EFFECTS OF COMPUTER SIMULATION STRATEGIES ON STUDENTS' ACHIEVEMENT AND ACQUISITION OF SKILLS IN PRACTICAL PHYSICS.

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Abstract

The study was designed to determine the effectiveness of of computer simulations strategies on students' achievement and acquisition of skills in practical Physics. A non-randomized pre-test, post-test control group of quasi-experimental Research design was adopted, with a sample of 315 SS II Physics students drawn by Multistage sampling techniques from six co-educational schools in Educational District III for the study. Instruments such as Practical Physics Achievement Test (PPAT) with reliability coefficient of 0.71, Practical skill rating scale (PSRS) with reliability coefficient of 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 were validated by experts for data collection. Students in the experimental group Sfollowed the demonstration of the experiment using Simulation method while those in the control group followed the demonstration of the experiment using the conventional method. The data collected were analyzed using Analysis of covariance (ANCOVA) and Estimated Marginal Means at 0.05 level of significance. The major findings from this study include the following: The students in the experimental group (Simulations) instructional strategies had a higher mean in the achievement and acquisition of practical skills than their counter parts in the control group (conventional) instructional strategy. The results revealed that the use of simulations significantly improved students' achievement and acquisition of skills in Practical Physics. Hence, this study suggests the need for Physics teachers to lay less emphasis on Conventional laboratory method, which is expository in nature. Based on the findings, recommendations were made which includes Physics teachers to use Simulations into teaching laboratory Physics.

Keywords: *Practical Physics, Computer Simulations, Practical Skills*

Introduction

Physics is the backbone of technological innovations that has empowered the 21st century students' acquisition of relevant skills such as Collaborative Learning Skills. Hence, it is essential that every child should be given the opportunity to acquire at the least basic knowledge and the concept of Physics as a science subject (Adeyemo, 2011). This in turn promotes the objectives of Secondary education as stated in the National Policy on Education to provide trained manpower in the applied science, technology and commerce at sub – professional grades (FRN, 2004). The Physics curriculum in Nigeria, therefore, recommends that teachers should stimulate and enhance creativity. As teachers promote creativity in secondary school students, it would lead to permanent learning and acquisition of knowledge thereby improving their performance. This will be a way forward to produce active learners who can investigate concepts and ideas, which may lead to National and International significance. Thereby raising a generation of people who can think for themselves and also respect the views and feelings of others (FRN, 2004). Moreover, Active learners are good inquirers, knowledgeable, effective communicators who are usually good thinkers and balanced emotionally (International Baccleurate, 2007). Teachers should handle active learners by improving the standard of teaching and learning of Physics at the Senior Secondary School level in this era of knowledge explosion.

Physics, being a science subject, constitutes two aspects: the theoretical aspect and the practical aspect. Students are examined in both aspects at both internal and external examinations. WAEC Chief Examiner's Reports (2013, 2014 and 2015) stated that students show deteriorating performances in the Practical Physics at the School Certificate Examination level. This in turn would account for their poor performances in theoretical Physics. Besides, most educators would agree that in learning Physics, practical work has a very important role.

Students' weaknesses in Practical aspect was attributed to so many reasons, some of which are –

- There is inadequate integration of laboratory activities with theory classes (Abimbola, 1994; Aladejana & Aderibigbe, 2007).
- There are studies, which pointed out that most often; practical activities are delayed until final external examinations are near (Abakpa et al., 2016; Akinbobola, 2015; Babajide, 2010; Stephen & Mboto, 2010). This might enable students to follow the procedure sheet finishing one-step after another and many times, they do not develop deeper understanding of experiment (Logar & Savec, 2011).
- Omorogbe and Celistine (2013) stated that there are few classrooms with demonstrations, and when in use it is often teacher demonstration that makes students passive.
- lack of functional Physics laboratory and inadequate equipment for Physics practical in most Nigerian secondary schools (Adegoke & Chukwunenye, 2013)
- Students are not exposed to efficient pedagogies of teaching and presenting information to learners (Buabeng et al., 2014).
- Students are taught with conventional methods instead of using laboratory-assisted instructional strategies (Abungu, et al., 2014).

