ASSESSING THE RELATIVE INFLUENCE OF SECONDARY SCHOOL STUDENTS' ACHIEVEMENTS IN GEOMETRY, TRIGONOMETRY AND ALGEBRA ASPECTS OF MATHEMATICS ON THEIR ACHIEVEMENT IN PHYSICS

1OLATOYE, RAFIU ADEMOLA Ph.D.; 2OLUTOLA, ADEKUNLE THOMAS Ph.D. & 3ADEROGBA, ADEGOKE ADEJI Ph.D.
1 & 2Department of Educational Foundations, Faculty of Education, Federal University, Dutsin-Ma, Katsina State, Nigeria.  
1rolatoye@fudutsinma.edu.ng; 2aolutola@fudutsinma.edu.ng
3Department of Science, Technology and Mathematics Education, College of Education, Osun State University, Ipetu-Ijesa Campus, Osun State, Nigeria.

Abstract
The study was carried out to enable the physics teachers whose students are not performing well in calculation aspect of physics know the aspects of mathematics to be revised or taught in order to enhance the students’ performance in physics. The sample consisted of 200 students randomly selected from the ten schools in Katsina metropolis, Nigeria. Two instruments were used: Mathematics Achievement Test (MAT) and Physics Achievement Test (PAT). Students’ achievement in geometry accounted for 41.9% of the total variance in students’ achievement in physics. Students’ achievement in trigonometry accounted for 29.2% of the total variance in students’ achievement in physics. Students’ achievement in algebra accounted for 31.1% of the total variance in students’ achievement in physics. There is a significant positive relationship between students’ achievement in geometry and physics (r = +0.647, p˂0.05), between trigonometry and physics (r =+0.540, p˂0.05), and between algebra and physics (r =+0.558, p˂0.05). Thus, the higher the students’ achievement in each of the concepts of mathematics (geometry, trigonometry and algebra), the higher the achievement in physics. It is recommended that physics teachers whose students are not performing well in calculation aspects of physics should emphasized more on geometry, followed by algebra and lastly trigonometry.

Keywords: Algebra, Trigonometry, Mathematics achievement, Physics Achievement

Introduction
In Nigeria, science is so important that a lot of emphasis has been laid on its teaching and learning. The major aims and objectives of science education are contained in the National Policy on Education
Science makes everyday life easier than it ever has been before. Knowledge of science is being applied in so many areas. Science education in Nigeria concentrates on the teaching of science concepts, method of teaching and addressing misconceptions held by learners regarding science concepts. Science education comprises three core subjects namely biology, chemistry and physics which are combined with education. Science education is very important to the development of any nation in many areas. If these subjects are well taught and understood by the students, a graduate of physics education can be self-employed. Many of the physics graduates already have some theoretical and practical knowledge of mechanics, electricity and electronics that are relevant to become electronic technicians, car mechanics and repairers of electrical equipment especially if they consciously acquire more practical skills outside the classroom. Aina (2009) explained that the knowledge of semiconductors taught in physics is very important in a growing economy like Nigeria. It is useful in ceramic industry and a well-trained physics education graduate can be gainfully employed in a ceramic industry.

Mathematics is also a body of knowledge essential for the achievement of a scientific/technological nation. Mathematics is one of the oldest subjects in primary and secondary school curricula. Mathematics has been the bedrock of several subjects in the school curriculum and it is indispensable to national educational goals and objectives. Mathematics is enshrined in the National Policy on Education (NPE) as a core and compulsory subject for all primary and post-primary school students in Nigeria (Federal Republic of Nigeria (FRN), 2004). This is largely because of the indispensable role it plays in the advancement of science and technology of any nation (Iyekekpolor & Bulus, 2009). In this scientific age, we cannot underestimate the importance of mathematics. Mathematics has its parts in virtually all fields of study whether mathematical or nonmathematical.

In fact, mathematics is the pivot on which all Sciences, Engineering, Bussiness and even Social Sciences revolve. Ale and Adetula (2010) stated that the line of demarcation between the developed and the underdeveloped nations is based on their level of mathematical attainment and ingenuity. According to them, mathematics is an undisputed agent of national development and wealth creation. Confirming this statement, Nosa and Ohenhen (1998) stated that evidence abound to show that nations that embrace mathematics, science and technology enjoy better standard of living and are less dependent on other nations. Adedayo (1997) stated that knowledge of mathematics promotes the habit of accuracy, logical, systematic, and orderly arrangements of facts in the individual learner. Also, mathematics encourages the habit of self-reliance and assists learners to think and solve their problems themselves. Mathematical knowledge indeed equips individuals with the skill to solve a wide-range of practical tasks and problems they may encounter in life.

