040-y>