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MATHEMATICS PROFICIENCY AS A PREDICTOR OF STUDENTS' ACADEMIC PERFORMANCE IN PHYSICS IN PORT HARCOURT LOCAL GOVERNMENT AREA OF RIVERS STATE

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Abstract

This study investigated Mathematics proficiency as a predictor of students' academic performance in Physics in Port Harcourt Local Government Area of Rivers State. The study was guided by two research questions and two hypotheses. Ex-post facto design was adopted for the study. Population of the study comprised of 5,090 Senior Secondary School Students in the 17 Government Secondary Schools in Port Harcourt Local Government of Rivers State. By simple random sampling, five (5) public educational schools located strategically in area of study were chosen for the study. A random sample of 30 students scores in Mathematics alongside Physics of SS III WAEC 2022/2023 academic session were selected from each of the five schools making a total sample size of 150 students. The instrument was a standardized examination provided by WAEC. The validity and reliability of the instrument were also supported by the standardized testing procedure. Mean, standard deviation and Pearson correlation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using regression analysis. Result after analysis revealed that there is a significant relationship between Mathematics proficiency and students' accademic performance in Physics; Mathematics proficiency significantly and positively predicts students' accademic performance in Physics. The study concluded that mathematics proficiency is a major predictor of students' academic performance in physics. That is students who are good in carrying out logical mathematical reasoning will also be successful in Physics. Recommendations were made among others that Science students should put in significant effort to develop strong skills in areas that require abstract logical thinking and numerical calculations, as this can boost their overall academic performance. Schools focused on improving student performance in Physics and similar science subjects should prioritize enhancing the teaching and learning of mathematics.

Keywords: Mathematics, Physics, Accademic performance, Mathematics Proficiency

Introduction

The primary objective of every educational system is to equip individuals with the necessary skills and knowledge to develop their full potentials. Mathematics, as a discipline, holds significant importance across various spheres of life. A study of mathematics unveils fundamental patterns that enhance the appreciation of nature (Yadav, 2019). In contemporary times, mathematics encompasses reasoning, inference, and empirical evidence alongside scientific principles, measurements and observations. Furthermore, it extends to mathematical representations of social systems, human behavior and natural phenomena.

Mathematics serves as the cornerstone for both science and technology (Anyagh & O'kwu, 2020). Science and technology are crucial for nurturing students' critical and creative thinking skills, which in turn, are pivotal for developing their entrepreneurial capabilities. Consequently, mathematics serves as a crucial tool in cultivating students' entrepreneurial skills. A good understanding of mathematics is the fundamental prerequisite for studying physics. The principles of physics find their clearest expression and interpretation through mathematics. Mathematics provides the logical framework essential for accurately formulating physical laws and quantifying their predictions.

A robust foundation in mathematics and a proficient talent pool in this domain are imperative to sustain a wide spectrum of value-added economic activities and innovations. The relevance of mathematics to society is underscored by the increasing attention given to the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) (Malaki, 2021). Mathematical proficiency supports numerous facets of daily life; from interpreting news articles to making informed financial decisions.

Proficiency means the quality of being skilled and demonstrating competence in handling something According to Turner (2010), mathematical proficiency

includes a range of skills necessary for applying mathematical knowledge in real-world situations. Kilpatrick *et al*. as cited by Brijlall & Ivasen (2022) clarified the competencies to include conceptual understanding, procedural fluency, strategic competence, adaptive thinking, and productive disposition, while Yulian and Wahyudin, (2018) noted that students' ability to solve problems is greatly impacted by their mathematical proficiency. When it comes to Physics performance, students with good mathematical ability had a higher mean percentage gain than those with low mathematical proficiency. The student's success in Physics is influenced by a combination of mathematics proficiency, instructional tactics, and gender (Ibibo & Francis 2017). Moreover, a linear relationship between mathematics and physics performance supports the premise that mathematical capacity is necessary for learning Physics efficiently (Chen *et al*., 2021; Long & Jiar, 2014). The higher the mathematical competency of the students, the better their scores on Physics tests as compared with the students with low mathematical competency (Doris, 2019). Most problems and concerns raised by students studying Physics came from the application of mathematical concepts and processes in the subject (Mumthas & Abdulla, 2019). Performance, according to Odogwu and Babajide (2018) is a measure of the output of learning. It is expressed in terms of change in knowledge, skills and attitudes of individuals as a result of their experiences within the school system. Academic performance is commonly measured through assessments and examinations.