Physics, as a practically oriented subject, requires continuous demonstrations and many 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). This tends to give importance to laboratories which are the most important learning environments that provide the development of attitudes and cognitive levels in a positive manner and that lead students to discover scientific facts and concepts in small groups as well as providing development of social relations through activities (Bilgin, 2006).

Moreover, laboratory activities are usually more engaging than formal lectures in a conventional classroom. Thus, the Practical activity classes offer opportunities for productive cooperative interactions among students and the teacher (House of Lords, 2006; Ajayi & Osoko, 2013). There is also evidence that practical work can increase students' sense of ownership of their learning (Dillon, 2008; Musasia et al, 2012; Musasia et al, 2016) and can increase their motivation (El-Rabadi, 2013). Furthermore, the laboratory courses are given importance because it is supposed to develop students' cognitive, psycho-motor, attitudinal and affective abilities related to experimental Physics, which essentially include, conceptual understanding, procedural understanding, experimental skills acquisition and experimental problem solving ability (Hughes & Overton, 2009; Khaparde, 2004; Yildiz et al., 2005).

The use of practical work to foster and support the learning process would help to carefully plan the laboratory work of a lesson, communicate the understanding of Physics concepts, models and laws (Sassi & Vicentini, 2002). It also requires teachers to engage students in practical works by conducting experiments, with the aims of developing their scientific knowledge and experimental skills (El-Rabadi ,2013) , arousing and sustaining their interest as well as cultivating scientific attitude to Physics and Physics related phenomena (Musasia et al., 2012; Ojediran et al.,2014). Ogunleye (2009) and Simbarashe, Emmanuel and Masimba (2011) confirmed the importance of laboratory work in promoting skills necessary to solve problems and hence , prompted the teachers to provide as many laboratory experiments in any topic area(Tatli & Ayas ,2011), even if it requires designing new experiments. This would help to promote mastering basic Physics concepts, linking the theory and practical aspect of the concepts as well as for students to understand the intentions the teacher has for the activity when she/he decides to use it with a particular class at a particular time. Hence, the students taught by the laboratory experiments score significantly higher than those taught by the traditional method (Musasia et al, 2016; Godwin et al, 2015; El-Rabadi, 2013).

Therefore, the researcher aims to make the Practical work in Physics curriculum to be the nucleus of the whole reform process.The Practical work assists students to develop the skills of a good scientist, helps in understanding facts and concepts , develops interest in the subject and so encourages active learning. In line with this, Adeyemo (2011) opined that for better performance in science examinations, it is essential that secondary school students acquire the necessary skills of scientists.

Musasia, Ocholla and Sakwa (2016) proved that good learner's intelligence and skills can be expressed if dynamic and creative instructional strategies are in place. This is in agreement with several studies which proved that students taught with laboratory-assisted instructional strategies are more successful than students taught with conventional methods (Okam& Zakari,2017; Abakpa et al, 2016); Ogundiwin et al, 2015; Adeyemo & Babajide, 2014; Azar & Sengüleç, 2011; International Baccleurate, 2007). This might be because the laboratory applications could increase the permanence of students' knowledge (Azar & Sengüleç, 2011).

Those studies also claim that learning which takes place when laboratory practices are in parallel with theoretical knowledge in Physics course increases the success such that students can actually see science as one to be learnt by activity and discovery and not by memorizing notes of the theory classes (Hughes & Overton, 2009; Kaya &Boyuk, 2011). In addition to that, the effect of practical activity being more effective in fostering students' acquisition of science process skills which may eventually improve students' performance (Nwagbo and Uzoamaka, 2011).

