STUDIES IN CURRICULUM

VOL. 6 September, 2012

STUDIES IN CURRICULUM

ISSN 119-0590

VOLUME 6. September, 2012

STUDENTS' EXPRESSED MATHEMATICAL ERRORS IN SOLVING NUMERICAL PROBLEMS IN PHYSICS

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Abstract

This study employed descriptive survey design to elicit students' mathematical errors in solving numerical physics problems. A total of 62 [illegible] physics students were involved in the study. Two instruments ([illegible] and [illegible]) were employed to gather data which were analysed using frequency, simple percentage and [illegible] comparative method. Findings revealed that students who performed poorly in physics test were deficient in majority of the mathematical concepts inherent in the numerical physics problems. Majority of the physics students were also prone to computational errors. The study concluded that it is imperative for teachers to emphasize mathematical relationship of physics concepts and provide numerous worked examples and exercises to boost students' confidence and computational skills.

Keywords: *Physics, Mathematical errors, Numerical Problems, Science background*

Physics and mathematics are two subjects that are intimately related and connected. Mathematical skills are required in physics for organisation and interpretation of data and for drawing meaningful conclusions about physical quantities. Mathematical skills and knowledge are widely applied in the study of physics than in any other science subject (Adeoye & Aiyedun, 2003). Scientific formulae which are common in most science courses require mathematics and consequently provide learning difficulties for a great many students ([illegible], 2004). These difficulties are a common reason for students not enrolling in science classes beyond those that are compulsory (NCCA, 2006). Learning to represent concepts using mathematics presents a considerable challenge for physics students to understand and for teachers to instruct.

In line with this statement, [illegible] and [illegible] (2001) noted that growth in competence of students in physics demands a parallel growth in competence in mathematics. Congruent to this view, Akinsola and Ogunleye (2003) asserted that students could only find the study of science subjects (particularly physics) more appealing when they perceive mathematics more interesting.

Mathematics as the language of science (Adeoye & Aiyedun 2003) plays a vital role in the study of physics and requires adequate attention of teachers for meaningful learning to take place. It is however puzzling to read that physics students are fond of committing mathematical mistakes while solving numerical problems in physics. West African Examination Council (WAEC, 2006) noted that "the marks lost by each physics student as a result of mathematical mistakes amounted to about half of the marks lost for errors in the subject". This implied that the mounting poor performance of students in physics was not solely due to lack of proper understanding of physics concepts, it could partly be due to some mathematical errors committed while solving numerical problems. Questions that readily come to mind are:

- What are these mathematical computational errors?
- What could have accounted for these mathematical errors?

Problem of the study

This study was designed to elicit students' expressed mathematical errors while solving numerical physics problems. This was achieved by identifying and determining the intensity and causes of students' expressed mathematical errors in solving numerical physics problems.

Methodology

This study employed a descriptive survey design. Twenty public schools were drawn through simple random sampling, one from each of the [illegible] Local Education District (L.E.D) in Lagos State. Intact science classes of senior secondary three (SS III) of these schools were used and a total of 625 students were involved in the study. Public schools were chosen because of easy accessibility.

Two instruments were employed. These were achievement test and unstructured interview. The achievement test was self-developed and titled "Students' Expressed Mathematical Errors in Physics" (SEMEP). This was a 20 - item free response numerical essay type of test drawn from the five major divisions of the physics curriculum (Space, time and motion, conservation principles, waves, fields and quanta). SEMEP was validated by three teachers (two physics and one mathematics). They were required to critically assess the clarity of expression, appropriateness and difficulty index of the items. A test retest reliability method within two week interval gave an index of 0.8[illegible].

Focus Group Interview (FGI) was employed in the study as a follow up to the achievement test. The essence was to clarify and ascertain the observed deficiencies from the marked script of students in the achievement test. The interview sprouted a set of questions: How often do you solve numerical questions in physics? Your computational mistakes bother on carelessness, why? Are you prone to such computational mistakes while solving mathematics problem? Do you take cognisance of the mathematical concepts required to solve a given physics problem?

Administration of SEMEP was carried out with the permission of the school principals and took place simultaneously in all the 20 L.E.D. At this time, the mock examination had been concluded. Physics teachers at the various schools obliged to conduct the test. Time allowed for administration of the test was 3 hours. FGI was carried out by identifying marked scripts of students whose performance was below 40%. These categories of students totalling 40% and divided into 5 groups for convenience sampling were gathered together for interview sessions.

