TEACHERS' INSTRUCTIONAL APPROACHES AND STUDENTS' DEVELOPMENT OF SCIENCE PROCESS SKILLS IN PHYSICS IN IBIONO IBOM, AKWA IBOM STATE, NIGERIA

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Abstract

This study was designed to determine the effect of teachers' instructional approaches and students' development of science process skills in Physics in Ibiono Ibom, Akwa Ibom State, Nigeria. Three research questions and three hypotheses were formulated to guide the study. Pretest and posttest non-equivalent quasi-experimental group design was adopted for the study. The population of the study consisted of all the 397 Physics students of 2024/2025 academic session in the 12 co-educational public secondary schools in the area of study. The study sample comprised 80 Physics students drawn from SS2 intact classes of four selected secondary schools using stratified random sampling technique. Two instruments and two treatment packages (one for main practical and the other for alternative to practical) were used to gather data for the study. The instruments were subjected to face validity by three lecturers from the Department of Science Education, Akwa Ibom State University. The reliability of the instruments was established using test-re-test method and Pearson Product Moment Correlation Coefficient. A reliability coefficient of 0.72 and 0.74 were obtained for the instruments. Data collected were analyzed using mean, standard deviation and analysis of covariance (ANCOVA) statistics. The results of the study revealed that students taught using the practical performed significantly better than those taught using alternative to practical approach. Findings also revealed a significant interaction effect of gender and instructional approaches on students' acquisition of science process skills in Physics. The researcher therefore, concluded that using practical approach to teach the concept of simple harmonic motion would help to enhance students' acquisition of science process skills. The researcher therefore recommends that Physics teachers should make effective use of practical approach in teaching concepts in Physics.

Keywords: Physics, science process skills, alternative to practical and practical physics

Introduction

Education is an instrument for national development. According to FRN (2018), education is an instrument par excellence for effecting national development'. Therefore, education is the instrument used for the development of human beings in the cognitive, affective and psychomotor domains. Education can be seen as the creation of a sound mind in a sound body. Adesope (2021) views education as the process of human upbringing that involves formal, informal acquisition of knowledge, attitudes and skills for the good and growth of the individual and of the society to which the individual belongs. This is achieved through the process of

learning. In clear terms, "education can also be said to be the heart of national development and the source of quality human capital development that will propel Nigeria to be among the top 20 economies in the world" (Ugwu , 2015).

Since Nigeria gained its political independence in 1960, the country has demonstrated its commitment to science education as a tool for personal and national development. In her effort to see science education as a vehicle for national development, Nigeria fashioned out the National Policy on Science and Technology Education as part of the educational reforms in 2018 (FRN, 2018). The standards and quality of the science educational system and the capacity to innovate determine the place of growth and development of a nation. Education, to a large extent, has contributed immensely to national development in many ways. The educational system provides the needed manpower for national development. It is believed that an educated polity or nation has enough manpower and each person occupies his or her rightful position to enhance national growth (Inyang et al., 2023). Science education, as an indispensable tool, imbues the citizens and assists nations in meeting their political, moral, cultural and economic aspirations. Education imparts the individual knowledge, skills, dexterity, character and desirable values that will precipitate and galvanize national development and self-actualization. The implication is that education moulds and trains individuals to be useful in society and contribute positively to national development. The development of any country is based on scientific knowledge. Progress in science depends upon continuous scientific investigations.

The role of science in the modern era of technology is wide and profound. In line with this reasoning, Utibe and Olah, (2024) emphasized the importance of scientific knowledge in boosting national prestige, military might, national income and international rating of the country. According to the study, science gives birth to the production of microcomputers and their innovative applications earned the developed countries, such as the United States of America and Japan, national wealth, military potential and enviable national prestige. The development of any nation depends on science and technology. Science education is a distinct way of seeing, exploring and understanding reality. Science has become such an indispensable tool that no nation, whether developed or developing, wishing to progress in the socio-economic sphere will afford to relegate the learning of science in schools to the background.