In order to tackle the problems highlighted so far, the study integrated laboratory practical instructional strategy such as Computer Simulations against Conventional methods of teaching Practical Physics in the practical Physics classroom environment. During the Physics Practical sessions, the teacher demonstrates the experiment using Computer Simulation strategy. In case of Simulations, the demonstration is performed either using Phet interactive simulation or Board works IGCSE Science which are the computer programs prepared to support Physics laboratory and to teach physical topic. After watching the demonstration, the student then carries out the experiment there by helping the students to acquire the various Science process skills such as Manipulative, Measurement, Observation, Mathematical, Drawing, Graphing and Inferring and Generalization.

The researcher wants to see if these strategies might encourage teachers to conduct constant and regular practical classes early enough. Moreover, there is a need to activate and utilize the latest technological techniques to achieve effective science teaching/learning process (Al Musawi et al., 2015). Therefore, the study investigated the effects of Computer Simulations strategies on acquisition of practical skills thereby improving students' achievement in Practical Physics.

Statement of the Problem

The teaching of Practical Physics is the backbone of Physics as a subject. It also makes the learning of Physics pleasurable and acceptable to students. There is an urgency to tackle the present situation regarding the decline in students' achievement in West African Senor Secondary School Certificate Practical examination (Akani, 2015). This view was substantiated by the Chief examiners report of 2013, 2014 and 2015.One of the several factors that contributed to students' poor achievement in practical Physics might be poor performance in Science process skills. The decline in students' acquisition of Practical skills could be due to inadequate equipment in some schools or poor use of equipment in schools. It could also be becauase of the insufficient number of equipment in comparison with the class sizes or the teachers' occasional lack of expertise in the science process skills due to inadequate and inappropriate training (Ango, 2002).

In addition to it, the Conventional method of demonstration used by most teachers lead to other problems likes ineffective demonstration of Practical lessons. This may be because it might not be easy to demonstrate key techniques, use equipment and take measurements in a large class. It may also be for teachers to gather students to focus on what is being demonstrated to ensure that everyone can see and hear. Hence, to help either the students to be suitably prepared for studies beyond Senior Secondary Level in Physics that may be engineering or in Physics-dependent vocational courses that they need to improve their achievement in Practical Physics as well acquire practical skills. Therefore, there is a need to investigate the use of laboratory practical strategy to improve the performance of students. This may involve the use of Computer Simulations strastegy for effective delivery of practical lessons according to the need of the situation.

The Objectives of the study

i. Determine the main effect of Computer simulation strategies (SS) on students' achievement in Practical Physics.

ii. Determine the main effect of Computer simulation (SS) on students' acquisition of skills in Practical Physics.

Research Questions

In order to achieve the objectives of the study the following questions are formulated:

i. What are the main effects of Computer simulation strategy (SS) on students' achievement in Practical Physics?

ii. What are the main effects of Computer simulation strategy (SS) on students' acquisition of skills in practical Physics?

Hypotheses of the study

In the following study, the following null hypotheses were tested:

i. There is no significant main effect of Computer simulation strategy on students'achievement in practical Physics.

ii. There is no significant main effect of Computer simulation strategy on students'acquisition of skills in practical Physics.

Methods and Materials

This study adopted a non-randomized pre-test, post-test control group of quasi-experimental research design using a 3 x 2 x 2 factorial representation. The aim of the researcher is to facilitate the students in acquiring the science process skills which would enhance a greater performance in Physics Practical examination, thereby boosting their performance in Physics. The target population of this study comprised of all the public co-educational Senior Secondary schools in six educational districts of Lagos state. Multistage sampling method was adopted to select 315 Senior Secondary Two (SSII) students (164 males and 151 females) who offer Physics from six co-educational Schools in Educational district III.There are two experimental groups and one control group. The experimental group used Simulation strategy to perform the demonstration of the experiment, while the control group followed the demonstration of the experiment using the conventional method. Data were collected using two research instruments Practical Physics Achievement Test (PPAT) and Practical skills rating scale (PSRS).

