Effects of Computer Simulations on Senior Secondary School Students' Achievements in Practical Physics in Educational District III, Lagos State, Nigeria

Dr. Sreelekha Jayantha Kumar[1]

[1] University of Lagos, Nigeria.

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Abstract

The study was designed and conducted to determine the effectiveness of Computer Simulations on Senior secondary School students? achievements in practical physics in Educational district III, Lagos state, Nigeria. A non-randomized pre-test, post-test control group quasi-experimental research design was adopted for the study. A sample of 219 Senior Secondary Two (SSII) physics students, drawn by multistage sampling method from six co-educational schools in Educational district III was used for the study. Three research instruments: Practical Physics Achievement Test (PPAT), Practical Skill Rating Scale (PSRS) and Students? Attitude Inventory Scale (SAIS) were validated by experts and used to collect data for the study. The data collected was analyzed using Analysis of Covariance (ANCOVA) and Estimated Marginal Means at 0.05 level of significance. Graphical illustrations were used to further explain the interaction effect. The study revealed that the students in the experimental group (Computer Simulations) instructional strategies had a higher mean in both the achievement and acquisition of practical skills than their counterparts did in the control group (Conventional) instructional strategy.

Index terms— computer simulations, practical skills, practical achievement, learning.

Graphical illustrations were used to further explain the interaction effect. The study revealed that the students in the experimental group (Computer Simulations) instructional strategies had a higher mean in both the achievement and acquisition of practical skills than their counterparts did in the control group (Conventional) instructional strategy. Attitude had no significant main effect however; there were significant interaction effect of treatment and attitude on the Senior Secondary Students' achievement in Physics practical. Hence, this study suggested the need for physics teachers to lay less emphasis on Conventional laboratory method, which was expository in nature.

Keywords: computer simulations, practical skills, practical achievement, learning.

1 I.

Background to the Study hysics is the backbone of technological innovations. It has empowered the new millennium students' acquisition of relevant skills such as Collaborative Learning Skills. Therefore, every child should be given the opportunity to acquire at least the basic knowledge and the concept of Physics as a science subject (Adeyemo, 2011). Physics, being a science subject, constitutes two aspects: the theoretical aspect and the practical aspect. Besides, practical work plays a positive role in science teaching and learning by making it comparatively easier to understand; and can strengthen students' content knowledge (Banu, 2011) (Abimbola, 1994;Aladejana & Aderibigbe, 2007) or delay in the conduct of practical activities until the final external examinations are near (Abakpa, Achor & Odoh, 2016;Akinbobola, 2015;Babajide, 2010 ;Stephen &

Mboto, 2010). This delay might enable students to follow the instructions given in practical Physics question paper finishing one-step after another; however, it is not necessary that they develop deeper understanding of the experiment (Logar & Savec, 2011). Another reason might be teachers' demonstration, which makes students passive **??**Omorogbe & Celistine, 2013) or lack of functional Physics laboratory and inadequate equipment for practical Physics in most Nigerian secondary schools (Adegoke & Chukwunenye, 2013). In addition to all other reasons, the fact that the students were taught with conventional methods instead of using laboratoryassisted instructional strategies (Abungu, Okere & Wachanga, 2014) could also contribute to the list of reasons. That is, students are not exposed to efficient pedagogies and presenting of information to learners (Buabeng, Ossei-Anto & Ampiah, 2014).

Physics, as a practically-oriented subject, requires continuous demonstrations with laboratory activities to explain some seemingly abstract concepts and to instill appropriate scientific skills needed for higher study and, consequently, technological advancement of the nation (Tamunoiyowuna & James, 2016). In order to tackle the problems highlighted so far, the study integrated practical instructional strategies with Computer Simulations against the conventional method of teaching Practical Physics in the laboratory. During the practical Physics sessions, the teacher demonstrates the experiment using Computer Simulation in the experimental group. The strategies would help the students to acquire more content knowledge and better knowledge retention as against the conventional method of demonstration.

Computer Simulations: are done by the use of the computer to predict the outcome of a real life situation by using a model of that situation. Simulations allow students to model the process of developing hypothesis, changing variables and observing the results, accumulating the data, resetting the value of variables, then running the simulation to test the hypothesis (Nesbit-Hawes, 2005).

Moreover, simulation speeds up teachers' educational potential and students' learning thereby allowing students to learn by discovery methods (Hughes & Overton, 2009;Hursen & Asiksoy, 2015). Hursen and Asiksoy (2015) and **??**askin and Kandermir (2010) in their studies found out that students who were taught using simulations were more successful than the students who were taught by the traditional approach in Physics. Besides, there is evidence that Simulations had shown a greater impact on students' achievement in other science subjects.