Scoring of SEMEP was done by first developing a marking guide. Through content analysis, mathematical concepts (change of subject formula, fractions, graph, arithmetic operations, geometry, variation, mensuration, indices, logarithms, growth function and differentiation) inherent in every stage of the marking guide were identified and labelled. Content analysis of students' responses was used to identify students'

mathematical errors in numerical physics problems. Frequency of students expressed errors was counted for each of the mathematical concepts and percentage frequency computed. For the focus group interview, the constant comparative method (Strauss & Corbin, 1990) was used to identify major themes that emerged from students' responses. Illustrative quotes representing major themes were identified from the original interview transcripts.

Results

Table 1: Students' Mathematical Errors in Solving Numerical Problems in Physics

S/N	Mathematics Concept	Percentage of Errors
1.	Change of Subject Formula	88.0
2.	Fractions	77.8
3.	Graph	90.0
4.	Arithmetic Operations	72.1
5.	Geometry	87.7
6.	Variation	87.7
7.	Mensuration	86.7
8.	Indices, logarithm and growth function	65.0
9.	Differentiation	100.0

Table 1 shows that the percentage of errors for all the mathematical concepts listed is high. It therefore means that majority of the physics students are very deficient in the mathematical concepts listed above hence they perform poorly in physics.

The focus group interview enabled the researcher to establish the cause of the high mathematical errors observed in the scripts. The following were the excerpts from students' responses:

Poster 1: The computational mistakes you observed from the scripts is due to your carelessness, why?

Majority of the students agreed that the errors committed were due to their carelessness and not lack of understanding of mathematics involved.

I got the answer to most of the questions wrong because of the mistakes I made in the arithmetic operations [illegible]. I think I will be more careful now.

Poster 2: Do you usually take cognizance of inherent mathematics concepts involved in solving numerical problems in physics?
Majority of the students responded that:

I solve physics problems as they come to me. I do not attach any importance to the mathematics involved in solving the problem.

Poster 3: How often do you solve numerical questions in physics on your own volition?

Majority of these students rarely practice questions out of their own volition. They however agree that there is room for improvement with constant practice. The following two excerpts revealed their opinion:

I do not attempt any problem outside the homework. I rarely have enough time to do that since I have eight other subjects to read.
I have realized my problem in physics now. I think this can be corrected with constant solving of numerical problems.

Poster 4: Are you prone to such errors while solving problems in mathematics?
Majority of these students responded thus:

I do not perform well in mathematics. However, my problem in mathematics is not that of committing simple errors of calculations and computations.

Discussion of Findings

This study revealed that physics students are deficient in all mathematical concepts studied; consequently they performed poorly in physics. This is in agreement with Igwe-Nwachukwu's (200[illegible]) finding that students who perform poorly in physics have inadequate background in mathematics. This implies that majority of the students are incapable of interrelating physics variables through application of requisite mathematical domain. Students' deficiencies of these mathematics concepts affect their ability to manipulate symbolic relationship which, according to Owolabi (2004), was a major weakness of physics students. Physics as a subject involves problem solving which requires their reasoning capabilities and abstract pattern recognition. Manipulation of symbolic relationship, according to Gardner (1993), has to do with logic, abstractions, inductive and deductive reasoning. These can only be acquired through the vehicle "mathematics" which provides adequate knowledge and enhances understanding of the interrelationship between and among physics variables.

The study also revealed that physics students were prone to computational mistakes, a confirmation of WAEC's (2008) observation. This study indicated that the computational mistakes were due to students' carelessness and individual attitude to requisite mathematical link between and among the physics variables. Also students rarely practice exercises involving numerical problems in physics.

Conclusion

Attempt was made in this study to probe the interface between mathematics and physics from students' perspectives by examining computational errors committed by them. Findings showed that simple but necessary mathematical expressions were solved very poorly by physics students. This situation is alarmingly surprising and requires urgent intervention. Mathematics and physics are two subjects that are inseparable despite the fact that they are taught separately. It becomes imperative that physics teachers should recognize the complementary existing between the two subjects by emphasizing mathematical relationship of physics concepts while teaching. Physics teachers should ensure that students are engaged in numerous worked examples and exercises to boost their confidence and computational skills. It will not be out of place to provide mathematical tasks related to physics concepts prior to teaching to further solidify the prerequisite knowledge and foster proper understanding while learning is going on.

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