Mathematics as a body of knowledge assists in the study of other sciences like physics (Galoyan& Betts, 2021). In their theory of identical elements, they argued that information could be transferred from one situation to another if the two situations shared identical or comparable elements. As a result, learning transfer might well be possible between two activities that share a set of stimulus qualities. Given the many similarities between mathematics and physics, it is probable that when learners are adequately guided in learning mathematics, such group of learners may be able to retain and transfer such thoughts into learning

physics. Individuals' capacity to lea,rn things is often enhanced when they practise on a series of similar or related tasks, according to their concept of learning to learn (Pereg & Harpaz, 2021). Tenzin, Tendar and Zangmo (2022) stated that the choice of science topics in Nigerian schools, particularly Physics, is highly impacted by the learner's math skills, because mathematical skills are crucial to the study of Physics and science in general. The researchers looked into Mathematics as a predictive to performance of physics students in this context

Mathematics, physics, and other natural sciences have had a long history of collaboration. Mathematics is the bedrock of science and technology since mathematics serves a variety of objectives in various domains. For example, a physicist's work relies heavily on measurement and other mathematical procedures (Abdurrahman & Madugu, 2014). Physicists use the mathematical tool known as the graph to help them understand the relationship between various variables, such as temperature and the presence of saturated water vapor in the atmosphere (Malaki, 2021).

Charles-ogan and Okey (2017) reiterate the impact of mathematics knowledge on physics students' understanding of electromagnetism. They reported the beneficial effects of strong mathematics aptitude on physics performance. They advocate rigorous mathematics education for physics students, emphasizing that mathematics is the language that articulates scientific discourse. They concluded that only mathematics could give matter structure and clarity, and that controlling nature required quantitative interpretations of thoughts and imaginations.

Charles-ogan and Okey (2017) determined that physics is so deeply established in mathematics that its effects can be seen throughout the discipline. Students' understanding and application of physics concepts can be improved with adequate knowledge of mathematics; thus, students' comprehension of fundamental mathematical ideas has a significant impact on how they respond to

higher-level physics concepts that require the use of these fundamental mathematical ideas.

Numerous studies have demonstrated that Mathematicsis a significant predictor of students success in physics, highlighting the essential role that mastery of mathematical concepts and their application plays in achieving strong performance in physics (Hassan *et al*., 2018). Yuoni *et al* (2024), evaluate the impact of mathematical knowledge on students' academic performance in physics at Mawuli School. A teacher-made test was the instrument used for data collection. The test consisted of questions in both mathematics and physics. The mathematics questions were strategically selected to align with concepts relevant to the physics curriculum. Pre-test and post-test were administered using similar sets of questions. Data analysis employed descriptive statistics, paired t-tests, correlation analysis, and regression analysis. The study findings indicated a statistically significant positive correlation between students' mathematical knowledge and their performance in physics.

Okey and ibibo (2015) researched the knowledge of mathematics on Students and how it influences learners Performance in Electromagnetism (Physics). The quasi experimental study sampled 200 senior secondary school two students offering physics using randomised sampling technique. Pre-test and post-test control design was adopted to examine physics performance through research designed test on mathematics ability and electromagnetism concepts with reliability coefficient of 0.94 and 0.74 respectively. Analysis of data was done using percentages, mean and analysis of covariance. From the analysis, high scorers on mathematical ability had higher mean gain percentage than those with low ability in mathematics. Students' ability in Mathematics, instructional strategies as well as gender had positive relationship with students' performance in electromagnetism scores. The study recommended that Physics students should pay adequate attention to the learning of mathematics to cope with the

calculations in physics. Also, that problem solving instances should accompany conceptual solutions of numerical problems in Physics.

Owolabi *et al* (2020) investigated whether the performances of students in the Senior School Certificate Examination (SSCE) in Physics, Biology and Chemistry could be predicted from their grades in Mathematics mock examination. 60 students were randomly selected from four Secondary Schools in Ekiti State with the instrumentality of mock examination and achievement test. The instrument was validated by the experts in science education and curriculum studies. The reliability coefficient of the instrument was found to be 0.84 using test-retest methods. Regression analysis was used to analyse the result at 0.05 level of significance. The result of the findings indicated that the performances of students in Mathematics could be used to predict results of SSCE Physics, Biology and Chemistry. Based on the findings, it was recommended that Mathematics teachers should to be committed to the teaching of the subject using the best approach because of its importance to sciences and consequently for technological development of the nation.

Umaru and Salau (2019) conducted a research to find out if students' achievement scores in Mathematics can be used to predict their scores in Physics and Chemistry. Thirty-three students were drawn from a total population of 450 from a Government Secondary School in Ilorin, Kwara State as the sample of this study. Students' Mathematics scores in the Senior Secondary School examination were compared with those of Physics and Chemistry, using regression analysis. Results showed that there was a p;ositive linear relationship between students achievment scores in Mathematics, Physics and Chemistry. Additional evidences from the scattergram also showed that students' mathematics scores were so positively and linearly associated with those of Chemistry and Physics. Both null hypotheses were rejected. Implications for other predictive studies are given and recomendations were made.

Statement of the problem

Physics is core to science at senior secondary level of education and do not require much adulation before students understand why they are required to offer it. These students are also aware of the need to pass physics, however, how to learn and perform adequately remains valid in the parlance of education. To experts, mathematics is a prerequisite in solving physics problems.

Mathematics is not only useful in coping with the rigour of physics at that level but also germane in higher education, especially in engineering, technology and other related fields. Science based students intending to study physics, mathematics, engineering and other physical science related courses in higher institutions are required to score a minimum of five credit passes (physics inclusive). This task becomes impossible to many as the mathematical expectations to cope with problem solving tasks in physics may be lacking.

Enrolment and performance of learners in physics has not been encouraging if compared to science subjects like chemistry and biology over the last decade in West African Senior School Certificate Examinations [WASSCE]. The poor enrolment understandably may have emanated from poor performance which may in turn discourage students from offering the subject. It is against this background that the researcher will therefore extract empirical data to ascertain whether Mathematics proficiency remains a predictor of students' academic performance in Physics in Port Harcourt Local Government Area of Rivers State

Objectives of the Study

The aim of this study is to investigate Mathematics proficiency as a predictor of students' academic performance in Physics in Port Harcourt Local Government Area of Rivers State. Specifically, the objectives of the study are to:

1. Investigate the relationship between mathematics proficiency and physics academic performance among students.
2. Determine the predictive power of Mathematics proficiency on Physics academic performance.

Research Questions

The following research question guided the study

1. Is there a significant relationship between Mathematics proficiency and students' academic performance in Physics?
2. To what extent does Mathematics predict students' academic performance in Physics?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

HO_1: There is no significant relationship between Mathematics proficiency and students' accademic performance in physics

HO_2: Mathematics proficiency does not significantly predict students' academic performance in Physics

Methods

The study is a correlational survey design using the ex-post facto type. This design was suitable as it helps to establish the relationship between mathematics proficiency and academic performance of students in Physics. Population of the study consists of 5,090 Senior Secondary School Students in the 17 Government Secondary Schools in Port Harcourt Local Government of Rivers State. (Source: Rivers State Senior Secondary School Board, 2024). A random sampling was used for the study to select five (5) public educational schools located strategically in area of the study. A sample of 30 students scores in Mathematics alongside Physics of SS III WAEC 2022/2023 academic session were selected from each of the five schools making a total sample size of 150 students for the study. The instrument was a standardized examination provided by West Africa Examination Council (WAEC). The instrument was already validated by WAEC before administering to the Students' since it was a standardized examination. The reliability of the instrument was already supported by the standardized testing procedures of WAEC and grading systems ensuring uniform application of

criteria across the senior secondary schools in the Local Government Area where the study was carried out.

The research questions were answered using Pearson Product Moment Correlatio, mean and standard deviation, while Regression analysis was used for the testing of the hypotheses. $P \leq 0.05$ level of significance was set for rejecting or accepting the null hypotheses.

Results

Research Question One: Is there a significant relationship between Mathematics proficiency and students' academic performance in Physics?

Table1: Relationship between Mathematics proficiency and students' academic performance in Physics

Treatment		MATHSCORE	PHYSICSSCORE	Mean	Std.D	M.D
	Pearson	1	.896**			
MATH	Correlation					
SCORE	Sig. (2-tailed)		.000			
	N	150	150	68.73	10.133	
	Pearson	.896**	1			0.92
PHYSICS	Correlation					
SCORE	Sig. (2-tailed)	.000				
	N	150	150	67.81	9.474	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 1 Shows the relationship between Mathematics score and Physics score using Pearson Correlation. Mathematics had a mean value of 68.73 with Standard Deviation of 13.133 while Physics had a mean value of 67.81and a Standard Deviation of 9.474. From the above values, it is obvious that Physics mean is very much closed to Mathematics mean. The result shows that there is a significant relationship between Mathematics proficiency and students' academic performance in Physics at .896 with a mean difference of 0.92.

Research Question Two: To what extent does Mathematics proficiency predict students' academic performance in Physics?