Huppert, Lomask and Lazarowitz (2002) investigated the impact of a Biology simulation on high school students' academic achievement and the findings indicate that the achievement of students using the simulation was higher than those not using the simulation.

Plass, Milne, Homer, Schwartz, Hayward, Jordan, Verkuilen, Ng, Wang and Barrientos (2012) investigated the use of a sequence of simulations for Chemistry learning and their findings, supported the effectiveness of simulations as a teaching tool in a classroom context.

2 Conventional Laboratory Method:

The Conventional Laboratory Method which is teacher centered is also expository in nature (Pyatt &Sims, 2007). The learner has to follow the teacher's instructions or the procedure given. The outcome is predetermined by the teacher and may be already known to the learner. This method does not promote the development of students' thinking skills: its 'cookbook' nature emphasizes the mechanical following of stipulated procedures that include collection of data in order to verify or demonstrate principles described in textbooks.

Alongside the different practical instructional strategies, the study also investigated the moderating effects of Attitude on the two dependant measures (achievement and acquisition of practical skills). Attitudes are general dispositions that stand behind people's evaluations and emotions (Zeidan & Jayosi, 2015).

Musasia, Abacha and Biyoyo (2012) in their study proved that, the girls who carried out practical investigations had developed better attitudes because of practical based instruction in Physics. Kaya and Boyuk (2011) in their findings stated that Physics lessons being held in the classroom on the sole theoretical basis is one of the factors that influence attitude of the students toward these lessons in a negative manner. Ye?ilyurt (2004) in his study developed an attitude questionnaire and applied to identify student teachers' interests and attitudes for basic Physics laboratory. The outcome of the study was that students were successful in undertaking basic Physics laboratory experiments, but they exhibited unfavorable attitudes towards laboratory experiments.

The teaching of Practical Physics is the backbone of Physics as a science subject. This is because practical work assists in arousing and sustaining the students' interest as well as cultivating scientific attitude to Physics and its related phenomena (Musasia, Abacha & Biyoyo, 2012; Ojediran, Oludipe & Ehindero, 2014). Besides, for a Physics student to be successful, the student needs to perform very well in the practical aspect as much as the theoretical aspect (Godwin, Adrian & Johnbull, 2015). If this is the case, there is an urgent need to tackle the present precarious performance situation regarding the decline in students' achievement in WAEC Practical Physics examination (Akani, 2015). In the aforementioned exam, the WAEC Chief Examiners Report of 2013, 2014 and 2015 averred that several factors were attributed to the students' poor achievement in practical Physics, one of such is the tediousness of conventional strategy of demonstration of Physics experiment, as this strategy makes lab exercises not necessarily contribute to the enhancement of practical abilities or content knowledge, rather it leads to just "task completion" or "manipulating equipment" (Haagen-Schuetzenhoefer, 2012).

This calls for Computer Simulations that will help the students to be suitably prepared for West African Senior Secondary School Certificate Practical Examination to improve their achievement in practical Physics as well as acquire practical skills. The following null hypotheses were tested in the study:

H 02 : There is no significant main effect of attitude on students' (a) achievement in practical Physics (b) acquisition of skills in practical Physics.

H 03 : There are no significant interaction effects of treatment and attitude on students' (a) achievements in practical Physics (b) acquisition of skills in practical Physics.

III.

