

Effect of Computer Simulation on Junior Secondary School Students' Achievement in Algebra

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Abstract

This study examined the effect of computer simulation on achievement of students in Algebra at junior secondary school level. Two research questions and two hypotheses were asked and formulated respectively. The research employed quasi experimental design of pre-test post-test control group type. A sample of 54 students participated in the study. The statistical tool employed in analyzing data for this study was Special Package for Social Sciences (SPSS). Algebra Achievement Test (AAT) was the instrument for data collection. The reliability coefficient of AAT was 0.98. The result showed that the use of computer simulation approach in teaching affects students' achievement in algebra than the conventional teaching approach. It is recommended that mathematics teachers should incorporate computer simulation approach among other instructional strategies employed especially in the teaching of Algebra.

Key words: Achievement, Computer Simulation, Algebra, Gender

Background of the study

The fact that mathematics is an important subject is not cajoled. Even an ordinary man on the street will agree to this fact. Indeed, mathematics is an important and necessary subject for progress anywhere in the world. It is a subject that cannot be divorced from the world of technologists which is a key to progress and development. However, any laudable achievement in technological development will be hampered if the potential Scientist, Engineers and technologists are not equipped with sound knowledge of mathematics (National Open University of Nigeria, 2006). Therefore, the growing importance of mathematics to Nigeria as a developing country cannot be overemphasized. Despite the considerable relevance of mathematics to human existence and despite the enviable position it occupies in the community of disciplines, students' achievement in the subject at public examination have continued to worsen year after year (Kolawole and Ilugbusi, 2007).

Over the years, mathematics educators have identified various causes of difficulties in learning mathematics. According to Kurumeh and Achor (2008), the difficulties of students in learning mathematics could be attributed to the approach to which the contents are being presented to the students, the abstractness of mathematical concepts, and poor foundation, among others. Korau (2006) opines several variables ranging from the teaching methods, learners themselves, the teachers, textbooks, the curricula, school environment to be responsible for students' poor achievement in mathematics. The poor performance in mathematics according to Betiku (2002) is due to the methods of teaching, attitude of the teachers that teach the subject and students lack of interest in the subject.

However, Ifedili and Ojogwu (2007) averred that the falling standard of education manifested in the performances of students at various examinations is leaving many people to wonder about the future and place of Nigerian education in the 21st century. So many factors have been pointed at

as responsible for the poor performance of Nigerian secondary school students. Some of these factors include inadequate instructional facilities, students lack of interest and motivation, teaching and learning methods.

Among the several factors pointed out by Kurumeh et al (2008), as causes of students' poor achievement in mathematics, they seemed to anchor on the teaching method as a major factor hindering mathematics achievement. However, many instructional strategies have been proposed, such as learning by doing, guided inquiry, problem solving and so on. In Nigeria emphasis is placed on the use of guided discovery instructional strategy (NOUN, 2006). This instructional strategy is activity oriented and involves practical demonstration. Students are guided by materials and leading questions from the teacher to discover mathematical concepts. Yet over the years, the result of this instructional strategy planned towards improving the quality of instruction in mathematics has been disappointing and seems ineffective. Current studies on how students learn science and science related subjects (mathematics) have proved effective. One of such innovative instructional strategies is the computer simulation approach (Akpan, 2002; Lunce, 2006; Tambade & Wagh, 2008).

As technology advances, there are suggestions that technology could be used as a tool to minimize difficulties that students incur in mathematics classrooms. The National Council for Teachers of Mathematics (NCTM) (2003) advocated that:

Every school mathematics program should provide students and teachers with access to tools of instructional technology, including appropriate calculators, computers with mathematical software, internet connectivity, handheld data collection devices, and sensing probes ... They [technology tools] also enhance computational power and provide convenient, accurate, and dynamic drawing, graphing, and computational tools ... With such devices, students can extend the range and quality of their mathematical investigations and encounter mathematical ideas in more realistic settings (p.2).

The NCTM's call for the use of technology in the classroom is based on the assumption that technology will help improve the learning of mathematical skills without compromising computational skills that students need to acquire. Other organizations also have joined the call for the inclusion of technology in mathematics classrooms, and this call is vibrant in the corridors of institutions that provide training for mathematics instructors.

It has been declared by Tokpah (2008) that computers could be used in the classrooms to improve students' acquisition of basic skills in specific subject areas, reduce the drudgery of learning by blending text with multimedia, broaden curriculum objective through the use of stimulations to aid in problem-based and collaborative learning, enable teachers to strengthen their mode of content delivery, and prepare technology literate citizens for the workplace.

It has been identified by Usman (2002) that computers can be used in three ways; as a tool, a tutor and a tutee. Taylor (1980) in Twing (2002) also affirms that there are three ways computers are used in educational setting: as a tutor, a tutee and a tool. When used as a tutor, the computer adapts to the student by selecting appropriate instructional resources and maintaining record of academic progress. As a tutee, the computer receives and executes instructions (in the form of programming language) from the student. As a tool, the computer is used to aid in calculations and graphical displays.

Computer simulation (or "sim") according to Wikipedia (2009), is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By

changing variables, predictions may be made about behaviour of the system. It could also be seen as a computer programme that attempts to simulate an abstract model of the particular system. Computer simulation as described by Thomas and Hooper (1991) in Akpan (2002) is a computer program containing a manipulable model of a real or theoretical system. The program enables the students to change the model from a given state to a specified goal state by directing it through a number of intermediate states. Thus, the simulation program accepts commands from the user, alters the state of the model, and when appropriate displays the new state.

According to Ton and Wouter (2007), common characteristics of educational computer simulations are:

1. Model Based: Simulations are based on a model. This means that the calculations and rules operating the simulation are programmed. These calculations and rules are collectively called "the model", and it determines the behavior of the simulation depending on user actions.
2. Interactive: Learners work interactively with a simulation's model to input information and then observe how the variables in the simulation change, based on this output.
3. Interface driven: The value changes to the influenced variables and the observed value changes in the output are found in the simulation's interface.
4. Scaffolded: Simulations designed for education should have supports or scaffolds to assist students in making the learning experience effective. Step by step directions, or small assignments which break the task down to help students, while they work with a simulation, are examples.

There are three (3) ways to use computer for simulation activities as stated by Robert (1999)

1. Run a simulation programme on the computer – which is the major focus of this study.
2. Use simulation on the World Wide Web.
3. Enhance simulation with computer i.e. one can display images and pictures on the computer screen to add reality to many simulations. (Robert, 1999).

According to Lunce (2006) the purpose of simulation is to motivate the learner to engage in problem solving. Lunce also stress that simulation is based on an internal model of a real-world system or phenomena in which some elements have been simplified or omitted in order to facilitate learning. Computer simulations can be used in the classroom to help students to gain additional insight into the phenomena. Computer simulations are also useful for providing more extended practice in thinking about a wide variety of examples (Tambade and Wagh, 2008).

Simulations have a number of advantages over other instructional methodologies. Students often find active participation in simulations to be more interesting, intrinsically motivating and closer to real-world experiences than other learning modalities (Alessi & Trollip, 2001). Simulations have been shown to provide transfer of learning with the result of what is learned facilitates improved performance in real-world settings (Leemkuil, et. al., 2003). Further, there is evidence to suggest that simulations may be more efficient modalities for learning in some content areas (Alessi & Trollip, 2001). Simulations can be very flexible in that both student and instructor can have a high degree of control over simulation variables (Duffy & Cunningham, 1996; Hung & Chen, 2002). Simulations can accommodate a wide range of instructional strategies, including microworlds, scientific discovery learning, virtual reality, laboratory simulations, role playing, case-based scenarios, and simulation gaming (Alessi & Trollip, 2001). Through simulations the learner is given the opportunity to practice on his or her own with a variety of situations which resemble "real-life" problems which they might face in the future. And it is this type of practice,

which they indicate enhances the learner's problem-solving skills (Akpan, 2001). Simulations are creative; students are organized into small groups, goals are set for individuals, as well as for the groups with which they work. The goal setting in conjunction with the competition with the other groups keep the students very involved in the learning (ITC, 2007).

Computer simulations do have distinct disadvantages compared with other modalities. First, because computer simulations are often used with “problem-based learning” methods, they stimulate learners to immerse themselves in a problematic situation and experiment with different approaches (Heinich, et. al., 1999). This type of learning may require significantly more time than other methods of instruction. Second, research has shown that, without coaching, the learner gains little from “discovery learning” from computer simulations (Min, 2001; Heinich, et. al., 1999). Third, constructivists argue that computer simulations “oversimplify the complexities of real-life situations”, giving the learner a “false understanding” of a real-life problem or system (Heinich, et. al., 1999). Finally, development of computer simulations may involve extensive planning and require significant investment of labor and financial resources. Despite the significant results recorded in other subjects and the advantages derived from computer simulation, evidence shows that not much has been done in the use of computer simulation as a teaching strategy in mathematics education and specifically in algebra.

Algebra according to Usman and Musa, (2015) is an aspect of mathematics which involves the use of letter and numbers. These letters combine with figures bring a lot of confusion to the students more so, with the letters changing values or one letter replacing another letter at intervals. Although, algebra is considered as one of the most important aspect of school mathematics; it does not only play an important role in mathematics but function as a gatekeeper to future educational and employment opportunities (Silver, 1997). For students to understand and possess the mathematical skills of problem solving, communication, reasoning and making connections that are necessary in human daily living they need algebra. This is so, because algebra is the language through which most of the mathematics is communicated (Iji, et al., 2013).

Furthermore, modern psychological studies have shown that gender as a variable relates to performance (Ezeugo and Agwagah, 2000). For instance, Olaguaju, (2001) observed that boys choose science courses in high schools than girls especially mathematics, chemistry and physics. This is due to the long-held view that women are weaker vessels who cannot stand the stress and strain involved in problem solving. Azuka (2000), stated that significant difference in the performance of male and females on geometric proofs does not exist. Adeleke (2007), showed a non-significant difference in the performance of boys and girls in the learning strategies he worked on. Kurumeh and Achor (2008), found out that there was no significant difference between male and female pupils taught using Cuisenaire Rods approach. Bassey, Joshua and Asim (2008), revealed the existence of significant gender achievement gap in favour of the rural male students. Agwagah found out that female students performed significantly higher than their male counterparts in mathematics readings. Thus, there is also the need for further investigation on whether male and female students would respond differently on Algebra when computer simulations are used.

Purpose of study

The major purpose of this study was to investigate the effect of computer simulation on the achievement of JSS II students in selected algebraic concepts. Specifically, the study seeks to

1. Determine the effect of computer simulation on students' achievement scores in algebra.
2. Determine the effect of computer simulation on the mean achievement scores of male and female students

Research questions

The following research question guided this study

1. What are the mean achievement scores of students taught with computer simulation and those taught with conventional approach as measured by Algebra Achievement Test (AAT)?
2. What are the mean achievement scores of male and female students taught using computer simulation as measured by Algebra Achievement Test (AAT)?

Hypotheses

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

1. There is no significant difference between the mean achievement scores of students taught with computer simulation and those taught with conventional method, as measured by the Algebra Achievement Test (AAT).
2. There is no significant difference between the mean achievement scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Achievement Test (AAT).
3. There is no significant interaction effect between method and gender on the students' achievement in Algebra.

Methodology

Design of the study

The Design of the study is quasi-experimental study or a non-equivalent control group design. According to Nworgu (2006) quasi-experiment is an experiment where random assignment of subjects to experimental and control groups is not possible. In this case, intact or pre-existing groups were used.

Area of the study

The study was carried out in Isoko North Local Government Area Education Zone of Delta State. There are eighteen (18) secondary schools in Isoko North Local Government Area. Out of the 18 secondary schools, three (3) are single sex schools comprising of two (2) males and one (1) female school while fifteen (15) are co-educational.

Population of the study

The population of the study is comprised all the Junior Secondary School Two (JSS II) students in Isoko North Local Government Area Education Zone of Delta State.

Sample and Sampling Technique

Fifty-four students, from two schools (male and female) sampled, were used as sample for the study. Purposive sampling technique was employed to sample two schools. The reason for purposively selecting two schools is because only the two schools have computer facilities and electricity. The two schools selected had up to two streams of JSS II students and from each school, one class was chosen through simple random sampling. Again, simple random sampling technique was used to select two intact classes from the schools selected. The researcher with a flip of a coin determined which of the intact classes become the experimental group and the one that becomes the control group.

Instruments for Data Collection

The Teacher Made Algebra Achievement Test (TMAAT) was the instrument used for the study. The TMAAT consisted of 20 multiple choice test items covering the three methods of Solving Equations. Out of the 20 questions, 7 were of higher order while 13 were of lower order.

Validation of the Instruments

The Teacher Made Algebra Achievement Test (TMAAT) was subjected to content and face validation. The content validation of TMAAT was ensured through strict adherence to the test blue print. The test blue print and the unit lesson plans were also validated by experts in Mathematics Education and Measurement and Evaluation in Department of Science Education from University of Nigeria, Nsukka.

Reliability of the instruments

The researchers carried out a trial testing of the Teacher Made Algebra Achievement Test to estimate the internal consistency of the instruments. The instruments were administered to a class of J.S.S II students from a school close to one of the schools selected for the study. One intact class of 44 students was used for the trial testing.

The internal consistency of the Algebra Achievement Test was determined using Kuder Richardson Formula 20 (K-R 20) method. Kuder Richardson was used because the test items involved multiple-choice items. The internal consistency coefficient $r = 0.98$ was gotten.

Experimental procedure

The experimental groups were taught using computer simulation approach while the control groups were taught the same topics using the conventional method.

The PREAAT was administered before the actual study. The actual teaching was done in the first, second and third week while the POSTAAT was administered in the fourth week. The scores from the posttest was recorded and used to provide information on students’ achievement in the treatment groups.

Method of Data Analysis

The research questions were answered using means (X) and standard deviation (S.D). While Hypotheses were tested at 0.05 level of significance using Analysis of covariance (ANCOVA).

RESULTS

The results of the study are presented according to the research questions in table 1 and 2 while the test of hypotheses is presented in table 3 and 4.

Research questions 1

What are the mean achievement scores of students taught with computer simulation and those taught with conventional approach as measured by Algebra Achievement Test (AAT)?

Table 1: The mean achievement scores of students taught mathematics using computer simulation and conventional approach

Group	N	Pre-test		Post test	
		\bar{X}	SD	\bar{X}	SD
Experimental	27	46.6667	23.12175	73.3333	18.02776
Control	27	38.5185	23.97173	47.5926	18.41667
TOTAL	54				

From the data above, the experimental group which represents those taught with computer simulation approach, obtained a higher mean achievement score of 46.6667 and a standard deviation of 23.12175 in pre test (PREAAT) and a mean score of 73.3333 and a standard deviation of 18.02776 in the post test (POSTAAT). While the control group representing those taught with the conventional approach, it was observed that they had a mean score of 38.5185 and a standard

deviation of 23.97173 in the pre test while in the post test, they had a mean achievement score of 47.5926 and a standard deviation of 18.41667. The better performance of the experimental group over that of the control group showed that students taught mathematics using computer simulation learnt mathematics concept better than those taught mathematics by the conventional method.

Research question 2

What is the mean achievement scores of male and female students taught using the computer simulation in the Algebra Achievement Test (AAT)?

Table 2: The mean achievement scores of male and female students taught mathematics using computer simulation

Group	N	Pre test		Post test	
		\bar{X}	SD	\bar{X}	SD
Male	12	52.5000	19.48193	30.4167	16.30091
Female	15	42.0000	25.34054	67.6667	17.81519
TOTAL	27				

Table 2 revealed that the male students had a mean score of 52.5000 and a standard deviation score of 19.48193 in the pre test and a mean score of 30.4167 and a standard deviation of 16.30091 in the post test. While their female counterparts had a mean score of 42.0000 and a standard deviation score of 25.34054 in the pre test and a mean score of 67.6667 and a standard deviation score of 17.81519 in the post test. The result above showed that the mean achievement scores of males in the pre test was higher than their female counterpart while the mean achievement scores of females in the post test was significantly higher than their male counterpart.

