COMPARATIVE ANALYSIS OF STUDENTS' PERFORMANCES IN MATHEMATICS AND PHYSICS AT SENIOR SCIENCE SECONDARY SCHOOLS IN GOMBE METROPOLIS

Bello, D. O
Mathematics Education Department,
Federal College of Education (Technical), Gombe
AND
Yunana, S.
Mathematics Education Department,
Federal College of Education (Technical), Gombe
AND
Abdulyakeen, S.
Mathematics Education Department,
Federal College of Education (Technical), Gombe

AND

Oluyinka, A. R.
School of Postgraduate Studies, Gombe State University
preferreddaniel@gmail.com

(08064085615)

Abstracts

Mathematics has an age-old relationship with physics and other natural sciences. It is the foundation of science and technology and the functional role of mathematics to science and technology is multifarious, that no area of science, technology and business enterprise escapes its application. This study interrelates the performance of students' in mathematics and physics in senior secondary schools. The paper highlighted two pertinent points; first to determine the relationship between mathematics and physics, and second is to see whether success in mathematics can be used to predict success in physics and vice-versa. Two null hypotheses were formulated to guide the study. Research data were extracted from (2018/2019) NECO examination results from five Secondary Schools in Gombe Metropolis of Gombe State that were selected. The study adopted a descriptive survey design that employs simple Linear Correlation Regression analysis in order to test the null hypotheses. The R value of 0.34, for the year 2018/2019 session indicated moderate to weak correlation. A test of significance, t-test was applied to the results at 5% level of significant, the null hypotheses were accepted. The result of the study therefore showed no significant relationship between students' performance in physics and their performance in mathematics. This work finds out that there is a good and positive correlation in the performance of students in physics and mathematics, students who perform better in mathematics, in most cases do well in physics. This research study suggested some solutions that may help to solve the problem associated with the mass failure in mathematics and physics in Senior Secondary Schools especially science students. It was recommended that teachers should be liberal in the course of their teaching to meet the demands of all categories of students.

Keywords: Students' Performance, Physics, Mathematics, Comparative, Analysis.

Introduction

Mathematics has an age-old relationship with physics, chemistry and other natural science. In other words, mathematics serves in many of the branches of sciences, it is the bedrock of all science and technologically based subjects. Hogan & Koko (2018) quote Herbert (2015) who viewed mathematics as the Queen and Servant of the sciences. He backed up his view with practical examples for instance; he opined that measurement and other mathematical device are vital in the work of physicist. Science and technology have become an integral part of the blood stream of modern civilization and is the major driving force for economic growth and development (Khan, 2013).

This paper is based on the Theoretical Conception of the link between Physics and Mathematics, the past study on the relationship that exists between them. Max (2015) states that, "Mathematics is the study of all structures whose forms can be express in symbols; hence we find that this entity called Mathematics is viewed as a completely abstract instruction". Steven (2016) defines Mathematics as the classification and study of all possible patterns that is any kind of regularity that can be recognized by the mind. It is in line with this definition that (Kwalala, 2014) sees this Mathematics as the science of numbers. Greater abstraction and competing philosophical schools which had prevailed since Aristotle's time, were abandoned in the 19th century as new branches of mathematics; such as group theory, analysis, projective geometry and non-Euclidean geometry, were developed and bore no obvious relation to measurement or the physical world. As mathematicians pursued greater rigor and more-abstract foundations, some proposed new definitions of mathematics which are purely based on logic: Mathematics is the science that draws necessary conclusions (Pospiech, 2017).

All Mathematics are Symbolic Logic (Bing & Redish, 2014). Pospiech (2017) did not think that mathematics is the same as logic, since he thought mathematics makes only hypothetical assertions, not categorical ones. Sherin, (2011) definition, on the other hand, expresses the logistic philosophy of mathematics without reservation. Competing philosophies of mathematics hence put forth different definitions of mathematics. Opposing the completely deductive character of logicism, intuitionism is another school of thought which emphasizes mathematics as the construction of ideas in the mind. Mathematics is mental activity which consists in carrying out one after the other, those mental constructions which are inductive and effective (Bing & Redish, 2014). In other words, by combining fundamental ideas together, one reaches a definite result in mathematics. On the other hand, formalism denies both physical and mental meaning to mathematics, and instead makes the symbols and rules themselves the object of study. for a typical formalist, Mathematics is the manipulation of the meaningless symbols of a first-order language according to explicitly syntactical rules. Mathematics is the science of structure, order and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects, (Encyclopedia Britannica 2016).