3 Methodology

This study adopted a non-randomized pre-test, post-test control group of quasi-experimental research design using a 3 * 2 * 2 factorial representation. The independent variables of this study are the different laboratory instructional strategies: Simulation strategy and Conventional method. The Moderator variables that intervene with independent variable are Attitude at two levels (positive and negative).These variables are dependent on the dependent variable, which are the Achievement scores and acquisition of Practical skills. Lagos is a cosmopolitan city; a former capital of Nigeria that is divided into six education districts. The study was conducted in Educational district III of Lagos State. The Educational district III covers four (4) zones namely Epe, Eti-Osa, Ibeju-Lekki and Lagos Island. The population of this study comprised of all the public co-educational Senior Secondary schools in six educational districts of Lagos state. Senior Secondary Class II (SSII) students of the participating schools were used for the study. This is because the bulk of the Physics content is covered in SS2, thereby making the class more attractive to research. The sample used for the study consisted of 219 Senior Secondary Two (SSII) students who offer Physics from six co-educational schools in Educational district III. Multistage sampling method was adopted for this study. First simple random sampling was used to select Educational District III out of six educational districts because all Educational districts have schools following NERDC curriculum. Out of the four Zones in Educational District III, two zones, that is, zone two (Eti-Osa) and zone four (Lagos Island) were randomly selected. From each zone, two schools were purposively selected. The selection is motivated by decision to choose such type of schools that have qualified Physics teachers with equipped laboratories, presenting students for WAEC examination, ready to assist the researcher in carrying out the treatment and have generator installed for power supply or constant power supply during teaching hours. Simple random sampling technique was used to assign the selected schools to various strategies (balloting) as the selected schools satisfy the requirements by the researcher. In experimental group, SS group had 116 students and the control group that is CM strategy had 103 students. Four research instruments were used in this study for data collection: Instructional procedural steps (Lesson plans), Practical Physics Achievement Test (PPAT), Practical Skills Rating Scale (PSRS) and Students' Attitude Inventory Scale (SAIS).Practical Physics Achievement Test (PPAT) was adapted from WAEC Practical Physics examination which was used to measure the students' achievement and their acquisition of higher order Practical skills. The reliability coefficient of the PPAT items was determined using Kuder and Richardson Formula 20 (KR-20) as 0.71. Practical Skills Rating Scale (PSRS) adapted from Babajide (2010) was revalidated by the researcher and the reliability coefficient for each of the skills determined using the Scott Pi statistical tool was-Manipulative skills=0.81, Measurement skills=0.79, Observation skills=0.72, Mathematical Skills=0.76, Drawing Skills = 0.71, Graphing Skills=1.0 and Inferring and Generalization skills= 0.83.The reliability coefficient of Students' Attitude Inventory Scale (SAIS) determined by the researcher using Cronbach's Alpha was 0.76.

4 IV.

5 Development of Instructional Strategies Package

The instructional strategies package contains Simulations and Video footages of practical works in the contents of the curriculum that includes Hooke's law, Lenses and Ohm's law. The researcher prepared the Computer Simulation instructional strategy package as follows-Simulations for Hookes law experiment was adapted from Physics Educational Technology (PhET) which was developed by the Physics Education Research (PER) group of University of Colorado while Simulations for Lenses and Ohms law experiments were extracted from Board works IGCSE Triple Science software. Then the simulations were copied into CDs. The simulations were performed using the CD, a computer and projector by the teacher in front of the students.

H 01 : There is no significant main effect of treatment (Computer simulation strategy) on students' (a) achievement in practical Physics (b) acquisition of skills in practical Physics.

V.

6 Data Analysis and Presentation of Results

7 Research Question 1(a):

To what extent does the treatment (Computer simulation strategy) affect students' achievement in Practical Physics? 4.6 shows that overall mean score of 81.37and standard deviation as 6.67 for positive attitude and while negative attitude has mean score of 77.29 and standard deviation as 9.17. Overall, there is a considerable difference between the mean scores of positive and negative attitude; this means there is interaction effect between treatment and attitude on students' acquisition of practical skills.

8 Hypothesis Testing H 01 (a):

There is no significant main effect of treatment on Students' Achievements in Practical Physics. Figure1 shows that there is no significant difference in attitude when SS method is used, but comparatively when CM is used, there is a slight significant difference in their attitude, that is more of positive attitude than negative attitude.

9 H 03 (b):

There are no significant interaction effects of treatment and attitude on students' acquisition of practical skills. Table 4.9 showed that two-way interaction effect of treatment and attitude is not significan [F (2, 219) =2.225; P $<$ 0.05], it then means that the treatment does not depend on attitude to be effective. Hence, H 05 (b) was accepted.

VI.

10 Discussion of Findings

The findings of the study in table 4.1 and 4.2 show significant main effects of treatment on students' achievements and acquisition of practical skills in Practical Physics. The result of the findings in Table 4.7 and 4.9 showed that out of the two strategies, Computer Simulation had greater effect on both achievement and acquisition of Practical skills in Practical Physics. This is because Simulation creates game like environment and with animations, it helps the students to visualize abstract helping interactive and reflective. Simulations help the learners to demonstrate a clear understanding of the concept by giving the learner opportunity to repeat the entire process. The findings of this study are consistent with other previous findings which shows that simulated instructional approach fostered higher achievement than the conventional approach **??**Huppert, Mengistu & Kahsay, 2015). This study proved that SS method enhances students' acquisition of skills in practical Physics while Kaheru (2014) conducted a study where no significant effect was found in the acquisition of the skill when computer simulations were used. **??**able 4.3 and 4.4 shows that attitude may influence on students achievements and acquisition of Practical Skills in Practical Physics. However, Table 4.7 and 4.9 using ANCOVA revealed that there is no significant main effect attitude on students' achievement and acquisition of skills in Practical Physics. Hence, the results revealed in Table 4.5 and 4.6 were due to chance factor. Furthermore, ANCOVA Table 4.7 established that there is interaction effect of attitude and treatment on student's achievements while Table 4.9 showed that there is no interaction effect of attitude and treatment on students 'acquisition of practical skills in practical Physics.

