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RELATIONSHIP BETWEEN MEASUREMENT ERRORS AND SENIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN SCIENCE PRACTICAL ACTIVITIES

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Abstract

Practical activities are pivotal in the teaching and learning of science. Students' errors during practical activities in the laboratory could be detrimental to the students' overall performance in science. The study focused on the relationship between errors committed by the students in the laboratory and senior secondary school students' performance in science practical activities. The study adopted a pretest, posttest quasi-experimental design. The population for the study consisted of all the 6,413Senior Secondary School III students offering core Science subjects (Biology, Chemistry and Physics) in all the 193 public secondary schools in Ekiti State, Nigeria. The figure obtained was as at the time of investigation. The sample consisted of 88 senior secondary school three students offering core science subjects (Biology, Chemistry and Physics) found in intact classes of two government colleges that were purposely selected for the study. An instrument tagged Science Practical Questions (SPQ) was used to collect data for the study. The Science Practical Questions (SPQ), was considered valid and reliable being an adopted standardized instrument from Senior School Certificate Examination (SSCE) past Biology, Chemistry and Physics practical questions.The data collected were analyzed using descriptive and inferential statistics involving mean, standard deviation and Pearson's Product Moment Correlation (PPMC) at 0.05 level of significance. The findings of the study revealed that there was significant negative relationship between errors committed by students and their performance in Science practical. The implication of this negative relationship is that the more students commit errors in Science practical, the less their performance and vice versa. It was therefore recommended that Senior Secondary Science teachers should adopt an instructional strategy like the use of Error Correcting Instructional Package (ECIP) during science practical classes so as to reduce errors committed by students to barest minimum.

Keywords: Science, practical activities, errors, students' performance

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Introduction

Over the years, man's inquisitiveness and interminable search for knowledge have led to the accumulation of a very wide store of knowledge, known as Science. Science is an all-encompassing discipline which involves acquisition of knowledge through study and practice. Virtually all the disciplines of the world have their roots in science.

That science is important to the development and productivity of any society is far from being fallacious. Science makes life fascinating to humanity through provision of basic tools for industrialization and economic growths in the areas of information communication, agriculture, transportation, medicines, and energy, among others. This implies that human existence is actually dependent mainly on science. Perhaps, the reason researchers such as Gracy (2016); Igbaji, etal. (2017), Adesoji and Olatunbosun (2018), Ojo and Owolabi (2021) concurred to the fact that man's daily survival is basically rooted in science.

One important aspect of the nature of science is "search for cause - effect relationship" which has to do with finding out the cause or the factor(s) responsible for an observed phenomenon. For example, what causes an iron to rust? What makes some leaves green and others are not? Why water and kerosene do not co-mix? These among many other questions would science always seeks answers to, and this is what brings about practical activities in science.

The role of practical activities in school science cannot be said to be infinitesimal as it makes the "learning by doing" principle of science more meaningful. Reflecting on the importance of practical activities as key to making learning more meaningful, Rafaqat (2012) noted that teaching science without practical is like having a body without soul. In tandem with this submission, Josiah (2013) submitted that science teaching and learning without practical activities are like having a world of men without women, or vice versa. Thus, Gracy (2016) affirmed that Science students will learn and do better if teaching and learning is designed as "I do, and I understand". This is also supported by Issaka (2020) that active participation of students in practical activities will make learning in science permanent. Practical activities in science will help students to understand abstract concepts, verify theories, laws, and principles surrounding science phenomena. Hence, science teachers should be encouraged to organize practical activities for students as frequently as possible so as to develop in them, the practical skills required for utmost performance.

Science and Technology have become integral part of the world's culture. Hence, different countries of the world are embracing Science and Technology so as not to remain backward among the committee of nations. In Nigeria, one of the aims of education as stressed in the National Policy on Education is to equip students with practical skills to enable them live effectively in this modern age of Science and Technology (FRN, 2014). This further emphasized the importance of Science practical as a requirement for scientific and technological

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development. Aina and Ayodele (2018) affirmed that Science education involves the teaching and learning of scientific knowledge with the purpose of sharing the knowledge with the society for sustainable development. The current situation in Nigeria shows that, all recently established institutions of learning, both at federal and state levels are oriented towards Science and Technology with the basic entry requirement of at least credit passes in the core science subjects (Biology, Chemistry and Physics).

Nigeria society could successfully tread the same path with advanced nations of the world like China where children of secondary school age are known for building gadgets, other domestic and office appliances for both individuals and collective use (Researchers' opinion). This feat could only be achieved through science practical activities that are devoid of errors. Hence, science students need to be well equipped with the appropriate skills for carrying out practical activities in Science right from secondary school level.