Physics deals with the study of laws that determine the structure of the universe with reference to the matter and energy in the universe (Utibe et al., 2022). The importance of Physics for the development of a nation is therefore, obvious. Physics is the most basic of the sciences and its concepts and techniques underpin the understanding of the disciplines. A thorough understanding of mechanics is necessary to chemists and material scientists since the structure of every atom in the universe is determined by mechanics. Physics is also a cross-cutting discipline that has application in many sector of economic development, including health, agriculture, water, energy and information technology (Utibe & Agah, 2014). There is no doubt that a good part of the scientific knowledge is derived from the principles of physics. Indeed, the knowledge of physics has led to so many inventions such as the production, application and utilization of integrated circuits. It also accounts for the discovery and production of hydroelectric power, gas turbine and thermonuclear power plant, telephones, refrigerators, heaters and cookers.

In spite of the fact that Physics curriculum has very good and reliable objectives, it appears that the objectives of teaching Physics in secondary schools are not achieved because students do not acquire the required skills (science process skills) that will enable them to comprehend abstract concepts. The science process skills include; observing, measuring,

classifying, communicating, predicting, inferring, deferring, questioning, and controlling variables, hypothesizing, defining operationally, formulating models, designing experiments and interpreting data (Utibe & Onwioduokit, 2019). This is necessary because, integrating the science process skills into teaching requires the processes of science to be more explicit in lessons, investigations and activities already in use in science curriculum (Awolere, 2015). Fifteen of these skills had been identified by Federal Ministry of Education (FRN, 2018). These are observing, measuring, inferring, and classifying, communicating, predicting, using number, using space/time relationship, questioning, controlling variables, hypothesizing, defining operationally, formulating models, designing experiment and interpreting data. Due to the level of the students in senior secondary school classes, only eleven of the science process skills are concerned with in this study, they are observation, recording, drawing, measuring, identifying, classifying, inferring, graphing, calculating, predicting, and experimenting.

The significance of the science process skills has led to the expansion of the goals of science education to include an understanding by and development in the students of these process skills (Inyang et al., 2023). Science Process Skills (SPS) are cognitive and psychomotor skills which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication (Awolere, 2015). Science process skills are special skills that learners and teachers use in carrying out mental operation of and physical activities in the field of science. It is an attempt to make students fully aware as well as understand the ways scientists work and the need to be equipped and prepared with possible careers in science and technology that will lead to development of science process skills as it was stated in the objective statement (Inyang et al., 2022).

The Science Process Skills need to be improved upon by the students through teaching using appropriate instructional strategies. Among the strategies that have been previously used are: experiential strategy by Awolere (2015), critical exploration strategy by Oloyede (2014), puzzle-based critical thinking motivation strategies by Ogundiwin (2013), to mention a few. Despite the use of all these strategies by teachers, students still experienced a low rate and poor demonstration of science process skills in the senior secondary school certificate examination, as it was reported (WAEC Chief Examiner's reports, 2013 & 2018). The students' poor performance in science process skills acquisition in Physics has been attributed to the inappropriate teaching strategies mainly employed by most Physics teachers. Researchers have revealed that the teacher-centred strategy normally used by teachers would not assist the learners to be active recipients of knowledge, by which their performance can be improved (Utibe & Olah, 2024; Babayemi, 2014). Scholars have therefore suggested the use of active teaching and learning strategies to take care of the deficiencies, which include project strategy and inquiry strategy.

Previous researches found that science subjects are taught in an abstract way without the acquisition of science process skills (Babayemi & Utibe, 2017; Babayemi et al., 2018). WAEC Chief Examiner's Reports of 2011, 2016 and 2017 in Physics, showthat students do have problems in practical which covers science process skills. They have therefore suggested that because of the low level of practical in Physics by the students, there is the need for the Physics teachers to help students acquire these practical skills by teaching them better (Utibe & Uko, 2009). Available statistics from WAEC Chief Examiner's Reports (2010 – 2019) on senior secondary school student's performance in Physics showed a very poor performance at Senior

Certificates Examinations especially in the essay and practical assessment where learners display negative and very poor acquisition of practical skills.