Physics is also seen as a practical and scientific oriented discipline which is concerned with the study of energy and matter with their interaction. Physics is sometimes referred to as the science of measurement and its knowledge has contributed greatly to the production of instrument and devices that are of tremendous benefits to human race, Omosewo (2013) and Oraifo (2015) opined that physics plays very important role in scientific and technological advancement that affect the lives of mankind. Physics according to Adeyemo (2010) is seen as a

discipline that is abstract in nature but despite this abstract nature, its teaching is to bring about scientific thinking in students, a mindset that required students to test out through experimentation. As a scientific discipline therefore, the teaching and learning of physics requires high level of practical or approach in the laboratory in order to simplify the teaching-learning process and thus, stimulate life-long enthusiasm of physics students and science as a whole. This will tend to reduce the abstract nature of physics and make it more real.

Physics is the science aimed at describing the fundamental aspects of our universe. This includes what things are in it, what properties of those things are noticeable, and what processes those things or their properties undergo. In simpler terms, physics attempts to describe the basic mechanisms that make our universe behave the way it does. The word physics is thought to come from the Greek word *phusis*, meaning "*nature*". The study of nature later came to be called *natural philosophy*. From ancient times through the Renaissance, natural philosophy encompassed many fields, including astronomy, biology, chemistry, mathematics, and medicine. Over the last few centuries, the growth of scientific knowledge has resulted in ever-increasing specialization and branching of natural philosophy into separate fields, with physics retaining the most basic facets. Physics, as it developed from the Renaissance to the end of the 19th century, is called **classical physics**. Revolutionary discoveries starting at the beginning of the 20th century transformed physics from classical physics to **modern physics** (Pietrocola, 2018).

Physics and mathematics are two areas of intellectual activity that have been deeply interwoven throughout the long history of science and yet they represent two separate ideological entities. This situation reflects the complexity of representing both disciplines in school curricula. Physics teachers often state that their students do not understand physics due to the lack of mathematical knowledge and claim that such knowledge guarantees successful learning of physics (Pietrocola, 2018). Mathematics and Physics are two closely connected fields. For physicists, mathematics is a tool used to answer questions. For example, Newton invented calculus to help describe motion. For mathematicians, physics can be a source of inspiration, with theoretical concepts such as general relativity and quantum theory providing an impetus for mathematicians to develop new tools. Mathematicians look for patterns and ask if that pattern is just a special case or indicative of something deeper. A simple example of a mathematical pattern:

$1^2 = 1^3$

$(1 + 2)^2 = 1^3 + 2^3$

$(1 + 2 + 3)^2 = 1^3 + 2^3 + 3^3$

$(1 + 2 + 3 + 4)^2 = 1^3 + 2^3 + 3^3 + 4^3$

One can manually calculate additional values in the series, but it's impossible to prove that this pattern exists beyond this series without infinite calculations. Instead, mathematicians use proofs, a logical argument that shows that something is true. But despite their close connections, physics and mathematics research relies on distinct methods. As the systematic study of how matter behaves, physics encompasses the study of both the great and the small, from galaxies and planets to atoms and particles. Questions are addressed using combinations of theories, experiments, models, and observations to either support or refute new ideas about the nature of the universe. In contrast, mathematics is focused on abstract topics such as quantity (number theory), structure (algebra) and space (geometry). Mathematicians look for patterns and develop new ideas and theories using pure logic and mathematical reasoning. Instead of experiments or observations, mathematicians use proofs to support their ideas. While physicists rely heavily on math for calculations in their work, they don't

work towards a fundamental understanding of abstract mathematical ideas in the way that mathematicians do.

Clarification of the nature and relationship of the two disciplines may imply important changes in their teaching. There is a rich anecdotal evidence of parents, teachers, students, school administrators, and policy makers in the Ministry of Education who hold various views on the subject. Physics is often perceived to be far more "complex", confusing, demanding of cognitive maturity, labor consuming, expensive to support by the school, and "unrewarding" in terms of matriculation assessment results (Bing & Redish, 2014). Physics possess an image of the area for a few brilliant savants, usually males, often arrogant and disconnected from their fellow classmates. Moreover, physics teachers often blame mathematics education for the difficulties they face with students unprepared in mathematics. From the cluster of true problems, we chose to address a specific problem. Very often, students are warned by teachers and school administrators that those who intend to study physics must be superior in mathematics (Krey, 2012). We wonder whether and in what sense it might be true. Is mathematics a prerequisite? If so, in what sense? What curricular changes may improve the situation? What level and what kind of mathematics are required for taking high school physics?

