THE EFFECT OF PRIOR STUDY OF ESSENTIAL MATHEMATICS TOPICS ON THE PERFORMANCE OF SENIOR SECONDARY SCHOOL STUDENTS IN PHYSICS

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Abstract
The study investigated the effects of prior study of essential mathematics topics on the performance of senior secondary school students in physics. It was carried out in Nnewi North and South Local Government Areas of Anambra state. The population of the study comprised all the SS II physics students in the two local government areas. Three research questions and three null hypotheses guided the study. The design of the study was quasi-experimental design. The instrument for data collection was Physics Achievement Test (PAT) administered to 110 physics students drawn from four randomly sampled secondary schools out of 24 schools in the local government areas. Data collected were analyzed using mean and t-test. Finding, among others, revealed that the group taught the essential mathematics topics before physics performed better than their counterparts who were not taught such mathematics before they were taught physics. Recommendation made, among others, was that school authorities need to ensure that at the department level, test items covering mathematical concepts necessary for learning senior secondary school physics must be made use of.

Introduction
Nigeria's hope for technological advancement can be realized onlyif a proper base is created for pure and applied sciences. Physics is one of the sciences that attention needs to be focused upon in this direction. Basically, physics is regarded as a natural science that involves the study of matter and its motion through space and time, along with related concepts such as energy and force. The physical world is intrinsically mathematical and the process of modeling the world involves extracting the correct mathematical description from a physical scenario. Hence, Stanbrough (2009) opined that mathematics has long been recognized to be vital in the understanding of physics. Physics requires the ability to use algebra and geometry and to go from specific to the general and back (Reddish, 1994). The use of mathematics in pure, applied and social sciences reveals its importance as predictor of scientific competitiveness (Okeke, 2008). Hence, mathematics is regarded as the bedrock of all scientific and technological breakthroughs and advancement of any nation. No nation can develop scientifically and technologically without the knowledge and proper foundation in school mathematics (Okafor, 2005). However, from the report of Wessel (2004), representing of physics concepts using mathematics during physics instruction has been found to be challenging to students. Sobolewski and Doran (1996) pointed out that much of students' inability to understand many concepts in physics is because among other sciences, physics' demand, in terms of mathematical application, is the highest. Students have to contend with different representation such as experiments, formulas and calculations, graphs, and conceptual explanations at the same time (Angell, Guttersud, Henriksen & Isnes, 2004).

Consequently, WASC Chief

Examiners' Report (2013) attributed physics candidates weaknesses in answering some questions correctly in May/June examination, among others, to students' poor computational skills and wrong conversion of units. Therefore, where the students lack basic computational skills and cannot convert units, the teacher finds it difficult to put across to them calculation-based topics since they cannot easily understand these topics. Going further, the Chief Examiners' Report (2015) highlighted that physics students performed poorly in WASSCE May/June 2010 due to some factors which include their inabilities to sketch a distance-time graph for a particle moving in a straight line and solve problems on stress and strain. Thus, from these reports, it is obvious that poor knowledge in mathematics or poor mathematical skills spells doom to any student studying physics since this can adversely affect his/her performance in the subject.

Statement of the Problem

Some mathematical concepts occur frequently in senior secondary school physics and their knowledge appears essential for understanding senior secondary school physics' principles. However, representing of physics concepts using mathematics during physics instruction has been found to be challenging to students. As a result, lack of relevant mathematical knowledge has been speculated to cause students' poor performance in physics examinations.

Therefore, the problem of this study is, to investigate the effect which prior study of essential mathematics topics will have on the performance of senior secondary school students in physics.

Purpose of the Study

The purpose of the study was to investigate the effect of prior study of essential mathematics topics on the performance of senior secondary school students in physics. Specifically, the study was to find out:

1) the mean achievement scores of students taught relevant mathematics topics prior to physics topics and those of students not taught;
2) the mean achievement scores of high achieving students taught relevant mathematics topics prior to physics topics and their counterparts not taught;
3) the mean achievement scores of low achieving students taught relevant mathematics topics prior to physics topics and their counterparts not taught.

Scope of the Study

Physics requires a number of mathematical principles and concepts for easy comprehension. The most important of these mathematical concepts that are covered in this work are:
(i) equations, (ii) graphs, (iii) vectors, (iv) indices and logs.
In physics, the under-mentioned topics which are part of Year Two scheme of work for Senior Secondary School physics arc covered: waves, scalars, vectors and equilibrium of forces, simple harmonic motion and measurement of heat energy.

Research Questions

1) What are the mean achievement scores of students taught relevant mathematics topics prior to physics topics and those of students not taught?
2) What are the mean achievement scores of high achieving students taught relevant mathematics topics prior to physics topics and their counterparts not taught?
3) What are the mean achievement scores of low achieving students taught relevant mathematics topics prior to physics topics and their counterparts not taught?

Hypotheses

1. There is no significant difference in performance between physics students who received relevant mathematics lessons before being taught physics topics andtheir counterparts who did not receive mathematics lessons before they were taught physics.
2. There is no significant difference in the performance of high achieving physics students who received prior lessons on essential mathematics topics before physics and their counterparts that did not receive essentialmathematics lesson before physics topics.
3. There is no significant difference in performance in physics between the low achieving physics students who received prior lessons on essential mathematics topics before physics and their counterparts who did not receive lessons on essential mathematics topics before physics topics.

Method

The design of this study was quasi-experimental design involving pre-test, post-test non-equivalent control group. The population constituted all the SS 11 senior secondary school students offering physics in government senior secondary schools in Nnewi North and South Local Government Areas of Nnewi Education zone, Anambra state. Intact classes were used for the experimental and control groups. The sample of the study comprised one hundred and ten (110) senior secondary II (SSII) physics students who were drawn from four randomly sampled secondary schools out of the twenty-four (24) secondary schools in the two local government areas. Two schools were sampled from Nnewi North while two schools were selected from Nnewi South. Simple random sampling technique was used to select one intact class from each of the four schools. Two schools (one from Nnewi North and one from Nnewi South) were assigned to treatment group while the other two schools were the control group.

The instrument used for the collection of data for the study was Physics Achievement Test (PAT) comprising twenty-five (25) multiple choice objective question items developed by the researchers.All the questions asked in the Physics Achievement Test were based on the physics concepts and principles taught to the SS 11 students in the study.

The validity of the Physics Achievement Test used was ensured by subjecting it to Physics Department of Nwafor Orizu College of Education, Nsugbe. The reliability was established to be 0.85 using split-half method.

The experimental group was first given the pre-test. The group was next taught the essential mathematics topics.This was taught at the rate of three contact periods per week. Each contact period lasted one hour and forty minutes ($1^2/_3$hrs). The mathematics was taught for three weeks. The next teaching treatment given to this group was the SS 11 Physics. This was taught for the next five weeks, at the rate of three contact periods per week. Each contact period lasted for one hour forty minutes ($1\ ^2/_3$ hrs). The teaching done to this group is shown in

Table 1 below.At the end of the eight weeks when the teaching of physics was over, four days was given for the revision exercise before the post-test examination was taken.

The control group was not taught any mathematics. But at the early part of the third week the group was given the pre-test. In the following week being the 4th week, the teaching of physics began simultaneously with the experimental group. Similarly the teaching of physics was done to this group at the rate of three contact periods per week and each contact period lasted for one hour forty minutes ($1^2/_3$hrs). The teaching of physics was done for five weeks. At the end of the last week, a time span of four days was given for revision and then the post-test was taken at the same time it was happening to the experimental group .

In order to reduce threats to the experimental results of both groups, the pre-test and post-test were the same, but the post-test items were re-shuffled so that questions changed positions. As well, the colour of the post-test question papers changed.

Table 1: Weekly topic coverage for experimental and control groups

Topic	Subject	Group Applicable	Week
-Equations	Mathematics	Experimental	1st
Graph	Mathematics	Experimental	2nd
Vectors	Mathematics	Experimental	2nd
Indices and Logs	Mathematics	Experimental	3rd
Waves	Physics	Experimental/Control	4th
Scalar Vectors and			
Equilibrium of Forces	Physics	Experimental/Control	5th
Motion	Physics	Experimental/Control	6th
Simple Harmonic Motion	Physics	Experimental/Control	7th
Measurement of Meat Energy	Physics	Experimental/Control	8th

Results

Data collected were presented in tables below and were analyzed using mean and t-test statistics.

Research question 1

What are the mean achievement scores of students taught relevant mathematics topics prior to physics topics and those of students not taught?

Table 2: Mean gain scores of experimental and control groups

Group	Mean of Pre-test	Mean of Post-test	Mean Gain Score
Experimental	4.95	62.75	57.80
Control	5.76	44.98	39.22

Experimental group that received relevant mathematics lessons before physics was taught to them had mean gain score of 57.80 while the control group that did not receive relevant mathematics lessons before physics had mean gain score of 39.22.

Research Question 2

What are the mean achievement scores of high achieving students taught relevant mathematics topics prior to physics topics and their counterparts not taught?

Table 3: Mean gain scores of high achieving students exposed to essential mathematics from experimental group and their counterparts from control group not exposed to relevant mathematics.

Group	Mean of Pre-test	Mean of Post-test	Mean Gain Score
Experimental	5.00	75.67	70.67
Control	7.40	54.93	47.53

The high achieving students exposed to mathematics before they were taught physics had greater mean gain score of 70.67 while the high achieving students not exposed to mathematics before they were taught physics had mean gain score of 47.53.

Research Question 3

What are the mean achievement scores of low achieving students taught relevant mathematics topics prior to physics topics and their counterparts not taught?

Table 4: Mean gain scores of low achieving students exposed to essential mathematics topics from experimental group and their counterparts not exposed to relevant mathematical topics from control group.

Group	Mean of Pre-test	Mean of Post-test	Mean Gain Score
Experimental	3.47	53.27	49.80
Control	4.40	35.00	30.60

From the above, the low achieving students exposed to mathematics topics before they were taught physics had greater mean gain score of.49.80 while the low achieving students taught physics without exposure to mathematics had lower mean gain score of 30.60.

Hypothesis 1

Ho_1 There is no significant difference in performance between physics students who received relevant mathematics lessons before being taught physics topics and their counterparts who did not receive mathematics lessons before they were taught physics.

Table 5:T-test comparison of post-test scores of experimental group that received mathematics lesson and control group that did not receive the **mathematics lessons.**

Group	No	Mean	SD	DF	t	t
					Cal	Crit.
Experimental	55	62.727	8.481	108	12.644	1.98
Control	55	44.982	6.0332			

There *is* a significant difference between the mean achievement of post-test scores of experimental and control groups at 5% level of significance with experimental group being at higher level.

Hypothesis 2

Ho_2 There is no significant difference in the performance of high achieving physics students who received prior lessons on essential mathematics topics before physics and their counterparts that did not receive essentialmathematics lesson before physics topics.

Table 6:T-test comparison of the post test scores of high achieving students of experimental group that received essential mathematics lessons before learning physics and their counterparts from control group that did not receive any essential mathematics lesson.

Group	No	Mean	SD	DF	t	t
					Cal	Crit.
Experimental	15	75.667	5.108	28	12.758	12.048
Control	15	54.930	3.67S			

The result of the analysis shows that the performance of high achieving students of experimental group (that received mathematics lesson) is significantly different from that of high achieving students of control group (that did not receive mathematics lesson) at 5% level of significance. This is because the calculated t value of 12.758 is greater than the table value of 2.048.

Hypothesis 3

Ho_3 There is no significant difference in performance in physics between the low achieving physics students who received prior lessons on essential mathematics topics before physics and their counterparts who did not receive lessons on essential mathematics topics before they physics topics.

Table 7:T-test comparison of post-test scores of low achieving students of Group A that received essential mathematics lessons and their counterparts from Group B that did not receive essential mathematics lessons.

Group	No	Mean	SD	DF	t	t
					Cal	Crit.
Group A	15	53.267	2.828	28	18.645	2.048
Group B	15	35.000	3.678			

The result shows that the calculated t-value of 18.645 is greater than the table value of 2.048, the null hypothesis is rejected. Thus, there is significant difference between the performances of low achievers of the two groups. Low achievers of experimental group performed better than low achievers of control group.

Discussion

The results are in agreement with the findings of Funda, William & Mark (2008) that physics requires good mathematics and it cannot be learned without sound mathematics background. Also confirming this, Adeneye (2016) opined that the teaching of prerequisite mathematics concepts in physics before physics teaching should be adopted as instructional technique for enhancing meaningful learning of physics.

According to Fakunde (1997), mathematics permeates all areas of physics and the concepts and principles of physics are expressed in mathematical formulae. The significant implication is that students having proper background in the relevant mathematics topics are essential step to good preparation for studying physics in the senior secondary school.

This also confirms that for high achieving students, as well as low achieving students, learning all the necessary mathematics that is essential for physics is important before the learning of physics would commence at the senior secondary school. This will lead to the best students' achievement in physics in senior secondary school certificate examinations.

Recommendations

These recommendations have been made from the findings in this study in order to aid national development:

1. The school authorities need to ensure that at the department level, test itemscovering mathematical concepts necessary for learning senior secondary schoolphysics must be made use of. Since second year curriculum is a very important part of senior secondary school physics; any second year student who could not successfully pass the test items should not be allowed to study physics further.
2. It is recommended that within faculties and department responsible forteacher education in the nation's higher institutions, adequate provisionsshould be made so that physics education majors should have enough mathematics service courses that would make the graduands competentenough in handling all applicable mathematical complexities that wouldbe encountered in the field of practice.

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