The goals of practical in Physics are to improve students' understanding, develop their skills in solving problems and understanding the nature of science, by replicating the actions of scientists. Sotiriou et al. (2017) states that while solving a scientific problem, students should act like scientist and follow scientific processes. According to Utibe and Agah (2014), practical work can motivate students, stimulate their interest in learning, enhance the learning of processes of science, give them experience in using scientific knowledge and widen their way of thinking. Physics practicals are a vital part of Physics curriculum. They help students to develop their understanding of Physics, appreciate that Physics is based on evidence and acquire hands-on skills that are essential if students are to improve in Physics performance and progress in Physics. Knowledge of how teaching methods affect students' learning may help educators to select methods that improve teaching quality and effectiveness (Babikian, 2020). An appraisal of the role of physics practical as an approach or method in the learning and teaching of physics is necessary. Moreover, the alternative to practical paper is simply an alternative mode of assessment to the practical examination paper. It requires the same kind of practical work in preparation as the practical examination paper (WASSCE, 2024). Alternative to practical paper assesses students' practical skills, including both data handling and familiarity with standard laboratory equipment. Any candidates without experience of doing practical work will be disadvantaged in this paper. In addition, students without practical knowledge may not be able to perform well in the alternative to practical paper or examination.

Apeadido et al. (2024) in a study determined whether the use of practical work can enhance general science students' science process skills acquisition and academic performance students in biology at Juaben Senior High School in Ghana. The study sought to answer two research questions and test one hypothesis at a 0.05 significance level. The study used action research, and the sample consisted of 45 students, selected through convenience sampling. The study used various instruments, including pre- and post-tests, weekly intervention exercises, and scoring rubrics, to collect data. The analysis of the gathered data employed descriptive statistics and a paired sample t-test to reveal and solidify the findings of the study. According to the study's results, the use of practical work resulted in a steady increase in students' acquisition of science process skills in each cycle, and all students were able to demonstrate some degree of required science process skills at the post-test level in contrast to the pre-test level. Furthermore, the pre- and post-test outcomes of a paired sample t-test analysis with a 95% confidence level showed a significant improvement in the academic performance of the students, attributed to practical work.

Abungu et al. (2014) investigated the effect of science process skills teaching strategy on boys' and girls' achievement in chemistry in Nyando district, Kenya. The study employed quasi-experimental design. The target population consisted of students in the secondary schools in Nyando District. Purposive sampling was used to select two district secondary schools to ensure that the number of boys and girls in each school was about the same. The samples consisted of 90 Form Three students drawn from two district secondary schools. The study covered two topics selected from the KCSE Chemistry syllabus, that is, Volumetric analysis (Titration) and Qualitative analysis. .Chemistry Achievement Test (CAT), consisting of simple calculations, True and False items, and Fill-in-the-blanks, were used as a pre-test. After the administration of treatment, which lasted five weeks, the same test was administered to the two groups as a post-

test. The CAT was adapted from the KCSE Chemistry practical past papers. The reliability coefficient of 0.88 was estimated for the CAT using Kuder-Richardson (KR_{21}). The data generated were analyzed using descriptive statistics, t-test, ANOVA, ANCOVA at a = 0.05 level of significance. The results revealed that SPSTS made significant difference on achievement in chemistry between boys and girls.

Gender disparity in science generally and Physics in particular has pushed students to exhibit low motivation, decreased level of participation, boredom and behaviour problems, including class or lesson avoidance. This is evident when the teacher is doing the best presentation in class, but the student may seem to be alienated and aloof (Olah & Utibe, 2022).

Gender equity is a major issue in the ongoing reform programs embarked upon by the Federal Government of Nigeria, and it is designed to address gender imbalance in education. This is because girls' access to basic education, especially in the northern states of Nigeria has remained low (Utibe et al., 2022). One of the goals of any school teacher is to improve the performance level of students and prepare them for further education. Gender has been identified as one of the factors influencing students' achievement in sciences at the senior secondary school level (Inyang et al., 2023). Therefore, the researcher is triggered to investigate how practical and alternative to practical instructional approaches could enhance students' acquisition of science process skills in public secondary schools in Ibiono Ibom, Akwa Ibom State.

Statement of the Problem

Studies on students' performances in Physics have mostly pointed to the fact that students' science process skills' acquisition is a major contributor to students' achievement in Physics, yet has received very little attention. There is therefore a need to study the effect of students' acquisition of science process skills on their cognitive learning outcomes in Physics. The paper, therefore, determined the effect of teachers' instructional approaches and students' development of science process skills in Physics in Ibiono Ibom, Akwa Ibom State, Nigeria.

Purpose of the Study

The purpose of the study is to investigate the effect of teachers' instructional approaches and students' development of science process skills in Physics in Ibiono Ibom, Akwa Ibom State, Nigeria. Specifically, it is undertaken to:

1. Determine the difference in the mean performance scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches to teaching.
2. Compare the mean performance scores of students' in practical physics based on gender.
3. Determine the interaction effect of gender and instructional approaches on students' development of science process skills in physics.

Research Questions

The following research questions were raised in this study:

1. What is the difference in the mean performance scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches to teaching?
2. What is the mean performance scores of students' in practical Physics based on gender?
3. What is the interaction effect of gender and instructional approaches on students' development of science process skills in Physics?

Hypotheses

To guide the researcher in the conduct of the study, the following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean performance scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches to teaching.
2. There is no significance difference in the mean performance scores of students' in practical Physics based on gender.
3. There is no significance interaction effect of gender and instructional approaches on students' development of science process skills in Physics.

Methods

This study adopted a quasi-experimental research design using pretest and posttest non randomized design. The study was conducted in Ibiono Ibom Local Government Area, located in Akwa Ibom State. The population for the study comprised all the Senior Secondary two (SS2) Physics students for the year 2024/2025 session in the 12 public coeducational Secondary Schools in Ibiono Ibom Local Government Area. The actual population of Physics students in SS2 for 2024/2025 academic session is 397 (Source: Local Education Committee Ibiono Ibom local Government Area, 2024). The sample for the study comprised of 80 SS2 Physics students drawn from four schools out of the 12 coeducational public secondary schools in Ibiono Ibom. The sampling technique adopted for the study was stratified random sampling technique. Two instruments and two lesson package were used in the study for data collection. These are: Physics Practical Test on Simple Harmonic Motion (PPTSHM), Physics Alternative to Practical Test on Simple Harmonic Motion (PAPTSHM), Two Practical Lesson Packages on the Concept of Simple Harmonic Motion for Group I and II.

The PPTSHM and PAPTSHM were adopted from the WASSCE Physics practical examinations for school and external based candidates respectively. The instruments and lesson package were subjected to face validation by two Physics lecturers and one lecturer from Research, Measurement and Evaluation all from Akwa Ibom State University. To further strengthen the validity of the above instruments, the instrument was administered to a trial testing group of 30 SS2 Physics students who were not part of the main subjects for the study but who were found to be equivalent in all respects to the subjects in the study. The results obtained in this administration using a test-retest method were subjected to Pearson Product Moment (PPM) correlation coefficient (r). The result showed a reliability coefficient of 0.72 and 0.74. On

the basis of the above reliability index, the instrument was deemed suitable for use in conducting the study. The data collected in the course of the study were analyzed using descriptive statistics and Analysis of Covariance (ANCOVA), using pretest scores as covariates. All hypotheses were tested at 0.05 alpha level of significance.

Results

Research Question 1: What is the difference in the mean performance scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches to teaching?

Table 1: Summary of Mean and Standard Deviation Analysis of Students' Pre-Test and Post-Test Scores Classified by Treatment Groups

Treatment Groups	N	Pre-test		Post-test		Mean Difference
		$\bar{x}$	SD	$\bar{x}$	SD	
Practical Approach	43	1.93	0.86	22.47	1.33	8.66
Alternative to Practical Approach	37	1.97	0.93	13.81	3.17	

Results in Table 1 revealed that the difference between the mean scores of students who were exposed to practical and alternative to practical approaches after treatment was 8.66 with those in practical approach group having a mean score of 22.47 while those of the alternative to practical group had a mean score of 13.81. This result clearly proves that practical approach to teaching the concept of simple harmonic motion has a positive effect on students' development of science process skills in Physics.

Research Question 2: What is the mean performance scores of students' in practical Physics based on gender?

Table 2: Summary of Mean and Standard Deviation Analysis of Physics Students' Pre-Test and Post-Test Scores Classified by Gender

Gender	N	Pre-test		Post-test		Mean Diff.
		$\bar{x}$	SD	$\bar{x}$	SD	
Male	48	1.81	0.94	18.81	4.54	0.87
Female	32	2.16	0.77	17.94	5.52	

Results as shown in Table 2 revealed that the difference between the mean performance scores of male and female students' development of science process skills in Physics was 0.87 with male students having a mean score of 18.81 while female students had a mean score of 17.94. Since the posttest mean scores of male students is slightly greater than their female counterparts, it therefore implies that male students' development of science process skill is slightly higher than their female students' counterpart. This result clearly proves that gender has a slight effect on students' development of science process skills in Physics.

Research Question Three: What is the interaction effect of gender and instructional approaches on students' development of science process skills in Physics?

Table 3: Estimated Marginal Posttest Mean (Adjusted Mean) and Standard Deviation Scores of the Interaction Effect of Treatments and Gender Using Pretest as Covariate

Treatment	Gender	N	Post-test	
			$\bar{x}$	SD
Practical Approach	Male	25	22.52	1.36
	Female	18	22.39	1.34
Alternative to Practical Approach	Male	23	14.78	3.06
	Female	14	12.21	2.75

a. Covariates appearing in the model are evaluated at the following values: Pretest = 1.95.

The results in Table 3 shows that the mean performance scores of male students taught the concept of simple harmonic motion using practical and alternative to practical instructional approaches are 22.52 and 14.78 respectively, while those of their female counterparts are 22.39 and 12.21 respectively. This result indicates that there is no interaction of gender and instructional approaches since the mean value of male students taught using practical instructional approach is higher than that of their male counterparts taught using alternative to practical instructional approach and the mean value of female students taught using practical instructional approach is higher than that of their female counterparts taught using alternative to practical instructional approach as shown in fig. 5.

Hypothesis One: There is no significance difference in the mean performance scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches to teaching.

Table 4: Summary of Analysis of Covariance (ANCOVA) of Students' Post-Test Scores Classified by Treatment Groups and Gender

Source		Type III Sum of Squares	df	Mean Square	F	P
Covariate	Pretest	2.24	1	2.24	0.438	.510
Main Effects	Treatments	1290.37	1	1290.37	252.86	.000
	Gender	33.843	1	33.843	6.632	.012
2-Way Interactions	Treatment * Gender	20.761	1	20.761	4.068	.047*
Error		362.322	76	5.103		
Total		29195.000	80			
Corrected Total		1925.888	79			

** = Significant at P< 0.05 level of significance*

In Table 4, the calculated f-value = 252.86 at P-value = 0.000 of the main effects (instructional approaches) is less than the significance level of 0.05. Therefore, the null hypothesis is rejected. This implies that at F = 252.86, there is a significant difference in the mean scores of students' development of science process skills when exposed to practical and

alternative to practical approaches to teaching the concept of simple harmonic motion in Physics. This difference is in favour of the Physics practical group.

Hypothesis two: There is no significance difference in the mean performance scores of students' in practical Physics based on gender.

As shown in Table 4, the analysis of male and female students' science process skills scores in Physics when taught the concept of simple harmonic motion is not significant since the calculated F-value = 6.632 at p-value = 0.012 of gender is less than the significance level of 0.05. Therefore, the null hypothesis is rejected. This implies that there is a significant effect of gender on students' development of science process skills in Physics when taught the concept of simple harmonic motion. This difference is in favour of the female students.

Hypothesis three: There is no significance interaction effect of gender and instructional approaches on students' development of science process skills in Physics.

In Table 4, the calculated F-value = 4.068 at P-value of 0.047 of the interaction effects of treatments and gender is less than the significance level of 0.05. Therefore, the null hypothesis is rejected. This implies that at F = 4.068, there exists a significant interaction effect of instructional approach and gender on student's development of science process skills in Physics when taught the concept of simple harmonic motion.

Discussion

Hypothesis one sought to determine the significant difference in the mean scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches in teaching the concept of simple harmonic motion. Findings from testing this hypothesis as shown in Table 4 revealed that there is a significant difference in the mean scores of Physics students' development of science process skills when exposed to practical and alternative to practical approaches in teaching the concept of simple harmonic motion. This result could be attributed to the fact that students that were exposed to practical approach in teaching the concept of simple harmonic motion had the opportunity to carry out hands-on experiment which explores the different facets of science process skills such as observations, measurement and evaluation of the various exercises involve in the process of learning simple harmonic motion of which students in the other groups did not. The result of this finding is in line with Apeadido *et al.* (2024) whose study reported that the use of practical work resulted in a steady increase in students' acquisition of science process skills in each cycle, and all students were able to demonstrate some degree of required science process skills at the post-test level in contrast to the pre-test level.

The finding in testing of hypothesis two as shown in Table 4 revealed that there is a significant effect of gender on students' development of science process skills in Physics when taught the concept of simple harmonic motion. The hypothesis sought to determine the influence of gender on students' acquisition of science process skills in physics. The outcome of the comparison indicated that gender has an influence on students' acquisition of science process skills in physics. Although, both male and female physics students learn the same content, their level of acquisition of science process skills differ in favour of female students. This finding is in line with the study of Abungu *et al.* (2014) who reported that science process skills teaching strategy (SPSTS) made significant difference on achievement in chemistry between male and female students.

The finding in testing of hypothesis three as shown in Table 4 revealed that there is significant interaction effect of instructional approaches and gender on student's development of science process skills in physics. Thus, the use of practical and alternative to practical instructional approaches in teaching the concept of simple harmonic motion in Physics was gender bias hence the result obtained. This result could be attributed to the fact that male gender group tends to build more confidence while working within the instructional approaches group more than their female students counterparts. This of course provides them with more opportunity to engage in the instructional process using the learning resources providing by the teacher, thereby having an edge in the development of science process skills more than their female counterparts. This finding leaned support to Abungu *et al.* (2014) whose study reported that science process skills teaching strategy (SPSTS) made significant difference on achievement in chemistry between male and female students.

Conclusion and Recommendations

Based on the findings of the study, the researcher hereby concluded that students' exposure to practical instructional approach in teaching the concept of simple harmonic motion in Physics was found to be most effective in facilitating students' development of science process skill without bias to school location.

Based on the findings and the conclusions reached, it was recommended that Physics teachers should effectively utilized practical instructional approach in teaching the concept of simple harmonic motion specifically and in the general teaching of Physics concepts as it has proven to enhanced students' development of science process skills.

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