Practical Physics Achievement Test (PPAT) questions were adapted from WAEC Physics practical examination from the selected Physics unit of "Hookes Law", "Lenses" and "Electric Current" and would be used to evaluate the effect of instructional strategy on students' achievement and acquisition of Practical skills. A Practical skills rating scale (PSRS) was used by the researcher during the Practical lessons to measure the Practical skills acquired by the students. PPAT was pilot tested and Kuder Richardson formula 20 (KR20) was used to establish the reliability coefficient (r = 0.71). The reliability coefficient of PSRS was found using Scott pi for each of the skills - 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 analysis of covariance (ANCOVA) was used to compare the pretest and posttest scores, with Simulation strategy used as the independent variable, the pretest scores as a covariate and the posttest scores as the dependent variable. ANCOVA takes into account the differences between the pretest means of the groups to compare their post-test scores. Then Estimated Marginal Means was done gives the adjusted means (controlling for the covariate 'pretest') for each treatment group.

Results

Table 1:Summary of 3 X 2X 2 Analysis of Covariance (ANCOVA) on the Posttest Achievement Scores of Students' achievements in Physics Practical According to Treatment, Gender, and Attitude.

Dependent Variable: Post-Test Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	24727.220[a]	2	12363.610	332.369	.000	.755
Intercept	439650.783	1	439650.783	11819.066	.000	.982
pretestachievement	17.684	1	17.684	.475	.491	.002
Treatment	23779.375	1	23779.375	639.257	.000*	.747
Error	8034.862	216	37.198			
Total	1608923.000	219				
Corrected Total	32762.082	218				

*Significant at $P < 0.05$.

Table 1 showed that there is main effect of treatment on Senior Secondary Students' achievements in Physics Practical. Further, Estimated Marginal Means (Table 2) of the output gives the adjusted means (controlling for the covariate 'pretest') for each treatment group.

Table 2: Estimated Marginal Means of Achievements in Physics Practical by Treatment.

Estimates

Dependent Variable: Post Test Achievement

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
SS	94.906[a]	.573	93.776	96.035
CM	73.494[a]	.609	72.294	74.695

Table2 shows the magnitude of the mean scores of students' Achievement in Physics Practical in each of the treatment and control group.

It is evident from Table 2 that students exposed to laboratory instructional strategies achievement was better compared to students who were taught using the conventional laboratory method. This is because

Table 2 indicated that students who were subjected to SS method obtained the highest achievement score (M=94.906) while the CM method obtained the lowest achievement score (M=73.494).This explains that SS was more effective than CM. The order of magnitude of the Physics achievement scores of the group is represented as SS>CM.

Table 3: Summary of 3 X 2 X 2 Analysis of Covariance (ANCOVA) on the Posttest Acquisition of skills in Physics Practical According to Treatment, Gender, and Attitude.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5109.387[a]	2	2554.693	97.830	.000	.475
Intercept	5924.197	1	5924.197	226.862	.000	.512
pretestacquisitionskills	74.285	1	74.285	2.845	.093	.013
Treatment	4463.338	1	4463.338	170.920	.000*	.442
Error	5640.540	216	26.114			
Total	1446961.000	219				
Corrected Total	10749.927	218				

Table3 shows the results of analysis of covariance of posttest acquisition of skills in Physics practical with the laboratory practical instructional strategies.

Further, Estimated Marginal Means (Table 4) of the output gives the adjusted means (controlling for the covariate 'pretest') for each treatment group.

Table4: Estimated Marginal Means of students' acquisition of skills in Physics Practical by Treatment.

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
SS	85.364[a]	.481	84.416	86.313
CM	76.046[a]	.512	75.038	77.055

Table 4 shows the magnitude of the mean scores of students' acquisition of practical skills in Physics Practical in each of the treatment and control group.

Table 5: Mean scores of Science process skills acquired in Physics Practical by Treatment.

Treatment Group	*Manipulative Skills*	*Measurement Skills*	*Observation Skills*	*Mathematical Skills*	*Drawing Skills*	*Graphing Skills*	*Inferring & Generalization Skills*
Experimental Group	96	99	93	95	100	96	91
Control Group	81	79	88	97	92	80	67

Table5 shows that experimental group achieved higher mean in acquiring the majority of science process skills compared to control group. This shows that the Computer Simulations strategies might be useful to facilitate in gaining skills. Both the groups reported that they acquired mathematical skills the maximum .Experimental group had acquired drawing skills,measurement skills and observation and graphing skills more compared to control group which had acquired more drawing skills.

