

**CORRELATIONAL ANALYSIS OF COMPETENCE IN
MATHEMATICS AND STUDENTS ACHIEVEMENT IN SENIOR
SECONDARY PHYSICS IN PANKSHIN, PLATEAU STATE, NIGERIA.**

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Abstract

This study was designed to investigate the correlation that exists between the students' competence in mathematics and their achievement in physics in Pankshin Local Government Area, Plateau State. The study is an analysis of cross correlational type where students' results in both competence in mathematics and their achievement in physics were compared. A total number of 129 Senior Secondary 2 students from five secondary schools were considered in this research. Three research questions and three hypotheses were tested. Two research instruments, Mathematical Competence Test and Physics Achievement Test (MCT, PAT) were used to collect data. The data were collected and analyzed using Pearson's product moment correlation coefficient and descriptive methods of mean and standard deviation. The result indicated that, there is strong positive correlation between students' competence in mathematics and their achievement in physics with correlation coefficient ($r=0.623$) at $\alpha=0.01$ level of significance. The results also revealed that there is a negative correlation between students' competence in mathematics and their achievement in physics based on gender (i.e. -0.12 and -0.28 for MCT and PAT respectively). Hence, competence in mathematics plays an important role in physics. It is therefore, recommended among others that physics teachers should constantly consult and work closely with mathematics teachers to identify and solve mathematics calculations involved in physics.

Keywords: Competence, competence in mathematics, achievement.

Introduction

Physics is the study of matter and its interaction with energy and motion. It is that branch of science which is largely concerned with fundamental ideas about nature and attempt to establish simple relationship between different quantities as precise as possible. Physics is concerned mainly with matter in relation to energy. Physics is the bedrock of technological development of any nation; because of the application of its principles, theories and laws in the technological world. For example, advances in the understanding of electromagnetism led to the development of new products which have contributed to the transformation of modern society, such as television, computers, domestic appliances, and nuclear weapons. Young and Freedman (2004) defined physics as an experimental science since its specialists observe the phenomena of nature and try to find patterns and principles that relate to those phenomena in the form of theories, physical laws or principles.

Despite the contributions of Physics to society, the West African Examination Council (WAEC) Chief Examiner's Reports (2015-2019) shows students fluctuating performances in Physics at the Senior School Certificate Examination level. The result shows a rise in physics academic performance in the year 2015, 2016 and 2017 with corresponding percentages of 57.6%, 63.7% and 63.9% respectively. However, there was a decline in the academic performance from 63.9% to 50.9% and 53.9% in 2018 and 2019 respectively. From the analysis, students' academic performance scores in physics was highest in 2017 and lowest in 2018. With respect to WAEC grading, the percentage of 58.0 represents a Credit pass in students' academic performance in physics. The Chief Examiner's reports indicated consistent lack of application of mathematical problem solving skills in physics questions contributed to the poor achievement of students in physics examinations. This has serious implications for national development, security, economy, and manpower for a country with a vision of becoming one of the leading nations in science and technology (Gambari and Yusuf, 2017).

Mathematics is often referred to as "language of science". Although, there is no universal agreement even among the experts on the acceptable definition of mathematics, but some found it to be a mental activity that deals with quantity, symbolic logic and carries out constructs one after the other in numeric terms. Mathematics plays both technical (calculating and solving differential equation, the semantics and physical meaning of mathematical structures) and a structural role (formal derivation of physical laws) in physics. While mathematics just

explores ways of solving equations, physics tends to utilize these equations to describe, learn, and understand physical systems. Mathematics is not only the language of physics but also tools for expressing, handling and developing logically physical concepts and theories. However, researches in time which have attempted to measure the impact of high school physics courses on students' success in undergraduate physics found that students who performed well in high school mathematics and physics subjects also did well in undergraduate physics. Charles-Ogan and Francis (2017) also found in their study that students of high mathematics abilities contributed to high performance while those of low mathematics ability performed poorly.

Nakakoji and Wilson (2018) when observing the relationships between General Educational Attainment, Mathematics Attainment, Physics/Engineering Attainment, and the Transfer of Learning between Mathematics and Physics/Engineering found that, mathematics is central for learning in these courses; attainment in mathematics is highly related to attainment in physics/engineering. Mathematics is predictive of science attainment. So, Science students have to learn how to engage mathematics for structured thinking about physical processes and how to interpret mathematical structures in physical terms if they are to soar in their science attainment.

Competence is defined as capability to apply or use a set of related knowledge, skill and attitude to complete a task according to its standards in a defined work area. In addition, competence can be scored and is measurable. Students' competence can be assessed through processes of observation and evaluation. Competence in mathematics has also been shown to be an important factor in physics conceptual learning. The basic laws of nature are represented in mathematical form. This fact makes physics a prototype of exact science and is primarily responsible for its predictive power. Competence in mathematics requires a full understanding of the concept of physics.

Science and mathematics have been regarded as the bedrock on which modern day technological breakthrough is built. That is the reason why nations the world, especially the developing ones like Nigeria, are striving to keep abreast technologically and scientifically. Despite the government and relevant stakeholders' effort to improve science education, including physics in Nigeria, students' achievements in physics over the years has been fluctuating. The analysis of result between 2015-2019 shows a rise in physics academic performance in the year 2015, 2016 and 2017 with corresponding percentages of 57.6%, 63.7% and 63.9% respectively. However, there was a decline in the academic performance from 63.9% to 50.9% and 53.9% in 2018 and 2019 respectively. This fluctuating performance in physics calls for urgent attention on

improving students' academic achievement in the subject. Consequently, the poor performance of students in Physics may be due to poor mathematical knowledge of Physics students who sat for the external examination.

According to Taangahar and Ameh (2019) there is a low students' academic performance in physics which is as a result of their belief that physics is a difficult subject for students. This is especially when the concepts taught are related to mathematical calculation. Charles, Ibibo and Okey (2017); Odogwu and Babajide (2018); Fatoki and Taangahar (2021) revealed a relationship between achievement in Mathematics and Physics and advocated for the grooming of Physics students in mathematics' before they commence treatment of similar numerical problems in Physics. Even though studies have shown a relationship between the comprehension of Mathematics concept and the ability to solve Physics problems, it is still suspected that some students may pass physics but not mathematics. Based on this assertion, this study finds out whether secondary students' competence mathematics correlates with their academic achievement in physics.

The study looked at the following objectives: examine the effect of senior secondary students' competence in mathematics on their achievement in physics; determine the mean difference between male and female student's competence in mathematics and their achievement in physics; and ascertain the effect of students' mathematics abilities on their application and analysis of problem solving in physics.

Research Questions

The study provided answers to the following research questions:

1. What is the effect of senior secondary students' competence in mathematics on their achievement in physics?
2. What is the mean difference between male and female student's competence in mathematics and their achievement in physics?
3. What is the effect of mathematics abilities on students' application of problem solving task in physics?

Hypotheses

1. There is no significant relationship between senior secondary students' competence in mathematics and their achievement in physics.
2. There is no significant relationship between male and female student's competence in mathematics and their achievement in physics.

- There is no significant relationship between secondary students' mathematics ability and their problem solving task in physics.

Methodology

The study adopted a cross-sectional correlation design. The population for this study consisted of all SS II students offering physics in the 25 government approved educational secondary schools in Pankshin Local Government Area of Plateau state. The sample for the study consisted of five public and private secondary schools in Pankshin Metropolis, Plateau State. 87 students were drawn from the public school while 42 were from private schools. It also consisted of 129 SS II students out of which 60 are males and 49 females offering physics.

Two instruments were used to collect data for the study. They are Mathematical Competence Test (MCT) and Physics Achievement Test (PAT).

The Mathematical Competence Test and Physics Achievement Test was adopted by selecting questions from WAEC and NECO past question papers between the Year 2019 and 2023 using the table shown in table 1 below to build the instrument after careful review of techniques for preparing test items and questions related to prescribe content for SS II Mathematics and Physics.

Table 1: Table of Specification

Topics	Mathematic	Physics	Knowledge & Comprehension	Application	Analysis, Synthesis & Evaluation	Total
Transformation of formulae		Simple pendulum	1	2	2	5
Angle properties		Prisms		1	1	2
Variations		Force, acceleration & inertia	1	2	2	5
Geometrical properties		Center of gravity	1	1	1	3
Diffentiation		Electrostatic	1	1	1	3
Exponential		Radioactive decay		1	1	2
Total			4	8	8	20

The instruments were validated and have a reliability coefficient of $\alpha = 0.592$ at 0.01 levels of significance using Kuder-Richardson reliability coefficient. The descriptive statistics (Mean, Standard Deviation and Variance) was used for answering the research questions, and Pearson Product Moment Correlation Coefficient (PPMC) was also used to treat the null hypothesis at 0.05 level of significance.

RESULTS

Research Question 1: What is the effect of senior secondary students' competence in mathematics on their achievement in physics?

Table 2: Effect of mathematical competence on physics Students' achievement

Variable	N	Range	Mean	Std. Deviation	Variance
MCT	129	62	29.71	15.183	230.522
PAT	129	66	25.23	12.753	162.633
Valid (listwise)	N 129				

Hypothesis 1: There is no significant relationship between senior secondary students' competence in mathematics and their achievement in physics.

Table 3: Pearson Product Moment Correlation Coefficient of the relationship between Senior Secondary Students' Competence in Mathematics and their Achievement in Physics.

Variable	N	Mean	df	γ	P - Value	Remark
MCT	129	29,71	126	0.623	0.000	Sig
PAT	129	25.23				

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

The result on table 2 shows the MCT and PAT mean scores 29.71 and 25.23 with standard deviation 15.183 and 12.753 and variance 230,522 and 162.633 respectively, the result reveals that the students mean score on MCT is higher than the students mean score on PAT. Therefore, the answer to research question 1 is that mathematical competence has positive effect on physics achievement among secondary students.

Table 3 indicates that there is a positive relationship between students competence in mathematics and their achievement in physics ($r = 0.632^{**}$, $df = 126$, $P \leq 0.01$). The result implies that there is a strong positive significant relationship between students' competence in mathematics and their achievement in physics. In other words, students who performed well in mathematics also performed significantly well in Physics. This also implies that students' poor achievement in Physics is as a result of their poor competence in mathematics. The result reveals so clearly that, students can in no way perform in Physics if their competence in mathematics is not rigid.

Research Question 2: What is the mean difference between male and female student's competence in mathematics and their achievement in physics?

Table 4: Difference between male and female student's competence in mathematics and their achievement in physics.

Gender	N	MCT		PAT		Mean Gain
		Mean	SD	Mean	SD	
Male	70	29.87	16.525	25.56	11.570	4.31
Female	59	29.51	13.558	24.85	14.120	4.66
Mean diff		0.36		0.71		0.35

Hypothesis 2: There is no significant relationship between male and female student's competence in mathematics and their achievement in physics.

Table 5: The relationship between male and female student's competence in mathematics and their achievement in physics.

Variables		MCT	PAT	Gender
MCT	Pearson	1	.632**	-.012
	Correlation			
	Sig. (2-tailed)		.000	.893
	N	129	129	129
PAT	Pearson	.632**	1	-.028
	Correlation			
	Sig. (2-tailed)	.000		.754
	N	129	129	129
Gender	Pearson	-.012	-.028	1
	Correlation			
	Sig. (2-tailed)	.893	.754	
	N	129	129	129

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

Table 4: shows that the mean score of male students is 29.87 and standard deviation of 16.525 while the mean score of female students is 29.31 and standard deviation of 13.558 for the MCT. The mean score of male students is 25.56 and standard deviation of 11.50 while the mean score of female students is 24.85 and standard deviation of 14.120 for the PAT. The mean gain of 4.66 against 4.31 shows that the female students performed better than their counterpart (male students).

The correlation between students' competence in mathematics and their achievement in physics based on gender is given in Table 5. The result revealed that there is a negative correlation between students' students' competence in mathematics and their achievement in physics based on gender (i.e -0.12 and -0.28 for MCT and PAT respectively). This indicates that there is a strong negative correlation between students' academic performance in physics and

academic performance in mathematics based on gender, thus, the null hypothesis is accepted.

Research Question 3: What is the effect of mathematics abilities on students' application of problem solving task in physics?

Table 6: Effect of Mathematics ability on students' application of problem solving task in Physics.

Variables	N	Mean	Av. Mean	Std. Deviation	Av. Deviation	Std.
MCT	129	29.71		15.183		
MATHS SCORE	129	41.47	35.59	17.191	16.19	
PAT	129	25.23		12.753		
PHYSICS SCORE	129	37.22	31.23	14.542	13.65	

Hypothesis 3: There is no significant relationship between secondary students' mathematics ability and their problem solving task

Table 7: Regression Analysis Summary for MCT on Students Problem Solving task in Physics.

Mode	B	β	t	Sig	95% CI	
					for B lower bound	Upper bound
(Constant)	9.451		4.911	.000	5.643	13.259
MCT	.531	.632	9.203	.000	.417	.645

a. Dependent Variable: PAT

Table 6 shows that the average mean score of students MCT and Mathematics Score is 35.59 with average Standard Deviation of 16.19 while the average mean score of students PAT and Physics Score is 31.23 with average Standard Deviation of 13.65. The mean difference of 4.36 shows that students' mathematical abilities have effect on their problem solving task in physics.

The analysis in table 7 showed that students mathematical competency is significantly related to their problem solving task in physics ($B = .632$, $\text{Sig} (p) < 0.000$). This implies that student mathematical competence determines to greater extent their problem solving task in physics. The relationship is positive and significant at 5% level of significance. Hence, the null hypothesis is rejected.

Discussion of Findings

The results on Table 3, reveals that, there is a strong positive significant relationship between students' competence in mathematics and their achievement in physics. The strong positive relationship between students' competence in mathematics and their achievement in physics is an indication that students' knowledge in mathematics will improve their achievement in physics. This however, is in line with the findings of Badmus and Zita (2023) who obtained correlation coefficient of 0.57. This finding also supports the view of Munir (2022) that there was significant difference in physics academic performance of physics students with high mathematical competence. It also corroborated the findings of Omeodu (2019), who found that students with high mathematical competencies performed significantly better than those with medium mathematical competencies and low mathematical competencies in Physics achievement and there was also a strong positive correlation between mathematical competency and performance in physics. He found that there was significant difference in academic achievement of the physics students based on their level of mathematics competencies. Also from the result, there is a negative correlation between students' competence in mathematics and their achievement in physics based on gender which is in contrast with Badmus and Jita (2022) who established equal cognitive capacity for both male and female learners in the subjects under examination. Furthermore, the position of this study agrees with the positions of Oluwatusin and Dele-Rotimi (2017), Olatoye (2008) and contrary to the study of Abubakar et al (2015) whose study reported in favour of male learners in both physics and mathematics performance.

The result also revealed that student's mathematical competency is significantly related to their problem solving task in physics. This finding supports Munir (2022) whose finding revealed that there was significant difference between students' problem solving ability in physics based on discrepancy in mathematical ability among secondary students. It also agrees with Akatugba and Wallace (2009) who discovered that mathematical competency among other issues was associated with students' use of proportional reasoning (problem-solving) in physics. While Long and Jiar (2014) states that Physics and Mathematics have similarity that is knowledge aiming at forming student skills in decision making and problem solving. It is clear that knowledge of Mathematics basic concept is an absolute thing which has to be possessed by student in studying Physics, or, in other words, studying Physics without comprehending Mathematics is an impossible thing. In learning Physics, almost all Physics concepts are related with Mathematics. Each Physics problem requires completion with mathematical approach. So, it can be said that knowing

and mastering knowledge of Mathematics basic concept will be very beneficial for student in completing Physics problems.

Conclusion

Based on the findings of this study, the conclusion was drawn that; Mathematical competence in the secondary school is sufficient for achievement in Physics at secondary level. This implies that secondary school Mathematics can sufficiently predict secondary students' achievement in Physics. Since mathematics is related to physics, effective application of mathematical knowledge is basic and essential to the performance of students' in physics. Since the study ascertains that there is a relationship between mathematics and physics, students are encouraged to give in their best in studying mathematics towards enhancing the student's performance in Physics.

Recommendations

The study makes the following recommendations:

1. Physics teachers should always update their knowledge from time to time through seminars, conferences and workshops to enable them adopt methods in integrating the teaching of mathematics in physics.
2. Female students should be given equal opportunity as their male counterpart to study science related carriers as they both exhibited the potential to excel in science.
3. Students who offer Physics have a need for the proper inculcation of the basic mathematics principles, laws, and theories, especially as needed in the understanding and application of the Physics concepts.
4. Guidance should be provided to students on significance of mathematics as an instrument of communication in physics. This will lead to appreciation of mathematical calculations in physics and thus raise the performance of students in physics.

References

- Abubakar, H., Idris, M., & Madugu, A. (2015). The effect of Further Mathematics on secondary school students' achievement in Mathematics, Biology, chemistry and Physics in Katsina State, Nigeria. *International Journal of Scientific & Engineering Research*, 6(4).
- Akatugba, A. H. & Wallace, J. (2009). An integrative perspective on students' proportional reasoning in high school physics in West African context. *International Journal of Science Education*, 31(11), 1473-1494.

- Badmus, O.T., & Jita, L.C. (2022). Pedagogical Implication of Spatial Visualization: A Correlate of Students' Achievements in Physics. *Journal of Turkish Science Education*, 19(1), 97-110.
- Badmus, O. T., & Jita, L. C. (2023). Does Further-Mathematics predict students' Performance in Physics? A Correlational diagnosis of three Years Secondary Education. *Journal of Technology and Science Education*. 13(1), 381-192.
- Charles-Ogan G. I., & Francis O. I. (2017). Effects of Mathematics knowledge on Physics students' performance in electromagnetism. *International Journal of Theoretical and Mathematical Physics*, 7(4), 61-67.
- Gambari, A. I., & Yusuf, M.O. (2017). Relative effectiveness of computer-supported jigsaw II, STAD and TAI cooperative learning strategies on performance, attitude and retention of secondary school students in physics. *Journal of Peer Learning*, 10(6), 76-94.
- Ibibo, C. G., & Francis, O. I. (2017). Effects of Mathematics knowledge on Physics students' performance in electromagnetism. *International Journal of Theoretical and Mathematical Physics*, 7(4), 61-67.
- Long, C. Y & Jiar, Y. K. (2014). Mathematical thinking and Physics achievement of secondary school students'. *Sains humanika*, 2(4), 231-237.
- Munir, A. (2022). Effects of mathematical ability on students' attitude towards Physics among senior secondary school in Katsina Metropolis, Nigeria. *Asian Basic and Applied Research Journal* 6(1), 1-6.
- Nakakoji, Y., & Wilson, R. (2018). Interdisciplinary learning in mathematics and science: transfer of learning for 21st century problem solving at university. *Journal of Intelligence*, 8(3), 32-35
- Odogwu, H. N. & Babajide, V. F. (2018). Effect of students' knowledge of Mathematics on students' achievement in Physics. A paper presented at the 7th international conference of global education network in conjunction with school of education and leadership, university of Ghana.

- Olatoye R.A. (2008). Effect of Further Mathematics on students' performance in Mathematics, Biology, Chemistry and Physics. *International Journal of Environmental & Science Education*, 2(2), 48-53.
- Oluwatusin E.A., & Dele-Rotimi A.O. (2017). Effect of Further Mathematics curriculum on students' performance in Science-Based subjects in senior secondary certificate examination in Ikere Local Government, Ekiti, Nigeria. *Mathematical Theory and Modeling*, 7(7), 23-33.
- Omeodu, M. D. (2019) Role of Mathematical Competencies in Enhancing Students' Academic Performance in Physics in Port Harcourt Local Government Area Rivers State. *European Scientific Journal* July 2019 edition, 15(2), 59-69.
- Taangahar, B. A., Fatoki, J. O., & Joshua, J. D. (2021). Students' academic performance in Physics as a correlate of their academic performance in Mathematics in Makurdi Local Government Area, Benue State. *International Journal of Multidisciplinary Research and Growth Evaluation*, 2(6), 16-19.