Table 2: Prediction of Mathematics proficiency and students' academic performance in Physics

Treatment		MATH SCORE	PHYSICS SCORE
Pearson Correlation	MATH SCORE	1.000	.896
	PHYSICS SCORE	.896	1.000
Sig. (1-tailed)	MATHS CORE	.	.000
	PHYSICS SCORE	.000	.
N	MATHS CORE	150	150
	PHYSICS SCORE	150	150

Table 2 Shows the prediction between Mathematics score and Physics score using Pearson Correlation. This reveals that Mathematics proficiency significantly predict students' academic performance in Physics at .896 This is based on the fact that the probability value of 0.000 is less than the alpha value of 0.05 set for the study. That is P= 0.00 < ∝ = 0.05.

Hypothesis One: There is no significant relationship between Mathematics proficiency and students' accademic performance in physics.

Hypothesis Two: Mathematics proficiency does not significantly predict students' academic performance in Physics

Table 3: Summary of Regression Analysis on the relationship between Mathematics proficiency and students' accademic performance in physics

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12283.896	1	12283.896	602.811	.000[b]
	Residual	3015.898	148	20.378		
	Total	15299.793	149			

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	3.741	2.672		1.400	.164	-1.540	9.022
	PHYSICSSCORE	.958	.039	.896	24.552	.000	.881	1.036

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.896[a]	.803	.802	4.514	.803	602.811	1	148	.000

The result of the simple regression analysis showed that the predictive relationship between Mathematics proficiency and students' academic performance in Physics was R = .896 which is high between Mathematics and Physics with an R-Square = .803 which describe the proportion of variance in Physics that could be explained by Mathematics. Put differently, only 80.3 % (0.803 x100) of the variance in Physics Score can be explained by Mathematics scores of the students as shown. Nevertheless, the ANOVA associated with the regression analysis revealed $F_{(1,148)} = 602.811$, $p < .000$ which is significant, hence, the stated null hypothesis is rejected.

The result was that, there is significant relationship between Mathematics proficiency and students' accademic performance in physics. In other words, students who performed well in mathematics also performed significantly well in Physics. In addition, the standardized coefficient beta value of .898 with t = 24.552, p < .000 was also found to be significant; further reaffirming that Mathematics proficiency significantly and positively predicts students' accademic performance in physics.

Regreson Equation: P = (.958)M + 3.741

For 1 unit rise in mathematics score (dependent variable) there is a corresponding rise by .958 in Physics score when the constant is kept at 3.741 Where: P = Physics , M = Mathematics

Discussion of Findings

The first hypothesis of the study states that there is no significant relationship between Mathematics proficiency and students' accademic performance in physics. However, because of the result of the analysis was R = .896 which is high between mathematics and physics with an R-Square = .803, the hypothesis was not accepted. This shows that there is significant relationship between Mathematics proficiency and students' accademic performance in physics. This also implies that students' poor performance in Physics is as a result of their poor background in mathematics. The result reveals so clearly

that, students can in no way perform in Physics if their background in mathematics is not rigid.

The findings support Yuoni *et al* (2024), who revealved that there is statistically significant positive correlation (relationship) between mathematis and Students' accademic performance in physics. Also the study of Charles-ogan and Okey (2017) shows that physics is so deeply established in mathematics that its effects can be seen throughout the discipline. Students' understanding and application of physics concepts can be improved with adequate knowledge of mathematics; thus, mathematics proficiency has a significant relationship with Physics. It brought an impact on how students respond to higher-level physics concepts that require the use of these fundamental mathematical ideas.

Hpothesis two of the study states that Mathematics proficiency does not significantly predict students' academic performance in Physics. This hypothesis was rejected because the ANOVA result shows $F(1,148) = 602.811$, $p < .000$ at 0.05 level of significance. Also, Beta result shows .896, $t = 24.553$; $p < 0.05$, implying that Mathematics proficiency does significantly predict students' academic performance in Physics. In other words, students who performed well in mathematics can also performed significantly well in Physics.

This support Umaru and Salau (2019) and Omeodu (2019) whose works revealed that there is a positive linear relationship between students Performance scores in Mathematics and Physics. Also, Owolabi *et al* (2020) indicated that the performances of students in Mathematics could be used to predict results of SSCE Physics.

Conclusion

Based on the findings of the study, the researcher concludes that; mathematics proficiency is a major predictor of students' academic performance in physics. That is students who are good in carrying out logical mathematical reasoning will also be successful in Physics. There is a strong positive correlation between students' mathematical proficiency and their performance in Physics.

One may generally conclude that students who are doing well in Physics are good mathematics students

Recommendations

Based on the findings of this study, the following recommendations were made:

- Science students should put in significant effort to develop strong skills in areas that require abstract logical thinking and numerical calculations, as this can boost their overall academic performance.
- Schools focused on improving student performance in Physics and similar science subjects should prioritize enhancing the teaching and learning of mathematics. This position advised that science students should be encouraged to undertake mathematics as it is useful in tertiary education, especially in STEM fields.

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