Practical activities are part of the determinant factors in achieving expected science teaching and learning goals. Through practical activities, discovery, investigative and manipulative skills like calculation, problem solving and inquiry are developed in students. Through these, they are exposed to selection of appropriate apparatus and setting them up, making careful observations and giving accurate reports. Students, if properly guided, could enjoy working together as a team, to measure, manipulate equipment, classifying data, designing experiment, testing hypotheses and making inferences. Pierre (2014) and Issaka (2020) confirmed that practical activities in science help students to be creative, imaginative and able to work collectively. Since most concepts in Science can be verified through practical means, the abstractness should no longer be a major problem in the core Science subjects.

It is worthy of note that practical activities must not just be for jamboree, rather, it must be meaningful. Students need to understand why an experiment is worth doing well, and the purpose it serves for better understanding of a concept. One of the ways practical activities could be meaningful is to 'almost' be error free. Errors are omissions or mistakes made during practical activities in science which could render the whole exercise faulty and meaningless. In support of this, Owolabi (2013) submitted that students are not paying good attention to vital areas of science practical, hence they commit errors which sometimes rendered their works useless.

The performance of science students in external examinations over the years have not been very impressive. If 40% of the total mark is from practical examination as attested to by external examiners, a student would likely make distinction if he/she could avoid errors during the practical aspect of the examination, and having distinctions in science subjects would invariably boost the student's chance of gaining admission into higher institution of learning to study

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science oriented choice of course such as science education, food technology, building technology, medicine, engineering, microbiology, among numerous others.

Over the years, the performance of students in science subjects according to Chief Examiner's report of the May/June West African School Certificate Examination have not been very impressive. The percentage of students with distinction in the science subjects is very low while most of the students often record weak credit passes. The reason for this outcome could be as a result of errors they committed during the practical aspect of their examination.

Students are expected to do well in science but this is far from the reality. Several researchers have worked and affirmed that science teaching and learning cannot be effective without adequate and accurate practical activities; yet, due attention has not been given to errors committed which could render the much talked about practical activities in science invalid. This calls for attention of stakeholders. Perhaps, if appropriate approach is employed in teaching science practical, there is possibility to decimate the common errors and improve students' academic performance with skill acquisition. Hence, this research was carried out to examine the relationship between students' errors and senior secondary school students' performance in science practical.

Purpose of the Study

The purpose of the study was to examine the relationship between errors committed by students and their performance in senior secondary school science practical activities. Specifically, the study investigated the amount of errors committed by students and their performance in science practical activities.

Research Questions

The following research questions were raised for the study:

1. What is the performance of students in science practical activities?
2. What is the amount of errors committed by students in science practical activities?

Research Hypotheses

The following null-hypothesis was formulated to guide the study:

1. There is no significant relationship between errors committed by students and their performance in science practical.

Methodology

The research design for this study was a pre-test, post-test quasi-experimental design. The design afforded the researchers the opportunity to collect relevant data from intact classes that were used for the study. Pre-test was used to establish the knowledge baseline of the students as well as to

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ascertain the academic homogeneity of both experimental and control groups. The post-test was used to determine the level of students' performance in the two groups after the application of the treatment. The paradigm for the design is presented below:

G_1: O_1 X_T O_2

G_2: O_3 X_C O_4

Where:

G_1	=	Experimental Group
G_2	=	Control Group
O_1 and O_3	=	Pre-test Observations
O_2 and O_4	=	Post-test Observations
X_T	=	Treatment using Instructional Package
X_C	=	Treatment using Conventional method

The population for the study consisted of all the 6,413Senior Secondary School III students offering core science subjects (Biology, Chemistry and Physics) in all the 193 public secondary schools in Ekiti State, Nigeria. Out of this population, 88 Senior Secondary School III (SSS III) students found in intact classes of the schools selected for the study constituted the sample. Two government colleges that are of the same standard in terms of students' performance and laboratory equipment in the core Science subjects were purposely selected for the study. Selected students from the two schools were made the experimental and control groups respectively.

Science Practical Questions (SPQ) was the only instrument that was used for the study.The instrument 'SPQ' consisted of past Senior School Certificate Examination (SSCE) practical questions where activities such as observations, calculations and plotting of graphs were made possible as regards the content area of focus which are Ecology, Volumetric Analysis and Mechanics in Biology, Chemistry and Physics respectively.

The Science Practical Questions (SPQ), being an adopted standardized instrument from Senior School Certificate Examination past practical questions had been validated by the examination body.Hence, considered reliable.

The research procedure for the study was in three stages viz: the pre-treatment stage, the treatment stage and the post-treatment stage. Eight weeks were used altogether for the whole exercise. At the pre-treatment stage, the researchers sought the permission of the authorities of the two schools that were selected for the study. Then, the head of the science departments of the sampled schools were

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contacted, and the concerned science teachers (Biology, Chemistry and Physics teachers) were well informed about the purpose of the study as well as the roles they are expected to play in the course of the study. At this stage, the pre-test items (SPQ) were administered on each of the groups to test for their homogeneity. This lasted for two weeks.