The physicist uses the mathematical device called the graph to give a clear picture of the relationship between different values like temperature and presence of saturated water vapor in the atmosphere. The laws of physics are stated in the form of algebraic formulae. The importance of mathematical knowledge in understanding engineering and technical education studies cannot be over emphasized. It is common knowledge that mathematics and science is one of the major requirements for admission into engineering and technical education programs in Nigeria and elsewhere. The classroom practitioners, notably the professional teachers of science and even non-science teachers believe that no student can make a head way in science and technology without a basic knowledge of mathematics and according to Taylor (2010), fewer people seem to be aware that mathematics carries the main burden in all of scientific reasoning and is the core of the major theories of physical science. In recent years all fields of science have become more and more quantitative. The distinguishing feature of mathematics is its quantitative character. All sciences depend on investigations and all investigations depend on measurements and measurement is a branch of mathematics (Barnes. 2016). Most investigators in the sciences are of the opinion that competence in mathematics is an essential part in the study of most courses in physics. Lloyd (2016) carried out a study which intends to identify cognitive abilities needed by students for success in first level college mathematics for science majors. Study findings indicated that the possession of basic mathematics skills ability to use fractions, exponents best discriminates between those who were likely to succeed as science majors and those who would not.

Objectives of the Study

This study aims to achieve the following objectives among others;

vii. To find out whether a relationship exist between the performance of students in physics and mathematics.
viii. To verify whether the performance of students in mathematics could be used to predict the performance of students in physics.

Research Questions

Two research questions were raised to guide the study:

14. Is there any relationship between students' performance in Mathematics and Physics in Senior

Secondary School in Gombe Metropolis?

15. Does student's performance in Mathematics predict their performance in Physics in Senior Secondary School in Gombe Metropolis?

Research Hypotheses

Two hypotheses are postulated and tested at 0.05 Alpha level of significance.

H_{O1}: There is no significance relationship between the students' performance in physics and their performance in mathematics in senior science secondary school levels in Gombe Metropolis.

H_{O2}: Students' performance in mathematics does not predict their performance in Physics in Senior Science Secondary School in Gombe Metropolis.

Methodology

The design of the study was an ex-post facto research design. mix of observational, descriptive and qualitative. It involves collecting and analyzing data without changing existing conditions. The target population for the research comprises of all the students that sat for the examinations (NECO 2018/2019 session) in the following five Senior Secondary Schools.

i. FCE (T) Demonstration Secondary School Gombe.
ii. Government Day Science Secondary School 2 (Science 2).
iii. Government Day Secondary School Pilot Gombe.
iv. Darul-Arqam Academy Gombe.
v. Alhidayah Academy Gombe.

Sample and Sampling Techniques

The researcher makes use of the Linear Systematic Sampling Method; to sample sixty (60) students from the population of each of the five schools.

Method of Data Collection

The method of data collection or source of data for this investigation was based on Secondary Source; consisted of 2018/2019 Examination Results of Final year Science Students in Mathematics and Physics, where by the researcher went to the schools to collect both results of Mathematics and Physics (NECO 2018/2019) of 60 students were selected using the Linear Systematic Method from each of the selected five schools. The results were directly supplied by each of the schools Examination Officers with the permission of the school authority/managements.

Aggregate values of students' performance

Table 1: Aggregate values of students' performance were based on the following guideline:

Range of Scores	80 - 100	70 - 79	65 - 69	60 - 64	55 - 59	50 - 54	45 - 49	40 - 44	0 - 39
Aggregate Values	99 (A1)	78 (B2)	68 (B3)	63 (C4)	58 (C5)	53 (C6)	48 (D7)	43 (E8)	38 (F9)

Source: Field work

Method of Data Analysis

The data collected was analyzed using the t-Test and Regression Statistical distribution. However, the Statistical distribution that was used to judge the Hypotheses are; the Pearson Product Moment Correlation Coefficient, t-test and the Regression Statistics. The two instruments for the Statistical distribution was used to test the Hypotheses and the research questions. Also, the data obtained from the study were Statistically analyzed

using Linear Regression at 5% level of significance.