Findings

There is significant main effect of treatment (Computer simulation strategies) on students' achievement and acquisition of skills in practical Physics. This indicated that the treatment given to the experimental group enhances their performance better than the treatment given to the control group.

Discussion

The findings of the study in table1 shows significant main effects of treatment on students' achievements in Physics practical while Table 3 shows significant main effects of treatment on students' acquisition of practical skills in Physics. That is, the findings revealed that laboratory strategies are a worthwhile exercise that helped students to enhance their achievement and the acquisition of practical skills which is in line with previous studies (Johnson, 2016; Yadav & Mishra, 2013; Ojediran, Oludipe, & Ehindero, 2014; Raimi & Adeoye,2004).

The result of the findings in Table 2 and 4 showed that out of the two strategies, Computer Simulation had greater effect on both achievement and acquisition of Practical skills in Practical Physics.Simulation method had benefitted the students more as indicated in their mean scores in table 2 and table 4. 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, Lomask & Lazarowitz, 2002; Chang, Chen, Lin and Sung, 2008; Ezeudu & Ezinwanne, 2013; Umoke & Nwafor, 2014; Mengistu & Kahsay, 2015). This finding could be attributed to the ability of Simulation to transform the abstract form of Physics concepts to Practical form with its animations and game – like environment.

In addition, it could also support interactive and inquiry learning. Besides, Simulation based learning activities help learners to acquire knowledge through the process of observation, exploration, experiencing, and reflection (Chen, Hong, Sung, & Chang, 2011). This agreed with Smetana and Bell (2012), suggested that simulations can be as effective, and in many ways more effective, than traditional (i.e. lecture-based, textbook-based and/or physical hands-on) instructional practices in promoting science content knowledge, developing process skills, and facilitating conceptual change. In line with this study , it is also proved that students can gain better understanding when they have an opportunity to use the Simulation and laboratory equipments in parallel (Unlu & Dokme, 2011; Jaakkola, Nurmi & Veermans, 2011; Adegoke & Chukwunenye, 2013; Sentongo, Kyakulaga & Kibirige, 2013; Sarabando, Cravino & Soares, 2014). On the whole, studies had proved that the use of computer simulation as a teaching aid supports students' understanding in learning the concepts (Mengistu & Kahsay, 2015; Alrsa'i and Aldhamit, 2014; Adegoke and Chukwunenye, 2013; Ezeudu & Ezinwanne, 2013; Hussain & Ali, 2012; Chang, Chen, Lin and Sung, 2008).

Conclusion

It might be concluded from this study that the effects of laboratory strategies on Senior Secondary Students' achievements and acquisition of Practical skills in Practical Physics is not comparable for students across the various treatment groups. The students in the experimental group had a higher mean in the achievement and acquisition of practical skills than their counter parts in the control group. This could imply that these strategies could contribute in transforming Physics concepts from theoretical to practical form, helping students' to understand concepts in Physics and hence motivating students to learn. This in turn assists in learning Physics to be less problematic and shedding light on how to deal with too many formulae, calculations, graphical representations and to link the mathematical aspects with Physics concepts. Thereby, helping students to become a real scientist and make sense of real world technology.

Recommendations

Based on the findings, it was recommended that Physics teachers need to include simulations into teaching laboratory Physics. These strategies are very useful in a large class where it is difficult to meet each student's need. It helps in making the students focus on the demonstration and thus making learning deeper and meaningful. In addition, it motivates the teachers to perform Physics practical by integrating it with theory. Government should aim at introducing teachers to various Professional Development Programs so that they could be continuously stimulated, trained, supported and motivated. Teacher educators should introduce Simulationsas Laboratory teaching strategy at colleges of education and faculties of education in Universities.

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