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# Effect of Computer Simulation Assisted Instruction on Secondary School Physics Students' Achievement in Abia State

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## Abstract
Pre-test post-test quasi-experimental research design was employed to investigate the effect of Computer Simulation Assisted Instruction strategy on achievement of students in physics. The population of the study was 3480 (SS2) Physics students from all the 225 coeducation public secondary schools in Abia State. A simple random sampling was used to sample 93 Senior Secondary School II (SS2) Physics students from two intact classes which were grouped into Experimental and Control Groups. The Experimental Group was exposed to Computer Simulation Assisted Instruction (CSAI) while the Control Group was exposed to Traditional Lecture Teaching Method (TLTM). Two research questions and two hypotheses guided the study. The instrument for data collection was Physics Achievement Test (PAT); subjected to test of reliability using Kudar Richardson formula 20 (KR – 20), and a reliability coefficient of 0.82 was obtained. Mean and standard deviation scores were used to answer the research questions and analysis of covariance ANCOVA at (0.05) level of significance was used to test the hypotheses. It was found that although there was no statistically significant difference between the mean achievement scores of students taught physics with CSAI and TLTM, CSAI enhanced students' achievement in physics more than the TLTM. The study also revealed that there was no statistically significant interaction effect of teaching strategies and gender on students' achievement in Physics when taught with CSAI and TLTM. It is therefore recommended that teachers should adopt CSAI in the teaching and learning of Physics.

**Keywords:** Achievement, Computer Simulation and Learning plateau

## Introduction

Physics plays important roles in the economic, scientific and technological advancement of every developing nation like Nigeria. Without the advancement in Physics and its applications, it wouldn't have been possible for man to explore other planets of the universe, design enhance semiconductors and other engineering materials through solid state Physics which can meet

specific elastic strength, conductivity, toughness and durability required for enhanced industrial activities (Oladejo et al; 2011). The learning of Physics is divided into theoretical aspect and practical aspect of Physics which are complementary. The practical work plays a vital role in science especially in Physics by making Physics concepts comparatively easier to understand and by enhancing students' content knowledge while the theoretical aspect deals with concrete and abstract concepts of Physics. Both the theoretical and practical aspects of Physics require innovative teaching strategies for students' better understanding and comprehension (Banu, 2011).

Like any other field of endeavor, learning of Physics has its own problems among students which partly arise from student misconceptions in Physics, students perceptions that Physics is a hard subject because Physics incorporates mathematics in its learning, poor understanding of most Physics concepts, and lack of functional Physics laboratory with adequate laboratory equipment in most secondary schools, together with poor instructional strategy employed in its teaching which make students passive learners ( Logar & Savec, 2011; Abungu et al; 2014). Buabeng et al. (2014) stated that students' poor performance in Physics is attributed to lack of exposure of students to efficient pedagogies and poor presentation of information to learners as seen in conventional teaching methods. This problem had contributed to average poor performance of students in Physics in Abia State senior secondary schools (SEMB, 2021).

Based on WAEC chief examiners report (2016–2021), it was revealed that students showed poor performance in both practical and theoretical aspect of Physics at the Secondary School Certificate Examination level with rated average performance 26% against 60% in essay part and 24% against 50% in practical section respectively. Based on the WAEC Chief examiners recommendation, Physics therefore requires dynamic presentation of concepts during learning sessions to make its concepts easy for students to understand. Use of Information and Communication Technology (ICT) like computer simulation offers in-depth explanation of some seemingly abstract Physics concepts of to make them concrete in the laboratory and classroom and build appropriate scientific skills among the students in secondary school for higher study and effective knowledge transfer for technological advancement (Tamunoiyowuna & James, 2016). Information and Communication Technology (ICT) in the form of computer simulation has contributed immensely to empower the new millennium students' acquisition of relevant science process skills in learning such as collaborative skill, reflective skills and ability to scaffold learning in Physics (Adeyemo, 2011). According to Mengistu and Kahsay (2015),

computer simulation in defined as models of a system input into the computer in the form of a program or mathematical description displayed on a computer screen for learners to view. Furthermore, computer simulation is defined as a model of a system designed for purpose of understanding the behaviour of the system and for evaluating various strategies within the limit imposed by a set of criteria for the operation of the system Kahiru (2014). Computer simulation allows students to observe and analyze situations that would be too difficult, too long and dangerous to perform in real situation. Liu and Hmelo-Silver (2019), opined that unlike conventional teaching strategy which uses still pictures, words and gesture; making it hard to convey abstract fundamental concepts to students, computer simulation serves as versatile visual aid, increasing communication and allowing for interactive engagement through dynamic lecture demonstration and concept test, simplifies concepts in order to reach predetermined learning goal and creates virtual experiments and inquiry in the science classroom and laboratory**.**