VII.

11 Conclusion

This study has concluded that Computer Simulation strategy proved superior to conventional strategy in enhancing the students' achievement in practical Physics and acquisition of skills in practical Physics. It has shown that there is no main effect of attitude while there is interaction effect of treatment and attitude on students' achievement in Practical Physics.

12 VIII.

13 Recommendations

Based on the findings, the following recommendations were forwarded [1]

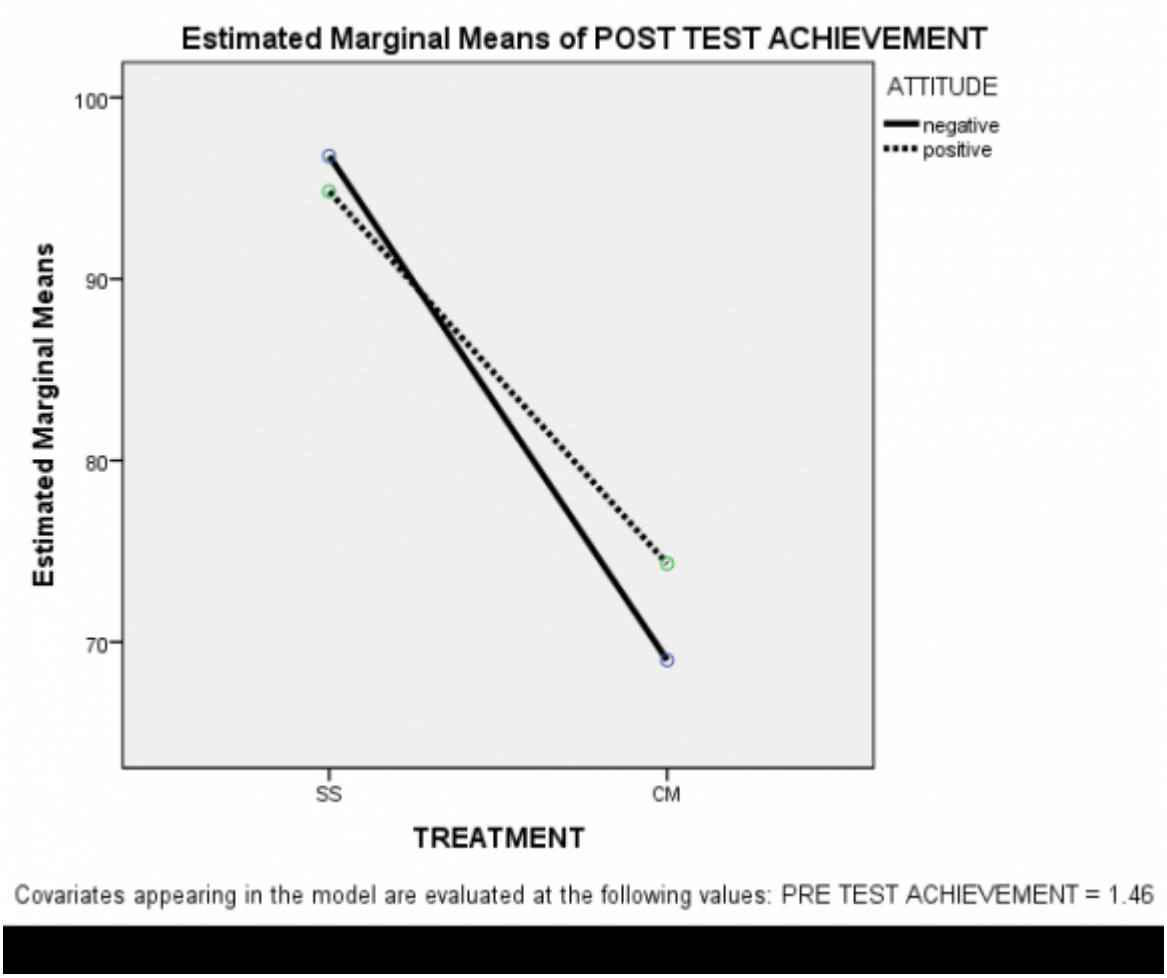

Figure 1: -

Figure 2:

Table 1.1: Mean and standard deviation scores of students' achievement in WAEC Practical Physics examination

Year	Mean (out of 50)	Standard Deviation
2006	24	9.54
2007	26	10.00
2008	23	11.49
2009	21	10.69
2010	23	9.90
2011	24	10.58
2012	30	9.95
2013	24	8.89
2014	24	10.00
2015	24	9.59

Source: http://waeconline.org.ng/elearning/Physics/physmain html

Students' weaknesses in Practical aspect might be due to inadequate integration of laboratory activities with theory classes

Figure 3:

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Research Question 1(b): To what extent does the treatment (Computer simulation and strategy) affect students' acquisition of skills in Practical Physics?