The treatment stage lasted for four weeks; each group had three lessons per week, each of which was double periods, making 12 lessons. The students in the experimental group were taught using Error correcting Instructional Package (ECIP), with explanation on activities to perform to avoid or minimize errors in science practical activities. Students in the control group were taught using conventional method covering all the concept areas of focus.

At the post-treatment stage, the items in SPQ used as pre-test were rearranged and re-administered on the students in both the experimental and control groups after the completion of the treatment, and this lasted for two weeks. The data collected were analyzed and used to determine the students' performance in science practical with respect to the treatments. The research questions raised were answered using descriptive statistics involving frequency, mean and standard deviation, while inferential statistics involving Pearson's Product Moment Correlation (PPMC) was used to test the hypothesis postulated for the study at 0.05 level of significance.

Results

Descriptive Analysis

Research Question 1:What is the performance of students in Science practical activities?

In answering the question, mean scores of students in Science (Biology, Chemistry and Physics) practical before and after being exposed to treatments were computed and compared. The result is presented in Table 1

Table 1

Mean and Standard Deviation of pre-test and post-test scores of students in the experimental and control groups

Subject	Strategies	Test	N	Mean	S.D	Mean Diff.
Science	Experimental	Pre Test	56	44.19	6.18	25.78
		Post Test		69.97	4.66	
	Control	Pre Test	32	43.09	6.45	11.11
		Post Test		54.20	5.91	

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	Total	88

Table 1 reveals the performance of students in Science practical before and after treatment. The overall mean difference in the performance of students in Science practical between pre-test and post-test scores for experimental group is 25.78 while that of control group is 11.11. It shows that the use of Error Correcting Instructional Package (ECIP) influences students' performance in Science practical activities.

Research Question 2:What is the amount of errors committed by students in Science practical activities?

In order to answer the question, mean scores of errors committed by students in science practical before and after being exposed to treatments were computed and compared. The result is presented in Table 2.

Table 2

Mean and standard deviation of errors committed by students in science practical activities before and after treatment

Subject	Strategies	Test	N	Mean	S.D	Mean Diff.
Science	Experimental	Errors Before	56	59.33	4.74	29.55
		Errors After		29.78	6.55	
	Control	Errors Before	32	61.17	5.17	9.75
		Errors After		51.42	6.39	
	Total		88			

Table 2 reveals the amount of errors committed by students in Science practical before and after treatment. The overall mean difference in the reduction of errors committed by students in Science practical before and after treatment for experimental group is 29.55 while that of control group is 9.75. It shows that the use of Error Correcting Instructional Package (ECIP) minimizes errors committed by students in Science practical.

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Hypothesis Testing

Hypothesis 1: There is no significant relationship between errors committed by students and their performance in Science practical.

The result is presented in Table 3.

Table 3

Relationship between Errors Committed by Students and their Performance in Science Practical

Variables	N	Mean	Stand Dev.	r-cal	p-value
ScienceError	88	37.65	12.30	-0.966	0.000*
SciencePerformance	88	64.23	9.19		

*P<0.05

Table 3 shows that r-cal value of -0.966 is significant because the p-value of 0.000 is less than 0.05 level of significance. The null hypothesis was rejected. This means that there was significant negative relationship between errors committed by students in science practical and students' performance in science practical. The implication of this negative relationship is that the more students commit errors in science practical, the less their performance in science practical and vice versa.

Discussion

The study investigated the relationship between measurement error and senior secondary school students' performance in science practical activities. The findings of the study descriptively revealed that the mean difference in the pre-test and post-test performance of students in science practical for experimental group was higher than that of their counterparts in the control group. Also, the mean difference in the errors committed by students in science practical before and after treatment for experimental group was higher than that of control group. This implies that the use of Error Correcting Instructional Package (ECIP) positively influenced students' performance and minimized errors they committed in science practical.

The findings of the study also revealed that there was significant negative relationship between errors committed by students in science practical and students' performance in science practical. The implication of this negative relationship is that the more students commit errors in science practical, the less their performance in Science practical and vice versa. This corroborates the

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submissions of Owolabi (2013) and Jegede & Otoide (2021) that students' ability to minimize errors and get accurate results in practical activities enhances good academic performance in science subjects. In addition, the finding affirmed the earlier findings of Achor and Kalu (2014) that low percentage pass in science subjects at Senior Secondary School Certificate Examination were partially due to errors students made in practical. In the same vein, the finding of this study is in accordance with the submissions of Jegede and Otoide (2021) that science practical activities in senior secondary schools are associated with different forms of errors with its negative effect on the performance of students in science subjects in both internal and external examinations.

Conclusion

Considering the findings of this study, it was concluded that there was negative relationship between errors committed by students and their performance in science practical. By implication, the more students commit errors in science practical activities, the less their performance in science practical, and vice versa.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Senior Secondary science teachers should adopt an instructional strategy like the use of Error Correcting Instructional Package (ECIP) during science practical classes so as to reduce errors committed by students to the barest minimum.

2. Students should be encouraged to pay more attention to errors and avoid them during science practical activities.

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