Physics is an intellectually challenging subject that requires strong practical foundations and adequate mathematical skills for thorough understanding. Anyakoha (2001) conceptualized physics as factual and exact measurements. According to him, measurement is a very important aspect of physics. He affirmed
that no fact is accepted, no ‘law’ is established, unless it can be exactly measured and quantified. Physics is the scientific study of forces such as heat light, sound, or relationships between them and how they affect objects. Although students generally consider physics a more difficult subject than biology. However, the place of physics in the scheme of things as far as science education is concerned makes it imperative for students to take the subject seriously. Its importance as a discipline cannot be over-emphasized especially in the area of science and technology. Physics as a science subject, generally is very interesting, and vast, almost all aspects of life science, both living and non-living have something to do with physics, ranging from engineering to mathematics. That is why physics is mostly regarded as “central” to all sciences owing to its confluence and influence to provide human basic needs and improve the quality of life. Alukwo, Okereke and Ezekannagba (2000) defined physics as the mother of all sciences that deals with composition and changes of matter.

Poor achievement in physics could be attributed to many factors among which gender itself is considered as important. Gender refers to the social meanings attached with being a male or a female including the construction of identities, expectation, behaviours, and power relationship that are derived from social interactions (Ambe-Uva, Iwuchukwu & Jibril, 2008). Orji (2002) asserted that in Africa, especially in a traditional Nigerian setting, female and male sex roles are seen as mutually exclusive. For instance, some professions like carpentry, engineering, woodwork, metalwork and automobile engineering technologies are still regarded in some quarters as ‘no-go-area’ for women while nursing and catering professions are seen as exclusive areas for women. This perception automatically scheme female out from any consideration for serious professional disciplines even in cases where the females appear to be more brilliant than their male counterparts. Some people even believed that males performed better than females in any course that deal with calculation as observed by Okeke (2008) who reported that male candidates performed better, relative to females in subjects requiring quantitative ability. He said males show superiority in subjects that require calculations.

School type also is another factor responsible for students’ poor achievement in physics. School type is characterized by public or private. Public and private schools are institutions owned as the names denote. The public schools in Nigeria have Federal State and Local Governments as their proprietors while the private schools have individuals, associations or organizations as the owners. There are different types of private schools in terms of the quality of the teaching learning process so also there are different types of public schools. There is no doubt that the private school proprietors pay more attention to their teachers’ input into the pupils than do the public schools (Salawu & Adedapo, 2001). They also spend substantial amount of money to provide instructional materials for the teaching and learning process. They take their students out on fieldtrips, excursions and so on. This kind of prudence is absent in most public schools, and that is what makes private school different in terms of quality from public ones.
This study therefore, investigated how different concepts in mathematics (specifically, algebra, trigonometry and geometry) influence students’ achievement in physics. This is to enable physics teachers whose students are not performing well in calculation aspect of physics know the specific concepts in mathematics that can be taught or revised in order to improve their achievement.

Research Hypotheses
The following hypotheses were tested:

1. There is no significant influence of students’ achievement in geometry on their achievement in physics.
2. There is no significant influence of students’ achievement in trigonometry on their achievement in physics.
3. There is no significant influence of students’ achievement in algebra on their achievement in physics.
4. There are no relationships between each concepts of mathematics (specifically, algebra, trigonometry and geometry) and students’ physics achievement.
5. There is no significant difference between male and female school students’ achievement in i. Mathematics. ii. Physics.
6. There is no significant difference public and private school students’ Achievement in i. Mathematics. ii. Physics.

Methodology
In the study, the independent variables (students’ achievement in mathematics) and the dependent variable (students’ achievement in physics) have already occurred. Therefore, Ex-post-facto research design was adopted. Many scholars agreed that Ex-post-facto design is the best design for collecting data on variables that have already occurred. The target population for this study includes all the senior secondary schools in Katsina metropolis, both public and private. This study was carried out in ten (10) secondary schools in Katsina metropolis. In order to ensure that each school had an equal chance of being chosen, a random sampling technique was used to select these ten senior secondary schools from the twenty two schools. Twenty students were then randomly selected from each school, so a total of 200 students participated in this study.

Two instruments were used for the study. They are:
1. Mathematics Achievement Test (MAT)
2. Physics Achievement Test (PAT)

The Mathematics Achievement Test (MAT) has three concepts (geometry, trigonometry and algebra), each with 15 multiple-choice objectives test items. The total number of items on MAT is 45. The Physics Achievement Test (PAT) has six (6) concepts (electronics, mechanics, optics and light, wave and sound,
thermodynamics and nuclear physics). Each aspect of physics has 5 multiple-choice objectives test items. The total number of items on PAT is 30. The Students were asked to choose the correct answer out of the four (4) options (A-D). Students were not asked to indicate their names on the questionnaires so as to make the responses anonymous. The validation of the instrument was done through tests of validity and reliability.

In order to ensure the validity of the MAT and PAT, the researchers gave the instruments to two lecturers in the Departments of physics and mathematics in a University. The face and content validities of the instruments were ensured. The reliability coefficients of the instruments were determined using test-retest reliability method. The instruments (PAT & MAT) were administered to a set of 20 students twice with 2 weeks. The results of the first and second test outcomes were compared. The co-efficient of reliability are 0.873 and 0.820 for MAT and PAT respectively. The researcher visited the schools selected for the research, administered the questionnaires to the respondents (SS III students) and collected on the same day, after securing the consent of principals and examination officers. The data were analyzed using regression analysis for research hypotheses 1 to 3, Pearson Product-Moment Correlation for research hypothesis 4 and t-test for research hypotheses 5 and 6. The research hypotheses were tested using a two-tailed test at 0.05 level of confidence.

Results

Hypothesis One: There is no significant influence of students’ achievement in geometry on their achievement in physics.

Table 1: Influence of students’ achievement in geometry on achievement in physics

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Sum of squares</td>
</tr>
<tr>
<td>Regression</td>
<td>1814.975</td>
</tr>
<tr>
<td>Residual</td>
<td>2100.481</td>
</tr>
<tr>
<td>Total</td>
<td>4335.875</td>
</tr>
</tbody>
</table>

R = 0.647, R Square = 0.419, Adjusted R Square = 0.416, Standard Error = 3.56817, * Significant (p <0.05).

In Table 1 above, students’ achievement in geometry accounted for 41.9% of the total variance in students’ achievement in physics (R Square = 0.419, p<0.05). This percentage is significant. Good knowledge of geometry will significantly enhance students’ achievement in physics. Therefore, the null hypothesis is rejected.

Hypothesis Two: There is no significant influence of students’ achievement in trigonometry on their achievement in physics.
Table 2: Influence of students’ achievement in trigonometry on achievement of physics

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1266.015</td>
<td>1</td>
<td>1266.015</td>
<td>81.656</td>
<td>0.00</td>
</tr>
<tr>
<td>Residual</td>
<td>3069.860</td>
<td>198</td>
<td>3069.860</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4335.875</td>
<td>199</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R = 0.540, R Square = 0.292, Adjusted R Square = 0.288, Standard Error = 3.93756,
* Significant (p <0.05).

In Table 2 above, students’ achievement in trigonometry accounted for 29.2% of the total variance in students’ achievement in physics (R Square = 0.292, p˂0.05). This percentage is statistically significant. Thus, trigonometry will significantly enhance students’ achievement in physics. Therefore, the null hypothesis is rejected.

**Hypothesis Three**: There is no significant influence of students’ achievement in algebra on their achievement in physics.

Table 3: Influence of Students’ achievement in algebra on achievement of physics

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1348.474</td>
<td>1</td>
<td>1348.474</td>
<td>89.375</td>
<td>0.00</td>
</tr>
<tr>
<td>Residual</td>
<td>2987.401</td>
<td>198</td>
<td>15.504</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4335.875</td>
<td>199</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R = 0.558, R Square = 0.311, Adjusted R Square = 0.308, Standard Error = 3.88431,
* Significant (p <0.05).

In Table 3 above, students’ achievement in algebra accounted for 31.1% of the total variance in students’ achievement in physics (R Square =0.311, p<0.05). This percentage is statistically significant. Good knowledge of algebra will significantly enhance students’ achievement in physics. Therefore, the null hypothesis is rejected.