Hypothesis 1

There is no significant difference between the mean achievement scores of students taught with computer simulation and those taught with conventional method, as measured by the Algebra Achievement Test (AAT).

Table 3: Summary of ANCOVA Result for AAT of students taught with computer simulation and those thought with the conventional method

Source of variation	Type III Sum of squares	DF	Mean sum of square	F	Sign
Intercept	17129.168	1	17129.168	117.687	.000
Pre test	7996.724	1	7996.724	54.938	.000
Groups	5808.552	1	5808.552	39.905	.000
Sex	946.310	1	946.310	6.501	.014
Group* Sex	26.412	1	26.412	.181	.672
Error	7132.442	49	145.560		
Total	223625.000	54			

The result of the analysis in table 3 above showed that the probability of obtaining the F-value (39.905) is zero (0.00), which is less than the 0.05 level of significance. In other words, the null hypothesis of no significant difference was rejected, which means there is a significant difference

in the mean achievement scores of students taught with computer simulation and those taught the same topic using conventional method.

Hypothesis 2

There is no significant difference between the mean achievement scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Achievement Test (AAT).

Table 4: Summary of ANCOVA Result for AAT for male and female students taught with computer simulation in algebra

Source of variation	Type III Sum of squares	DF	Mean sum of square	F	Sign
Intercept	13851.258	2	13851.258	67.956	.000
Pre test	2474.406	1	2474.406	12.140	.002
Sex	424.343	1	424.343	2.082	.162
Error	4891.844	24	203.827		
Total	153650.000	27			

The result on table 4 above shows that the probability of obtaining the F-value (2.082) is 0.162, which is higher than the 0.05 level of significance. Thus, the null hypothesis of no significant difference for gender was not rejected since sex was not significant.

Hypothesis 3

There is no significant interaction effect between computer simulation and gender on students' achievement in Algebra.

The result on table 3 above showed that the probability of obtaining the F-value (0.181) is 0.672, which is higher than the 0.05 level of significance. Therefore, the interaction effect due to computer simulation approach and gender (Group * Sex) was not significant. Thus, the null hypothesis of no significant interaction effect between the computer simulation approach and gender on students' achievement was not rejected.

Discussion of Findings

Analysis of the result as shown in table 1, indicated that the mean achievement scores of students in the experimental group was significantly higher than the mean achievement scores of the control group both in the pre test and the post test scores.

Analyses of the result as shown in table 2 for research question two showed that the mean achievement scores of males in the pre test was higher than their female counterpart while the mean achievement scores of females in the post test was significantly higher than their male counterpart.

From the first hypothesis, there was a significant difference in the mean achievement scores of students taught algebra using computer simulation approach thereby rejecting the first hypothesis. These findings appeared to be consistent with those of Tambade and Wagh (2008) that students taught Oscillations using computer simulation performed better than those taught using

the conventional approach. Also, Akpan (2002) findings aligned with findings of the present study. He found out that students exposed to computer simulation had better achievement performance.

With regards to the second hypothesis, table 4 showed that gender was not rejected and the hypothesis was accepted. This result supports the findings of Azuka (2000), that significant difference in the performance of male and females on geometric proofs does not exist. Also, Adeleke (2007), showed a non-significant difference in the performance of boys and girls in the learning strategies he worked on. This finding implies that whether a student is a male or female, gender does not make a difference in their academic achievement.

Hypothesis three sought to find out whether there existed a significant interaction effect between the teaching method (computer simulation) and gender on students in algebra topics taught. The findings on table 3 showed that there was no significant interaction effect between teaching method and gender.

Conclusion

The result of this study established the following

1. The use of computer simulation approach significantly enhanced students' achievement in algebra topics taught more than the conventional approach. This was observed in the mean score of the experimental group being higher than that of the control group.
2. There is no significant difference between the mean achievement scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Achievement Test (AAT) both in the pre test and post test.
3. There is no significant interaction effect between the teaching method and gender on students' achievement in algebra topics taught.

Recommendations

In view of the findings of this study, the following recommendations are made.

1. Mathematics experts should be encouraged and funded by government for the production of computers and computer simulation programmes in various mathematics topics for schools.
2. The state and federal ministries of education should invest on massive acquisition and distribution of computers machines and mathematical software to secondary schools.
3. Mathematics textbook authors and publishers should incorporate the use of computer simulation approach in their text books.
4. There is need for the establishment and equipment of Educational Resource Centres in each education zone of the state. Such Centres will provide avenues for collection of computer simulations in various mathematics topics that are relevant and suitable in the teaching and learning of mathematics.
5. Professional organizations like the Science Teachers Association of Nigeria (STAN) should organize workshops, seminars and conferences to train mathematics teachers on the importance of computer simulation in the teaching and learning of mathematics.

REFERENCES

- Agwagah, U.N.V. (1993). *Instructions in Mathematics Readings as a factor in Students' Achievement and Interest in Word problem solving*. Unpublished doctoral dissertation. University of Nigeria, Nsukka, Nigeria.

- Akpan, J.P. (2002). Which comes first: computer simulation of dissection or a traditional laboratory practical method of dissection. *Electronic Journal of Science Education* (Vol. 6, p. 4). Retrieved from <http://www.unr.edu/homepage/crowther/ejse/akpan2.pdf>
- Alessi, S. M. & Trollip, S. R. (2001). *Multimedia for learning: Methods and development* (3rd Ed.). (214, 254-257). Boston: Allyn & Bacon. Retrieved from www.eduquery.com/jaet/JAET3-1_Lunce.pdf
- Azuka, B. (2000). Motivation in technological development. Focus on the next millennium implication for secondary school education. *ABACUS: The Journal of the Mathematics Association of Nigeria*, 25(1) 63-73.
- Bassey, S.W., Joshua M. T. & Asim, A.E. (2001). *Gender Differences and Mathematics Achievement of Rural Senior Secondary Students in Cross River State, Nigeria*. Retrieved from http://www.Cvs.gnowledge.org/./pro_pdf.php
- Betiku, O.F. (2002). *Factors responsible for poor performance of students in school mathematics suggested remedies*. Proceedings of the 43rd annual conference of CASTME. Africa Heinemann Educational Books NIGPLC.
- Duffy, T. & Cunningham, D. (1996). Constructivism: Implications for the design and delivery of instruction. In D. Jonassen (Ed.), *Handbook of research on educational communications and technology*. New York: Simon & Schuster.
- Ezeogu, N.C. & Agwagah, U.N.V. (2000). Effect of concept mapping on students' achievement in algebra: Implication for secondary mathematics education in the 21st century. *Abacus: Journal of Mathematical Association of Nigeria*, 25 (1) 1-13. Retrieved from <http://www.unn.edu.ng/index.php/download-d...>
- Heinich, R., Molenda, M., Russell, J. & Smaldino, S. (1999). *Instructional media and technologies for learning*. (6th ed) (pp. 14-15, 21, 213-214, 290-291, 319-324). Upper Saddle River, New Jersey: Prentice-Hall.
- Hung, D. & Chen, D. (2002). Two kinds of scaffolding: The dialectical process within the authenticity-generalizability (A-G) continuum. *Education Technology & Society*, 5(4), 148-153.
- Ifedili, C.J.A. & Ojogwu, C.N. (2007). An appraisal of globalization and Nigerian educational policies. Retrieved on July 19, 2011 from http://findarticles.com/p/articles/mi_qa3673/is_1128/ai_n29381535/pg_2/.
- Iji, C., et al. (2013). Effects of algebraic game on students' achievement in algebraic linear graph. *International Journal of Social Sciences*, Vol/issue: 1(4), pp. 1-12.
- Innovative Teaching Concepts (I.T.C), (2007). *Interactive Classroom Simulations*. Retrieved from <http://www.todaysteacher.com/Simulations.htm>
- Karau, Y.K. (2006). *The effect of using fomula approach on teaching of mathematical concept in senior secondary schools*. Retrieved from www.abu.edu.ng/staff/view_staff_det..
- Kolawole, E.B. & Ilugbusi, A.A. (2007). Comparative effectiveness of three problem-solving instructional strategies. Retrieved from www.medwelljournals.com/abstact/
- Kurumeh, M. S. C. & Achor, E. E. (2008). Effect of Cuisenaire Rods' approach on some Nigeria primary pupils' achievement in decimal fractions. *Educational Research Journals*. Retrieved from <http://www.academicjournals.org/ERR>
- Leemkuil, H., de Jong, T., de Hoog, R., & Christoph, N. (2003). KM QUEST: A collaborative Internet-based simulation game. *Simulation & Gaming*, 31(1), 89-111.

- Lunce, L.M. (2006). Simulations: Bringing the benefits of situated learning to the traditional classroom. *Journal of Applied Educational Technology*. Retrieved from http://www.eduquery.com/jaet/JAET3-1_Lunce.pdf
- Min, R. (2001). *Simulation and Discovery Learning in an Age of Zapping & Searching: Learning Models*. Retrieved from: <http://projects.edte.utwente.nl/pi/Papers/DiscLearning.html>
- National Council of Teachers of Mathematics (2003). *Position Statement on the use of technology in the learning and teaching of mathematics*. Retrieved from http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/technology.pdf
- National Open University of Nigeria (2006). *Mathematics curriculum and instructions in Secondary schools*. Retrieved from <http://www.nou.edu.ng>
- Nworgu, B.G. (2006). *Educational research: basic issues and methodology*. Owerri. Wisdom Publishers Limited.
- Olagunju, S.O. (2001). Sex, age and performance in mathematics. *ABACUS: The journal of mathematics association of Nigeria*, 26(1), 8-16.
- Robert, E.M. (1999). *Element of a successful educational simulation*. Retrieved from <http://www.CreativeTeachingSite.com/simconcept.htm>
- Tambade, P.S and wagh, B.G (2008). *Investigating effect of computer simulations in physics teaching at undergraduate level*. Retrieved from http://www.editlib.org/index.cfm/files/paper_29940.pdf?
- Taylor, P.C. (1980). *Computer as a tutor, tool and tutee*. Retrieved from www.med8.info/cpf/taylor/index.htm
- Thomas, R.L. & Hooper, E.S. (1991). *Using modeling and simulation in science teaching*. Retrieved from www.misclab.umeoce.maine.edu/boss/class...
- Tokpah, C.L. (2008). *The effect of computer algebra system on students achievement in mathematics*. Retrieved from www.etd.ohiolink.edu/send-pdf.cgi/Tokpa...
- Ton, D.J & Wouter, V.J (2007). *What do we know about computer simulations ?* Retrieved from [www.noe-kaleidoscope.org/public/pub/lastnews/images/kaleidesckope_broch%20\(2\).pdf](http://www.noe-kaleidoscope.org/public/pub/lastnews/images/kaleidesckope_broch%20(2).pdf)
- Twing, (2002). *Computer as Tutor, Tool and Tutee*. Retrieved from <http://www.med8.info/cpf/taylor/index.htm>
- Silver, E. A. (1997). *Fostering creativity through instruction rich in mathematics problem solving and problem posing*. *Zdm*, 29(3), 75-80.
- Usman, K.O. (2002). *Computer competencies required of mathematics teachers for the use of computers in Teaching Mathematics in Nigeria*. Unpublished doctoral dissertation, University of Nigeria, Nsukka, Nigeria.
- Usman, M. A. & Musa, D. C. (2015). Effects of Inquiry Teaching Method on Students Achievement in Algebra in Bauchi LGA of Bauchi State, Nigeria. *The Journal of the Mathematical Association of Nigeria*, 40(1), 70–76.
- Wikipedia (2009). *Computer simulation*. Retrieved from http://en.wikipedia.org/wiki/Computer_simulation.