Figure 4: Table 4 . 1 :

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mean and the conventional method has the least.

Research Question 2 (a): To what extent does attitude affects students' achievements in Practical Physics?

Figure 5: Table 4 . 2 :

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Attitude	N	Pre-test Mean	Std.Dev	Mean	Std.Dev	Post-test
Positive	198	1.46	.932			
Negative	21	1.43	.926			

Table 4.3 shows that positive attitude obtained
a mean difference score of 84.35 while the negative
attitude had a mean difference score of 74.19. It is evident that there is a considerable mean difference show

Figure 6: Table 4 . 3 :

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Physics According to Attitude

Attitude	N	Pre-test Mean	Std.Dev	Mean	Std.Dev	Mean Diff.	Post-test		
Positive	292	8.24				.606	81.37	6.67	73.13
Negative	23	8.14				.655	77.29	9.17	69.15

Figure 7: Table 4 . 4 :

4

Research Question 4(a): What is the interaction effect
between treatment and attitude on students'
achievements in Practical Physics?

Figure 8: Table 4 .

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Treatment	Attitude	Mean
SS	Negative	96.60
	Positive	94.77
	Total	94.84
CM	Negative	69.06
	Positive	74.39
	Total	73.56
Total	Negative	75.62
	Positive	85.81
	Total	84.84

Table 4.5 shows that overall mean score of
85.81 and standard deviation as 11.72 for positive
attitude and while negative attitude has mean score of 75.62 and standard deviation as 13.65. Overall, there

Figure 9: Table 4 . 5 :

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Treatment	Attitu de	Mean	N	Std. Deviation
	Negative	87.60	5	3.435
SS	Positiv e	85.41	111	3.584
	Total	85.50	116	3.591
	Negative	74.06	16	7.903
CM	Positiv e	76.23	87	6.130
	Total	75.89	103	6.441
	Negative	77.29	21	9.171
Total	Positiv e	81.37	198	6.665
	Total	80.98	219	7.022

Table

Figure 10: Table 4 . 6 :

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*[Note: *Significant at P < 0.05.]*

Figure 11: Table 4 . 7 :

Estimates			
Treatment	Mean	Std. Error	95% Confidence Interval Lower Bound Upper Bound
SS	95.801[a]	1.375	93.092
CM	71.656[a]	1.368	70.043

It is evident from Table 4.8 that students who were subjected to SS method obtained the highest achievement score (M=95.801) while the CM method obtained the lowest achievement score (M=71.65

The order of magnitude of the Physics scores of the group is represented as S

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the greater eta value of 0.228 signifies the main effect of treatment. Hence, H 01 (b) was not accepted.

H 03 (a): There are no significant inte treatment and attitude on students' ac Practical Physics.

Table 4.7 showed that two-way interaction

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Source	of Squares Type III Sum	df	Mean Square	F	Sig.	Squared Partial Eta
Corrected Model	5186.328 a	4	1296.582	49.872	.000	.482
Intercep t	5853.290	1	5853.290	225.148	.000	.513
Pretest acqu isition skills	64.698	1	64.698	2.489	.116	.011
TR EATMENT	1639.146	1	1639.146	63.049	.000*	.228
Attitud e	.042	1	.042	.002	.968	.000
TR EATMENT * Attitude	57.839	1	57.839	2.225	.137	.010
Error	5563.599	214	25.998			
Total	1446961.000	219				

SS

CM

It is evident from Table 4.10 that students who were subjected to SS method obtained the highest acquisition of practical skills score (M=86.275 while the CLM method obtained the lowest acquisition of practical skills score (M=75.319).This explains why SS was more effective than CM. The order of magnitude of the Physics acquisition of practical skills scores of the group is represented as SS>CM.

H 02 (a): There is no significant main effect of attitude on students' achievements in Practical Physics.

Table 4.7 reveals that there is no significant main effect of attitude on students' achievements in Practical Physics, [F (1, 219) = 1.124; P > 0.05]. Hence, H 03 (a) was accepted.

Figure 13: Table 4 . 9 :

Figure 14:

Figure 15:

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