Also, Scalise et al. (2011) revealed that computer simulation facilitates teaching by creating a common virtualization between students and instructor which facilitates interactions between students and instructor, enhancing group activities, enabling learning at ones pace when students learn using computer simulation applets themselves. Furthermore, Dejong et al. (2013) opined that computer simulation reduced length and time of laboratory work when used as preparatory experience before actual practical. Computer simulation serves as alternative tool for learning where real equipment is either not available or nor in-practical to set up and can change variables which would be difficult to change with real apparatus to respond to students' questions effectively (Logar & Savec, 2011). Furthermore, Computer Simulation enables students in engineering to observe and test specific designs to eliminate possible areas of stress, danger, examine force responses and other physical variables and provides leaner centred environment that allow students to explore and manipulate variables of a system and test hypothesis before its actual implementation and construction (RuttenVan Jolingen & Van Der Vern, 2012). Moreso, Nwanne (2017) affirmed that Computer Simulation has the potential to enhance students participation in the classroom, creates motivation and multiple science learning goals, science process skills, creates learning environment that gives rooms for the leaner to scaffold hidden features of abstract concepts to gain better understanding of the concepts presented during study. Also, Aina (2013), describes Computer Simulation as an aid teaching and learning. CSAI which can come in form of CD plate or internet simulations programs keyed into the computer which could be assessed by a user to learn and solve specific

problems, improve learning in different areas of study, take the leaner from abstract to concrete real experience, enhances leaners competence, academic achievement, interest, understanding and retention of concepts in Physics.

Traditional Lecture Teaching Method TLTM in this study is described as a teaching method that is teacher centred where learners learn as passive participants; which involves a teacher presenting information to the students in order to attain a predetermined instructional goal with no adequate attention given to learners' individual differences. In some cases, the teacher may demonstrate using traditional materials and students are not given the platform to ask questions and explore their opinions in the learning situation. Logar and Savec (2011) described TLTM as a method of teaching which involves a teacher transmitting information about a subject matter and content verbally to the students and it involves writing on the chalk board with traditional instructional materials. It also involves students listening and taking note of facts considered important.

Furthermore, Omivirhiren (2013) opined that TLTM helps leaners to develop communication skills such as note taking, listening skills and summary writing but stressed that it has limited use in Physics learning and other science subjects as it involves more of chalk board activities, does not give enough room for students with difficulties to ask questions to understand concepts taught by the teacher. As a result, it may lead to anxiety, boredom and diminish interest in learning. In accordance with the forgoing, Parhi (2013) stressed that misconceptions in physics are not effectively corrected using TLTM which is didactic, teacher centred and leads to poor performance in science subjects.

The concept of achievement is another important aspect of this study. In an examination, the leaners ability to exhibit a high level of mastery of concepts in form of high grade scores among many in a set shows that the individual has relatively made some achievements. According to Akani (2015), achievement is the ability of a student to study, retain and remember facts and being able to communicate same written or orally in an examination condition. On the contrast, academic achievement is seen as the measure of a leaners' ability to apply learnt concept satisfactorily and effectively in reality (Babajide, 2010). Also, academic achievement can equally be viewed as a measurable index which can be ascertained by testing and plays a

significant role in any educational system; depicting the level a learners' cognitive, affective and psychomotor domains abilities came into play in learning which can be seen as the end point of academic assessment exercises in education (Parhi, 2013). The cognitive domain ability shows the learners reasoning and thought level, the effective domain deals with the attitude of the leaner such as feelings and emotions while the psychomotor domain is concerned with learners' physical abilities and manipulative skills.