**Hypothesis Four**: There are no relationships between each concepts of mathematics (specifically, algebra, trigonometry and geometry) and students’ physics achievement.
Table 4 Relationships between Students’ achievement in each concept of mathematics and achievement in physics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Geometry</th>
<th>Trigonometry</th>
<th>Algebra</th>
<th>Physics Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometry</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trigonometry</td>
<td>0.563**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebraic</td>
<td>0.490**</td>
<td>0.471**</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Physics Achievement</td>
<td>0.647**</td>
<td>0.540**</td>
<td>0.558**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* Significant (p <0.05).

In Table 4 above, there is a significant positive relationship between students’ achievement in geometry and physics (r = +0.647, p˂0.05), between trigonometry and physics (r =+0.540, p˂0.05), and between algebra and physics (r =+0.558, p˂0.05). Thus the higher the students’ achievement in each concept of mathematics (geometry, trigonometry and algebra), the higher the achievement in physics. However, the values of the correlation co-efficients show that geometry has the highest relationship with physics followed by algebra and lastly trigonometry. The descending order of the importance of different aspects of mathematics on students’ physics achievement therefore is: geometry > algebra > trigonometry. Therefore, the null hypothesis is rejected.

**Hypothesis Five:** There is no significant difference between male and female students’ achievement in (i) Mathematics. (ii) Physics.

Table 5: Comparison of male and female students’ mathematics achievement

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>X</th>
<th>Std Dev</th>
<th>Std error</th>
<th>df</th>
<th>t-value</th>
<th>P</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Achievement</td>
<td>Male</td>
<td>102</td>
<td>15.7451</td>
<td>6.42656</td>
<td>0.63632</td>
<td>198</td>
<td>0.230</td>
<td>0.890</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>98</td>
<td>15.5408</td>
<td>6.15130</td>
<td>0.62138</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
</tbody>
</table>

NS=Not Significant (p >0.05).

In Table 5 above, there is no significant difference between male and female students’ achievement in mathematics (t=0.230, p>0.05). This implies that male and female students have the same level of achievement in mathematics. The mean scores for achievement of male and female students in mathematics are 15.7451 and 15.5408 respectively. The students’ achievement in mathematics is below average. The maximum obtainable score is 45. Therefore, male students are just as good as their female counterparts. Therefore, the null hypothesis is not rejected.
### Table 6: Comparison of male and female students’ physics achievement.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>(\bar{X})</th>
<th>Std Deviation</th>
<th>Std Error</th>
<th>df</th>
<th>t-value</th>
<th>P</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>Male</td>
<td>102</td>
<td>10.7451</td>
<td>4.61741</td>
<td>0.45719</td>
<td>198</td>
<td>-0.555</td>
<td>0.252</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>98</td>
<td>11.1122</td>
<td>4.73609</td>
<td>0.47842</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NS=Not Significant (p >0.05).

In table 6 above, there is no significant difference between male and female students’ achievement in physics \((t=-0.555, p>0.05)\). This implies that male and female students have the same level of achievement in physics. The mean scores for male and female students in physics are 10.7451 and 11.1122 respectively. The students’ achievement in physics is below average. The maximum obtainable score is 30. However, the mean score of female students is a little bit higher than their male counterparts; still male students are just as good as their female counterparts because the difference is not significant. Therefore, the null hypothesis is not rejected.

**Hypothesis Six**: There is no significant difference public and private school students’ achievement in

(i) Mathematics.

(ii) Physics.

### Table 7: Comparison of public and private secondary school students’ mathematics achievement

<table>
<thead>
<tr>
<th>Variable</th>
<th>School Type</th>
<th>N</th>
<th>(\bar{X})</th>
<th>Std Deviation</th>
<th>Std Error</th>
<th>Df</th>
<th>t-value</th>
<th>P</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Type</td>
<td>Public</td>
<td>99</td>
<td>11.8687</td>
<td>3.11889</td>
<td>0.31346</td>
<td>198</td>
<td>-10.54</td>
<td>0.00 S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private</td>
<td>101</td>
<td>19.3465</td>
<td>6.39912</td>
<td>0.63674</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S=Significant (p <0.05).