Results

The results of the null hypotheses tested and the analyses of data are presented and were summarized in the tables below

Table 2: t-Test for All the Five Senior Secondary Schools in Gombe Metropolis

	Variable 1	*Variable 2*
Mean	59.06666667	55.28333333
Variance	28.28985507	18.09671126
Observations	300	300
Pearson Correlation	0.3428284	
Hypothesized Mean Difference	0	
Df	299	
t Stat	11.79365484	
P(T<=t) one-tail	6.42504E-27	
t Critical one-tail	1.649965768	
P(T<=t) two-tail	1.28501E-26	
t Critical two-tail	1. 967929605	

Source: Field Work

Table 1.1: T-test Analysis

Variables	**No of Cases**	**Mean**	**Df**	**MD**	**Alpha Value**
Mathematics (X)	300	59.06	299	3.80	0.05
Physics (Y)	300	55.28	299		

From the Table above; T-test for the Coefficient (r) was found to be approximately 0.34 i.e the strength of the relationship and T-test from table gives; tcal = 11.79 and tcrit = 1.65.

Summary of analysis in relation to **H_{O1}** and **H_{O2}**

Hypothesis 1

Hypothesis 1 states that; there is no significant difference between the performance of physics students and mathematics students at Senior Science Secondary Schools in Gombe Metropolis.

Hypothesis 2

The Null Hypothesis 2 states that; Students' performance in Mathematics does not predict their performance in Physics in Senior Science Secondary Schools in Gombe Metropolis.

Table 3: Regression Statistics for All the Five Senior Secondary Schools in Gombe Metropolis

	Coefficients
Intercept	39.08748424
X Variable 1	0.274196091

From the table above; the intercept is approximately 39.09 and X (variable) is 0.27.

Summary of the analysis in relation to the research questions;

Partially it is true that only the mathematical mind can take up the study of physics and also the performance of student is moderate. However, the Regression Statistics reveals that; the relationship of the students' performances in mathematics and physics is that; the students' performances in mathematics can be used to predict the performances of students in physics.

Hence the relationship is given by; Y = MX + C i.e. Physics score = Math score (0.27) + 39.09.

Table 4: Values of t-table for each of the five (5) schools

Schools	Mean	Variance	Pearson Correlation	t-statistics	t-critical
FCE (T) Demonstration Secondary School Gombe	57.6666667	17.6836158	0.54661559	3.66184256	1.67109303
Government Day Science Secondary School (II)	55.16667	48.61582	0.893268	-4.0397	1.671093
Government Day Secondary School Pilot	59.16666667	13.02259887	0.81955871	22.39828631	1.671093033
Darul-Arqam Academy Gombe	61.08333333	17.87429379	0.82252614	5.636420031	1.671093033
Al-hidayah Academy Gombe	62.25	14.25847458	0.792126766	38.55175865	1.671093033

Discussion

From table 4, the findings from each of the schools show that both null hypothesis one ($\mathbf{H_{01}}$) "there is no significant difference between the performance of physics students and mathematics students at Senior Science Secondary Schools in Gombe Metropolis" and null hypothesis two ($\mathbf{H_{02}}$) "Students' performance in Mathematics does not predict their performance in Physics in Senior Science Secondary Schools in Gombe Metropolis" are rejected for the following schools, FCE (T), Demonstration, Government Day Secondary School Pilot, Darul-Arqam Academy Gombe and Al-hidayah Academy Gombe; while, they are accepted for Government Day Science Secondary School (II). That is, there is significant

difference between the performance of physics students and mathematics students at Senior Science Secondary Schools in Gombe Metropolis. Also, Students' performance in Mathematics do predict their performance in Physics in Senior Science Secondary Schools in Gombe Metropolis. Thus, a good and positive relationship exists between the two subjects in the school.