Academic achievement in Physics demands that the leaner to be strongly in the three domains of learning in education and be successful in both the practical and the theoretical aspect. Computer simulation as an aid to learning is one of the educational technologies which could have the potential effect to correct misconceptions of students in Physics, scaffold hidden features of abstract systems through the use of model of such systems to improve the cognitive skills of the students and encourages collaborative learning and learning by discovery in education which in turn enhances their academic achievements (Gambari et al; 2015). In accordance with this, Alameyeseiha and Kpolorie (2013) affirmed that assessment test to determine academic achievement is vital in education; as it would be irrational to think of teaching without assessment test, measurement and evaluation.

From the psychological and sociological points of view, gender differentiates the nature and role of human beings based on sex. Sociologically, gender depicts the nature of human dressing with respect to sex, sitting posture and nature of dance of males and females in a given society. Psychologically, Parhi (2013) opined that male gender is predominantly masculine while female gender possesses a feminine nature. This physical outlook, predict possibly that male can perform better than their female counterpart in some physical task in the society and generally in education stressing that male gender performs better in certain areas like mechanical work than the female, while the female does better in certain areas like linguistics and emotion management more than the males. These misconceptions revealed that performance of the female and male genders in specific areas of human endeavours are probably relative. In Physics, relative performance of students can be attributed to some factors such as poor understanding of abstract concepts, teaching pedagogy, nature of instructional materials used to teach physics ( Babajide, 2010 ). In accordance with this, Khan (2011) opined that the challenges of gender differences can be overcome when supportive policies are made to ascertain positive expectation for academic achievement in education. In addition, most sciences subjects are perceived as more masculine subjects than other fields of study. In line

with the forgoing, Parhi (2013) opined that some female gender believes that courses like Physics, Mathematics, Engineering, and Medicine are for the male while females are inclined to areas of study such as arts, secretarial studies, Nursing, linguistics and teaching that are viewed as feminine. As a result, some female students do not engage effectively in science related studies because they psychologically regard them as masculine oriented subjects and field of endeavour. In accordance with this, Aina (2013) affirmed that when given equal opportunities, male students performed higher than the female students in sciences especially Physics and Mathematics. However, Abungu et al. (2014) opined that when exposed to similar conditions of learning, students will perform well irrespective of their gender.

Furthermore, Tolga (2011) affirmed from that computer simulation enhanced students' achievement and attitude in Physics more than traditional Physics teaching method. In line with the findings, (Sreelekha, 2018; Miriam 2015) opined that computer simulation enhances students' achievement, practical skill and understanding in Physics better than conventional practical -teaching method. Expectantly, CSAI in learning could give students equal level playing ground to learn concepts in Physics irrespective of gender in the teaching-learning processes. In line with this assertions Izzet and Ozkan (2008) opined that CSAI enhances gender parity in teaching and learning of Physics. Hence, this study focused on computer simulation in the learning of Physics; partly seeks to find out integrally if gender affects achievement of students in Physics when they are giving equal opportunities with varying learning conditions.

**Research Question:**

The following research questions with the corresponding hypotheses guided the study:

1. What are the mean achievement scores of students taught Physics using Computer Simulation Assisted Instruction CSAI and Traditional Lecture Teaching Method TLTM?
2. What are the mean achievement scores of male and female students taught Physics using Computer Simulation Assisted Instruction CSAI and Traditional Lecture Teaching Method TLTM?

**Hypotheses:**

$H_{O1}$: There was no statistically significant difference between the mean achievement scores of taught Physics using CSAI and TLTM.

$H_{O2}$. **$H_{02}$**: There was no statistically significant interaction effect between teaching strategies (CSAI & TLTM) and Gender on the mean achievement scores of students taught physics using CSAI and TLTM.

**Methododolgy**

The pre-test-post-test quasi-experimental research design involving two non-randomized intact classes grouped into experimental and control groups and a population of 3480 senior secondary school two (SS2) Physics students in Abia state (SEMB, 2021); were used for the study. Simple random sampling technique was used to sample Ohafia education zone out of the three education zones in Abia state. Also, simple random sampling technique was used to sample the two LGAs and two schools used for the experimental group and control group.

The sample size was 93 SS2 Physics students. The control group has 46 students comprised of 18 males and 28 females while the experimental group has 47 students comprised of 20 males and 27 females. The instrument used for data collection is the Physics Achievement Test PAT adapted from WAEC past question papers. The reliability of the instrument was calculated using Kudar-Rechardson (KR-20) formula and a reliability coefficient of 0.82 was obtained. The PAT was face and content validated by three experts in the field of science education. The students' class teachers were trained by the researcher as research assistants before the commencement of the study. The CSAI was presented to the students using a projector on a white screen by the research assistants. During the learning sessions, only relevant sections of the lesson that require computer simulation were presented to aid explanation and students understanding. The Pre-test assessments were administered to both groups before treatment followed by the Post-test administered after treatment and the data were collected at the spot in all cases by the research assistant in each of the schools used. The data collected were analyzed using mean and standard deviation to answer the research questions while ANCOVA at (0.05) level of significance was used to test the hypotheses.

**Result:**

**Research question 1:** What are the mean achievement scores of students taught Physics using computer Simulation Assisted Instruction CSAI and Traditional Lecture Teaching Method TLTM?

**Table 1: The mean Achievement Scores of Students taught Physics with Computer Simulation Assisted Instruction and Traditional Lecture Teaching Method**

| Teaching Method | N | Pre-test Mean Score | SD | Post-test Mean Score | SD | Mean gain Score |
|---|---|---|---|---|---|---|
| **TTM** | 46 | 42.21 | 7.50 | 55.50 | 7.99 | 13.29 |
| **CSAI** | 47 | 41.88 | 7.47 | 58.40 | 8.10 | 16.52 |

The mean gain score of 16.52 obtained by the students in Experimental Group and13.29 for the Control group showed that that teaching strategies CSAI and TLTM enhanced mean achievement of students in Physics in both groups but the CSAI enhanced achievement of the EG students with mean achievement score of 58.40 more than that of the CG students with mean achievement score of 55.50.

**$Ho_1$:** There was no statistically significant difference between the mean achievement scores of students taught Physics using CSAI and TLTM.

**Table 2: Analysis of Covariance (ANCOVA) for the Mean Achievement Scores of Students Taught Physics with Computer Simulation Assisted Instruction CSAI and Traditional Lecture Teaching Method TLTM.**

| Source of Variation | Sum of Square | df | Mean Square | F | p-value Decision |
|---|---|---|---|---|---|
| Corrected Model | 328.767 | 2 | 164.384 | 2.569 | 0.82 |
| Intercept | 3772.540 | 1 | 3772.540 | 58.965 | 0.000 |
| Pre-test | 132.683 | 1 | 132.683 | 2.225 | 0.153 |
| Group | 206.337 | 1 | 206.337 | 3.225 | 0.076 |

| | | | |
|---|---|---|---|
| Error | 5758.136 | 90 | 63.979 |
| Total | 307902.000 | 93 | |
| Corrected Total | 6086.903 | 92 | |

a. R Squared =.054 (Adjusted R Squared = .033), NS = Not Significant

**Table 2** showed that the probability value associated with the calculated $F_{cal}$ (3.225) for the mean achievement of students of the experimental group and control group is 0.076. This value is greater than (0.05) level of significance. Hence, the $H_{01}$ was not rejected. This implies that there was no statistically significant difference between the mean achievement scores of students taught Physics with CSAI and TLTM.

**Research question 2:** What are the mean achievement scores of male and female students taught Physics using Computer Simulation Assisted Instruction and Traditional Lecture Teaching Method?

**Table 3: Mean Achievement Scores of Male and Female Physics Students Taught Physics Using Computer Simulation Assisted Instruction and Traditional Lecture Teaching Method.**

| Method/ Interaction | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| TLTM | Female | 54.89 | 7.38 | 28 |
| | Male | 56.50 | 9.08 | 18 |
| | Total | 55.70 | 8.03 | 46 |
| CSAI | Female | 57.26 | 7.38 | 27 |
| | Male | 60.05 | 8.91 | 20 |
| | Total | 58.66 | 8.10 | 47 |
| Interaction effects | Female | 56.05 | 7.41 | 55 |
| | Male | 58.37 | 9.05 | 38 |
| | Total | 57.00 | 8.15 | 93 |

**Table 3** showed that male and female students of the experimental group had mean achievement scores of 60.05 and 57.26 while the male and female of the control group had mean achievement scores of 56.50 and 54.89. This showed that teaching strategies had positive effect on male and female students' mean achievement scores on both group with students of the experimental group having more mean achievement scores than the male and female students in the control

group. The pooled mean of 58.37 for male and 56.05 for female indicate that the teaching strategies had positive effect on mean achievement scores of male and female students of the two groups when students are exposed to CSAI and TLTM in Physics learning but in favours of male and female students in the experimental group. This revealed that CSAI enhances gender parity among students in then learning of Physics.

**$H_{02}$**: There was no statistically significant interaction effect between teaching strategies (CSAI & TLTM) and Gender on the mean achievement scores of students taught physics using CSAI and TLTM.

**Table4: Analysis of Covariance (ANCOVA) for the Mean Achievement Scores of Male and Female Physics Students taught Physics using CSAI and TLTM**

| Source | Type III Sum of Squares | Df | Mean Square | F | P-value |
|---|---|---|---|---|---|
| Corrected Model | 2922.742[a] | 4 | 730.685 | 20.149 | .000 |
| Intercept | 609.383 | 1 | 609.383 | 16.804 | .000 |
| Pretest | 2606.055 | 1 | 2606.055 | 71.863 | .000 |
| Group | 20.951 | 1 | 20.951 | .578 | .449 |
| Gender | 10.287 | 1 | 10.287 | .284 | .596 |
| Strategies(*)Gender | .735 | 1 | .735 | .020 | .887 |
| Error | 3191.258 | 88 | 36.264 | | |
| Total | 308271.000 | 93 | | | |
| Corrected Total | 6114.000 | 92 | | | |

**Table 4** showed that the probability value associated with the calculated $F_{cal}$ (0.902) is 0.887. The P (0.887) is greater than the (0.05) level of significance. Hence the $H_{02}$ was not rejected. This implies that there was no significant interaction effects of teaching strategies and gender on students' mean achievement scores in Physics when exposed to CSAI and TLTM. This indicates that gender of the students did not actually combine with teaching strategies to affect male and female students' achievement in Physics and the observed positive effects were due to the teaching strategies used but in favour of the experimental group.

**Discussion**

Table 1 showed that there was no statistical significant difference between the achievement of students in Physics when expose to CSAI and TLTM. These implied that both CSAI and TLTM

strategies equivalently enhanced achievement of students in Physics. However, Table 1 showed that CSAI enhance students' achievement in Physics more than the TLTM. This was attributed to the potential of simulation to create a game like environment with animation, making students to visualize models of a system, become reflective and interactive in discussion. It also helps them to form mental pattern (gestalt) of the Physics concepts presented. The findings of this study were consistent with previous findings which showed that CSAI strategy enhanced students' understanding and achievement in Physics more than conventional (traditional) teaching method strategy (Adeyemo, 2011; Tolga, 2011; Miriam, 2015; Sreelekha, 2018).

This is however, at variance with the findings of Candida et al. (2014) who found that there was significant difference between students' conceptual understanding in Physics comparing students exposed to conventional teaching method and computer simulation strategy.

Table 4 showed that there was no statistical significant interaction effect of teaching strategies and gender on achievement of student in Physics when exposed to CSAI and TLTM. This revealed also, gender did not actually combine with teaching strategies to enhance students' achievement in Physics. Rather, the observed difference in students' achievement was due to teaching strategies used in favour of the experimental group exposed to CSAI. More so, Table 4 showed that teaching strategies had positive effect on male and female students' achievement in Physics but in favour of male and female students exposed to CSAI. This indicates that CSAI enhances gender parity in Physics learning in collaboration with the findings of Izzet and Ozkan (2008) who opined that computer simulation enhances gender parity in Physics. The findings of the study were in contrast with the findings of Abungu et al. (2014) who found that there was difference between the performance of male and female students in Physics under same conditions of learning.

**Conclusion**

Computer simulation assisted instruction CSAI strategy was found to enhance students' achievement in Physics comparatively than the traditional lecture teaching method TLTM. Gender did not combine with the teaching strategies CSAI and TLTM to enhance male and female students' achievement in Physics, rather the positive effect observed was attributed to the teaching strategies used in favour of the study CSAI strategy. This revealed that CSAI enhances gender parity more than the TLTM in the learning of Physics in senior secondary schools in Abia State.

## Recommendation

Based on the findings of this study, the following recommendations were made.

1. Curriculum planners should incorporate CSAI into the secondary school Physics curriculum to ensure teachers adopt it in the teaching and learning of Physics.
2. Computer simulation design should be included as a course of study in Physics curriculum to enable students in science education programs in colleges of education and universities to develop skills is computer simulation design and development.

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