In table 7 above, there is significant difference between public and private students’ achievement in mathematics \((t=-10.536, p<0.05)\). The mean scores for the achievement of public and private students in mathematics are 11.8687 and 19.3465 respectively. This implies that private school students performed significantly far better than their public school counterparts. Therefore, the null hypothesis is rejected.
Table 8: Comparison of public and private secondary school students’ physics achievement

<table>
<thead>
<tr>
<th>Variable</th>
<th>School Type</th>
<th>N</th>
<th>( \bar{X} )</th>
<th>Std</th>
<th>Std Error</th>
<th>Df</th>
<th>t-value</th>
<th>P</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Type</td>
<td>Public</td>
<td>99</td>
<td>11.8687</td>
<td>8.7071</td>
<td>2.45886</td>
<td>198</td>
<td>-7574</td>
<td>0.00</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Private</td>
<td>101</td>
<td>19.3465</td>
<td>13.0990</td>
<td>5.2771</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S=Significant (p <0.05).

In table 8 above, there is significant difference between public and private students’ achievement in physics (t=-7.574, p<0.05). The mean scores for the achievement of public and private students in physics are 11.8687 and 19.3465 respectively. This implies that private school students performed significantly far better than their public school counterparts. Therefore, the null hypothesis is rejected.

Discussion of Findings

This study has shown that the specific concepts of mathematics (geometry, trigonometry and algebra) have significant influence on the students’ physics achievement physics achievement. This study collaborates with the opinion of Omer and Petek (1999) that mathematical ability of students seems to be the major factor influencing students’ achievement in physics. The close relationship between the two subjects was also cited by Czerniak, Weber, Sandmann and Ahern (1999) in their literature review of science and mathematics integration. They said that mathematics and physics have been closely intertwined since ancient times. The development of the different fields in physics can be attributed to the vital role played by mathematics.

From the results it was also revealed that there is no significant correlation between male and female achievement in physics and in mathematics. This implies that both genders have potential to perform well in these subjects. This confirms the findings of Daramola (1983) that gender difference has no influence on students’ performance in Basic Physics Test. Olatoye and Agbatogun (2009). Olatoye (2009a, 2009b) reported that there is no gender difference in science achievement. Even in an experimental study involving project-based and demonstration methods as treatment, Olatoye and Adekoya (2010) reported that there was no significant interaction effect of treatment and gender on students’ achievement. This implies that both male and female students are at the same level of achievement in science. However the female students have higher mean score than the male students in physics, but the difference is not statistically significant. In mathematics achievement, the mean score of male students is slightly higher than the female students but the difference is not statistically significant. This contradicts the submission of Awoniyi (2000) that male candidates performed better than females in subjects requiring quantitative ability. He said males show superiority in science, statistics and accounting. This also contradicts the submission of Olutola and Dosunmu (2015) that there...
is significant difference between gender and science achievement of secondary school (SS) students’ in Katsina State

From the results it was also confirmed that there is a significant difference between public and private secondary school students’ achievement in mathematics. (t = -10.536, p <0.05). The mean achievement for public school students is 11.8687 while that of private school is 19.3465. Thus, private school students performed significantly far better than their public school counterparts. This supports the findings of Olatoye and Agbatogun (2009), Olatoye (2009a, 2009b) who also reported that private school students perform better. There is no doubt that the private school proprietors pay more attention to their teachers’ input into the pupils than do the public schools (Salawu & Adedapo, 2001). They also spend substantial amount of money to provide instructional materials for the teaching and learning process. They take their students out on fieldtrips, excursions and so on, which are not common in most public schools. This is what makes private schools different in terms of quality.

**Conclusion**

Students’ knowledge of some concepts of mathematics (algebra, trigonometry and geometry) helps them to achieve high in physics. The order of the importance of different concepts of mathematics on students’ physics achievement in descending order of importance is: **geometry > algebra > trigonometry.** Students’ performances in physics and in mathematics in senior secondary schools are not gender sensitive; male and female students have the same level of achievement in mathematics and physics. However, considering their mean score it was confirmed that, male students are slightly better in mathematics, while in physics female students performed better, but all the differences are not statistically significant. It has also been confirmed that school type affects students’ performance in both mathematics and physics, whereby private schools performed far better than public schools.

**Recommendations**

Based on the findings of this research it is therefore recommended among that:

1. Physics teachers whose students are not performing well in calculation aspects of physics and need to revise some concepts in mathematics should emphasize more on geometry, followed by algebra and lastly trigonometry.
2. A body should be set up by the Katsina State Education Board to study private secondary schools’ operations in order to find out what methods and strategies are employed in assisting their science students in achieving good performance so as to emulation of such practices in the public secondary schools.

**References**


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