Ordinarily, the above values indicate from moderate relationships to weak correlation involving students' achievement in mathematics and physics. What this implies is that achievement in physics is both moderate/weak predictors of success in mathematics. However, the R value of 0.34 indicated moderate to weak correlation involving students' performance in physics and mathematics during the period of this research. It is therefore difficult to use students' achievement in physics as an accurate predictor of their success in mathematics. This finding is in disagreement with that of Hogan (2018) who correlates students' performance in mathematics and their performance in technical drawing, mechanical engineering technology, electrical engineering design and electric power and machines. The result of his study indicates an apparent multiple relationship existing between mathematics and

engineering disciplines as well as technology education. So also, the findings of (Ubden, 2012) to some extent indicated that performance in mathematics can form the basis for predicting success in physics and vice versa.

Conclusion

On the basis of the findings of this investigation, the following conclusions were drawn:

i. Perceived correlation in a group of related subjects does not necessarily imply that knowledge in one subject can predict success in the other subject.
ii. Even though there appears to be a relationship between students' performance in physics and mathematics; the achievements in physics may not all the time be accurate predictor of success in mathematics.

Recommendations

The following recommendations were made based on the findings of the study:

3. Teachers should be liberal in the course of their teaching to meet the demands of all categories of students in Mathematics and Physics.
4. Government should make provision of teaching and learning materials for suitable and effective learning in the two subjects.
5. Similar study should be carried out in other areas of study to ascertain claim of this study.

References

Adeyemo, S.A. (20 I0). The impact of information and communication technology (lCT) on Teaching and learning of physics. *International journal of educational research and Technology. 1* (2), 48-49.

Barnes, L. M. (2016), "Mathematics Skill Test (Mast) Georgia", Georgia State University Press.

Bing, T. & Redish, E. (2014). Analyzing problem solving using math in physics Epistemological framing via warrants. *Physical Review Special Topics - Physics Education Research, 5*(2), 020108.

Herbert, K. A. (2015), "The New Book of Popular Science Dari bury", Connecticut: Grolier Inc.

Hogan, E. E. & Koko, G. (2018) "The Relationship between students'

Performance in Mathematics and their performance in selected engineering courses". Nigeria Certificate in Education (N.C.E. Technical) thesis, the Polytechnic, Calabar, 1983. (Unpublished).

Khan, G.M. (2013), "Cognitive analysis of problem of learning mathematics in primary school children" National Institute of Psychology Quidi, Azam University Islamabad,1995. (Unpublished M. Phil thesis).

Krey, O. (2012). *Zur Rolle der Mathematik in der Physik: wissenschaftstheoretische Aspekteund Vorstellungen Physiklernender*. Berlin:

Kwalala B. (2014), Science and Technology, Catalyst to Achieving vision 2020 Sunday Triumph, 3rd October 2009.

Lloyd, B. M. (2016). "The identification of cognitive abilities needed by students for success in a Georgia, State University in partial fulfillment of the requirements for the award of Doctor of Philosophy.

Mathematics, (2016). In *Britannica Online Encyclopedia.* https://www.m-w..com/encyclopedia/mathemtics.

Max, B. (2015), Teaching Work Case: Learning to Questions (in): The Changing Face to College Teaching SanFrancisco, California.

Omoseno, E.O. (2013). Views of physics teachers on the need to train and retrain physics teachers in Nigeria. *African research review*, 3(1), 314-325

Oraifo, S.O. (2015). *Process consultation:* Its role in organising development Reading MA: Addisson- Wesley.

Pietrocola, M., & Pospiech, G. (2018). Modelling mathematical reasoning in Physics education. *Science & Education, 21*(4), 485–506.

Pietrocola, M. (2018). Mathematics as structural language of physical thought. In M. Vicentini & Sassi.

Pospiech, G. (2017). On understanding, explaining and mathematical formulation of physical Problems in secondary school. In *GIREP-EPEC Conference Frontiers of Physics Education-Selected Contributions.Rijeka*.

Steven S. W. & De-Bello T.C (2016), Comparism of Eleven major Learning Style Models Variable Appropriate Population, Validity of Instruments and the Research Behind the Reading, Writing and Learning Disability Vol. 6 Page 203-206.

Sherin, B. L. (2011). How Students Understand Physics Equations. *Cognition and Instruction*, *19*(4), 479–541.

Taylor, S. J. (2010), "Exploring mathematics thought". London: Gum and co. Ltd.

Ubden, O. (2012). *Mathematisches Denken im Physikunterricht Theorieentwicklung und* Ubden, *Problemanalyse*. Berlin: