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# DOES FURTHER-MATHEMATICS PREDICT STUDENTS' PERFORMANCE PHYSICS? A CORRELATIONAL DIAGNOSIS OF THREE YEARS SECONDARY EDUCATION

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**Abstract**

The awareness and application of the knowledge of Further Mathematics transcends the boundary of Physics as a discipline. The application of further mathematics in physics and vice versa is evident in the curriculum and literature. This study explores the attrition between physics and further-mathematics among senior secondary school students with a view to expose relationship in predictive terms. Ex post facto research of the co-relational type was employed to investigate respondents results in West African Senior School Certificate examination (WASSCE). Purposive sampling technique was employed in the selection of 103 participants. PPMC and MANOVA statistical tools were employed in the analysis of data. The study observed a significant relationship in the performance of students offering further mathematics and physics. A further probe along gender and school type were also done in this study. This study established equal cognitive capacity for both male and female learners in the subjects under examination. Furthermore, no significant difference in the performance of learners was observed in urban and rural schools as against the expected norm. We recommend equal opportunity for all gender, as well as, provide basis for truce in the debate on public and private schools with respect to performance.

***Keywords –*** Correlation, Further-mathematics, Mathematics ability, Physics performance

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## 1. Introduction

The relationship between mathematics and physics is almost eternal according to literature (Ahmed, Mohamed & Fahar, 2015; Awodun & Ojo, 2013; Baskan, Alev & Karal, 2010; Rossdy, Michael, Janteng & Andrew, 2019; Hudson & Mcintire, 1977). Scholars continue to debate the inter-relatedness and use of mathematics in physics and vice versa as new areas of discipline evolve (Dehipawala, Shekoyan & Yao, 2014; Mangaoang-Boado, 2013; Redish, 2006). What type of mathematics is most useful for tertiary education in Science Technology Engineering and Mathematics (STEM) fields? Further mathematics/Advance mathematics as identified by experts and researchers as the most relevant in STEM

fields, especially at tertiary level of education (Barham, 2012; Bowyer & Darlington, 2016; Chadwick, 1985; Kneibil & Robilotta, 2015). Evidently, Further Mathematics (F/M) is not a course of study at any level of tertiary education or at least, not tagged, rather, a subject at senior secondary school. At this level, students learn further mathematics as a subject to prepare them for STEM fields and make use of in physics at the same level (Ademola, 2014; Baldwin, de Pomerai & Smith, 2016). The high school/secondary school is where the subject is introduced (Baldwin et al., 2016; Rossdy, et al., 2019). Literature has established mathematics to be one of the most difficult subjects at all levels of education (Fuchs, Fuchs & Compton,, 2012; Nelson & Powell, 2018; Powell, Fuchs, Fuchs, Cirino & Fletcher, 2009).

Difficult enough is mathematics for students that some curricula introduced mathematical literacy as simpler alternative to mathematics at secondary level to remediate students' shortcomings (Ojose, 2011; Pasomentier & Jaye, 2006; Yuliati, Yogismawati & Nisa, 2018; Zain & Jumandi, 2018). Further mathematics is advanced mathematics which requires more rigour than that of mathematics, however, more rewarding, with respect to tertiary education and career application (Ademola, 2014; Baldwin et al., 2016; Chadwick, 1985). Mathematics at senior secondary school level is of two form: General mathematics and Further Mathematics. General Mathematics is the compulsory type that all students irrespective of their area of study offer (Dehipawala et al., 2014; Baskan et al., 2010) and a prerequisite for university admission into most areas of disciplines (Ahmed et al., 2015; Okey & Gladysibibo, 2015). Conversely, further mathematics is optional to students and is offered by mostly science and technical students (Ademola, 2014; Oluwatusin & Dele-Rotimi, 2017). Further Mathematics is not compulsory and commonly ignored by students owing to difficulties they encounter in its learning (Bowyer & Darlington, 2016; Michelsen, 2015). However, the relevance of FMA to physics learning has gained prominence at all levels among researchers globally (Chadwick, 1985; Michelsen, 2015; Rossdy et al., 2019). Studies have explored aspects of physics and requisite mathematical concepts for their teaching (Abubakar, Idris & Madugu, 2015; Izaak, 2015; Kauffman & Ul-Haq, 2015; Rossdy et al., 2019). Investigations had been done on prior knowledge of further mathematics for better academic performance in physics, engineering and other mathematics concepts demanding fields in tertiary education (Ahmed et al., 2015; Bowyer & Darlington, 2016; Hudson & Mcintire, 1977).

We investigate the attrition in these two subject areas at senior secondary school level over a learning period of three years of formal education. We base our evaluation on the Senior Secondary Certificate Examination (SSCE) conducted by West African Examinations Council (WAEC). We aggregate data without teaching or interference with classroom activities among participants and participating schools. Gender and school type were investigated within the available data. Existing literature at this level have looked at perception of students towards further mathematics in preparation for Undergraduate experience in physics (Bowyer & Darlington, 2016), the afore stated is different from this study in terms of sample, instrument, scope and methodology. The study of Ademola (2014) researched female students' performance and school type on further mathematics as against the present study. Taangahar, Fatoki and Joshua (2021) examined physics performance as correlate of mathematics performance in descriptive research which deviates from this study in terms of subject area, instrumentation, sampling, locale and methodology. Limited literature exists among scholars in correlative paradigm between further mathematics ability (FMA) and students' performance in physics. However, the terminologies employed with regards to the present study requires that we expose this audience to the curriculum, teaching, learning and context before literature review.

Subsequent exposure is required regarding the context of this study. The review of Nigeria's Senior Secondary School Physics Curriculum in 2009 remain significant in the steps toward the improvement of science and technology in Nigeria (Federal Republic of Nigeria - FRN, 2013; McCulloch, 2020; MucCullock, Goodson & González-Delgado, 2020). Also, the extraction of further mathematics topics like calculus into general mathematics curriculum lay credence to the interwovenness and evolutional requirement in physics. Prior to year 2011, integration, differentiation, matrixes among others topics were components of further mathematics. Therefore, physics students who don't offer further mathematics do not have prior knowledge of major mathematical component required to learn aspects of physics at

senior secondary and tertiary levels. This limitation was identified and remediated by curriculum experts to accommodate this peculiarity but with consideration for non-science students. The complexity in the integration was not a welcome development to non-science learners as they may never transfer such knowledge for future use (Federal Republic of Nigeria, 2013; Ademola, 2014).

Through the National Policy on Education (NPE), an educational policy document of the Federal Republic of Nigeria (Federal Republic of Nigeria - FRN, 2013) which sought an all-inclusive education capable of fostering unity and purpose-driven education for all. The NPE, among other things respect the uniqueness of science and particularly physics. Developing and managing competence in various strata of education requires tooling each subject area to compete favourably towards ascertaining global, national and domestic educational objectives (Federal Republic of Nigeria - FRN, 2013; Önder, Şenyiğit & Sılay, 2018; Zain & Jumadi, 2018). West African Examinations Council (WAEC) is one of the examination bodies in West-Africa saddled with devising syllabi and conducting Examinations in West Africa, specifically at the senior secondary level. The West Africa Senior School Certificate Examinations (WASSCE) is the umbrella name for the conduct. Further mathematics syllabus is devised by this examination body from the Curriculum of Nigerian Educational Research and Development Council (NERDC). The aim of Further mathematics is to: conceptualise and device manipulative skills in Mathematics and provide understanding to requisite courses in STEM. Specifically, FMA foster acquisition of aspects of Mathematics capable of meeting the needs of future Mathematicians, Engineers, Scientists and other professionals for data analysis, making valid logical conclusions and, equipping individual with abstract and precise reasoning skills (West African Examinations Council Syllabus - WAEC Syllabus, 2020).

Performance levels is a measure of learning in and outside academics. Its history in academics goes as far back as learning itself (Oluwatusin & Dele-Rotimi, 2017; Ademola, 2014). Learners are categorised into low, medium and high scorers having met certain rudiments accounting for such student's performance in examinations (Barham, 2012). Performance level is the placement of grade of learners after test or examination which categorise them into high, medium and low performer (Ademola, 2014; Awodun & Ojo, 2013; Izaak, 2015). Usually, the high performing students score between 70% - 100% in performance test, moderate performers are learners with scores ranging from 50% - 69%, while low scorer/performers are learners whose score ranges from 0% and 49% (Aluko, 2008; Salami, 2004). The data of students' performance in physics and FMA collected in this study are presented in stanine form (A-F) which were further translated into High, medium and low for both public and private schools.

Public schools in this study, were secondary schools owned by government while the private schools were owned by corporate bodies and individuals. Public schools in Nigeria have local, State, and federal Governments elements in its leadership while private schools have individuals or group of individuals as the owners (Badmus, Amuda & Bada, 2020). The responsibility of school fees payment lies with the parents in private schools and are more involved in the decision making than parents whose wards attend public schools (Olatoye & Agbatogun, 2009). Gender debate in the classroom and it influence on students' performance abound in the literature for years (Badmus & Jita, 2022; Baldwin et al., 2016). Studies have argued for and against male and female students in terms of capacity for classroom activities (Badmus & Jita, 2022; Baldwin et al., 2016). We traverse along this existing debate with a view to posit and update literature.

## 2. Literature Review

Burkholder, Murillo-Gonzalez and Wieman (2021) examined advanced/further mathematics usefulness to introductory physics. The researchers explored the correlation between learners' preparation in calculus-based introductory mechanics courses, as well as introductory calculus-based content within first year electricity and magnetism topic. The research took into account the usefulness of college mathematics courses students underwent along with high school (senior secondary) preparation. In the study, multiple linear regression was employed to analyse prior preparation while examining the correlation between mathematics courses and final exam scores in introductory physics in the university.

With calculus-based mechanics, it was found that prior college mathematics courses were not significant in predicting students' final score in introductory calculus-based electricity and magnetism. However, a course in vector calculus was significant in predicting students' performance, after controlling for students' calculus-based introductory mechanics' score. Also, "vector calculus gap" impacted the differences in understanding of vectors and geometry, as well as the variations in learning circuit and forming conceptual understanding of it. Vector in calculus was not required to perform well on the final exam in physics.

Nakakoji and Wilson (2018) worked on first-year mathematics application in science. The investigation set out to examine knowledge transfer from mathematics to physics and engineering. Evidence of transfer of mathematics in first two semesters in sciences/engineering courses formed the objective. Transfer index measured, elicited assessments on matching of content questions which needs mathematical rudiments and skills in students' science/engineering examinations. Path models of how transfer is associated with educational attainment and other factors were inferenced. Knowledge transfer was observed from mathematics to physics and engineering courses unlike biology and molecular bioscience where such knowledge is not easily demonstrable due to lack of opportunity to do so. For physics and engineering, knowledge of mathematics transferred had positive effect on transfer of learning which allows for direct and indirect effect on students' performance. Knowledge transfer is associated with level of educational attainment in physics and engineering among the sampled respondents.

Oluwatusin and Dele-Rotimi (2017) studied the effect of further mathematics curriculum on science-based subjects in senior secondary schools. Significant difference was observed between non-further mathematics and further mathematics students' performance in all the science subjects and Mathematics. Similarly, Olatoye (2008) examined whether further mathematics performance influence students' performance in the sciences and mathematics at senior secondary school level. It was found that students offering further mathematics perform better than their non-further mathematics counterpart in science and mathematics, however, the difference was not significant as measured.

Okey and Gladysibibo (2015) researched the knowledge of mathematics on Students and how it influences learners Performance in Electromagnetism. 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.

Abubakar et al (2015) researched influence of advance Mathematics on learners' performance in mathematics and sciences at senior secondary school level. The sample consisted of 150 students from 7 Secondary Schools purposively selected in the study. The study employed quasi experimental research to compare students' performance with a test administered to participating students with no further mathematics question. The study found no significant difference between the performance of further mathematics and non-further mathematics groups. However, F/M students were overall best performers among the sample. The study recommends that science students should be encouraged to study further mathematics to improve their performance in science courses.

Joseph (2014) researched the influence of location, type and proprietorship of school on no performance of students in mathematics. The study was Ex post facto research which sampled randomly 853 respondents from 20 senior secondary schools as participants. A researcher design test with 40 items examined the students on the variables involved. School type and location had no significant effect on

students' performance in mathematics unlike school proprietorship. Olasehinde and Olatoye (2014) in a similar study researched secondary school science performance in private and public schools. Descriptive research of the survey type was employed in the study with two hundred and four students randomly sampled. Science Performance Test (SAT) was the instrument deployed to collect data and t-test was used to analyze the data. Private-school students were reported to have significantly outperformed their public-school counterparts. No significant difference was observed in the scores of private and public-school students' in biology and chemistry unlike in physics aspect of the SAT.

Alimi, Ehinola and Alabi (2012) researched influence of type and facilities in schools on students' academic performance. A descriptive survey design was employed, and proportionate sampling was used in selecting 50 schools with two sets of research instruments. T- test was used to analyse the data at 0.05 alpha level. Private schools in the study had better facilities when compared with the public schools. However, insignificant difference in academic performance of students in the schools was reported. Lubienski, Lubienski and Crane (2009) reported difference in significant terms in the performance of students in mathematics between of Catholic schools and public schools after accounting for student background variables. The researchers further reported that after controlling student background variables, mathematics scores of Catholic and other private schools were significantly lower when compared to scores of students in public schools. Although, it was acknowledged that the data were cross-sectional, therefore, it was impossible to control students' prior academic performance.

## 3. Problem Statement

Further Mathematics is a subject least offered by science and non-science students at secondary schools in Nigeria (Abubakar et al., 2015; Alimi et al., 2012). A critical review of its importance to present and future aspirations in science and technology related fields ascertain its relevance. When students don't offer Further Mathematics, teacher may only compel them to do so. Students of science extraction need reasons to offer Further mathematics aside the fact that their parents or teachers have so advised (Okey & Gladysibibo, 2015; Olatoye, 2008; Tangahar et al., 2021). 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, mathematical concepts are a prerequisite in solving physics problems (Aluko, 2008; Burkholder et al., 2021). Further 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 (Lubieski, Lubienski & Crane, 2009; Salami, 2004).

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 (Nakakoji & Wilson, 2018). However, improving students' performance in physics has been researched extensively over the years with recommendations from different scholars (Alimi et al., 2012; Olasehinde & Olatoye, 2014). 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 (Awodun & Ojo, 2013; Nakakoji & Wilson, 2018; Rossdy et al., 2019; Zain & Jumandi, 2018).

The need to review Mathematics Curriculum to accommodate Further Mathematics topics like Calculus and other was premeditated and germane to the emerging trajectory of events in physics with the introduction of a recent theme in physics curriculum. The theme 'Physics in Technology' propagates the industrial application of physics in 2009 review of the physics curriculum. With this addition and the global trend of events among scholars of physics and mathematics education, a review of the mathematics curriculum was borne in 2011. Subsequently, students have underwent this new addition for

ten years with insignificant interpretation as it relates to their performance, especially when compared with the previous years. An investigation is therefore required to extract empirical data to ascertain whether Further Mathematics remains a correlate of physics performance among senior secondary school students. Evident from the afore stated, the rationale to rejuvenate students' interest in Further Mathematics to improve their performance in physics formed the focus of this study. This study therefore investigated Further Mathematics as correlate of senior secondary school student's performance in Physics.

## 4. Research Hypotheses

The following hypotheses were tested in this study;

*$HO_1$: Students' further mathematics will not significantly predict their physics performance.*

*$HO_2$: gender will not significantly influence the prediction between students' further mathematics ability and physics performance..*

*$HO_3$: school type will not significantly influence the prediction between further mathematics ability and physics performance.*

## 5. Methodology

West Africa African Examinations Council (WAEC) is the examination body that conducts Senior School Certificate Examination (WASSCE) across 5 West African countries (Gambia, Ghana, Liberia, Nigeria and Sierra Leone). The examination body was established in 1952 and the regional headquarter in Ghana. In this study, grades of students in physics in WASSCE is referred as physics performance. WAEC examinations are standardized, reliable and valid as basic requirement for admission into tertiary education programmes across the globe. The respondents in this study sat for the same examination and were marked and graded equally as the year of exam was the same, questions were the same with same marking scheme. Encryption of results in physics and further mathematics were done during the consent form and result collection stage to avoid violation of ethical issues as stated and regulated by the National University Commission (NUC) of Nigeria. The consent form stage entailed identification of students offering Further Mathematics and physics. Subsequently, a total of 111 students sampled were sensitized on the research process and consent forms were distributed to 103 students interested in participating from the three senatorial districts of Kwara State. Result collection stage involved the collection and collation of results from the participating schools.

We employed co-relational type of *ex post facto* research. In this study, the usual classroom activity of students was not disrupted as results from their final year examinations were collated for analysis. Consent forms were given to willing participants offering both physics and Further Mathematics in the WASSCE conducted by WAEC. The criteria for the selection of the participating schools included: a common syllabus and qualified teachers and students offering the two subjects. Also, the schools must have participated in WEAC examinations for at least ten years to have basis for comparison. Only students who filled and signed the consent form with their parents/guardian formed the sample for this study as ethical processes were not compromised.

It is worthy of note that all the participating students offer general mathematics as it is compulsory along further mathematics which was tested in this study. However, Further mathematics is optional in all senior secondary schools in Nigeria. This study employed a convenient sampling technique as limited number of schools offer further mathematics. A total of twenty-seven schools participated in the study with the school having the highest number of candidates with eleven students while the school with the lowest number of candidates had 2. For clarity, students result in further mathematics was referred in this study as students' FMA while their result in physics bears physics performance. Score level in this study formed the categorization of students as high scorers (70-100%), medium scorers (50-69%) and low scorers (0-49%).

### 5.1. Ethical Permission Information on the Study

The ethical permission was applied for in the University of Ilorin. University Ethical Review committee (UERC) approved this research with protocol identification code, UERC/EDU/245 and UERC approval number, UERC/ASN/2018/1291. This was issued on 14th of June, 2018 with activity expiration on 13th of June, 2022.

## 6. Results

Table 1 presents 103 respondents who partook in the study, 79 of them representing (76.7%) were male, while 24 (23.3%) were female. Out of the 103 students that participated in the study, 49 (47.6%) were from public secondary schools, while 54 (52.4%) were from private schools. Invariably, male students had greater representation than female students. Also, Private schools had more representation in the study.

| Variables | Frequency | Percentage (%) |
|---|---|---|
| **Gender** | | |
| Male | 79 | 76.7 |
| Female | 24 | 23.3 |
| Total | 103 | 100.0 |
| **School Type** | | |
| Public | 49 | 47.6 |
| Private | 54 | 52.4 |
| Total | 103 | 100.0 |

Table 1. Demographic Distribution of Respondnts

**$HO_1$:** Students' further mathematics will not significantly predict their physics performance.

Testing Hypothesis 1, participants' WASSCE grades in Further Mathematics and Physics were analysed as shown on Table 2 using PPMC statistical tool. From the table, the R-value calculated was .57 compared to calculated significance of .00 and df of 2/103 at α level of .05, therefore, Hypothesis 1 is therefore rejected. The implication is that students' FMA is a significantly predictor of their Physics performance, with calculated significance of (.00) which is less than .05 alpha level ($\varrho < .05$). The Further Mathematics mean score of 73.40 was also greater than the mean score of physics 70.45 (Further Mathematics = 73.40 **>** Physics Performance = 70.45).

| Variables | Number | Mean | Std | df | Cal.r | Sig.(2-tailed) | Decision |
|---|---|---|---|---|---|---|---|
| Further Mathematics | 103 | 73.40 | 13.56 | 101 | 0.57 | 0.00 | $H_{01}$ Rejected |
| Performance Physics | 103 | 70.45 | 11.44 | | | | |

Table 2. PPMC of the Prediction between Further Mathematics and Physics Performance

**$HO_2$:** gender will not significantly influence the prediction between students' further mathematics ability and physics performance.

Testing for Hypothesis 2, MANOVA was employed to analyse respondents' results in Further Mathematics and Physics based on gender as shown on Table 3. Gender influence was not significantly in the prediction between students' further mathematics and physics grades. Evident from the calculated F value of 1.794 as well as p value of .172 which is greater than .05 α level (.172 > .05). The value p here is greater than .05 α level, therefore, the hypothesis is not rejected. Here, the influence of gender in the prediction between students' performance in physics and mathematics is not significantly.

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .969 | 1557.552[b] | 2.000 | 100.000 | .000 |
| | Wilks' Lambda | .031 | 1557.552[b] | 2.000 | 100.000 | .000 |
| | Hotelling's Trace | 31.151 | 1557.552[b] | 2.000 | 100.000 | .000 |
| | Roy's Largest Root | 31.151 | 1557.552[b] | 2.000 | 100.000 | .000 |
| Gender | Pillai's Trace | .035 | 1.794[b] | 2.000 | 100.000 | .172 |
| | Wilks' Lambda | .965 | 1.794[b] | 2.000 | 100.000 | . 172 |
| | Hotelling's Trace | .036 | 1.794[b] | 2.000 | 100.000 | .172 |
| | Roy's Largest Root | .036 | 1.794[b] | 2.000 | 100.000 | .172 |

Table 3. MANOVA of Gender Prediction between Students' Further Mathematical Ability and their performance in Physics

**$HO_3$:** school type will not significantly influence the prediction between further mathematics ability and physics performance.

Further mathematics and physics grades of respondents was analysed using MANOVA based in checking the influence of type of school on the prediction between further mathematics ability and students' performance in physics. As shown on Table 4, type of school did not influence significantly the prediction between students' further mathematics ability and students' physics performance. As revealed on Table 4, calculated value of F is 1.762 and p-value .177 for school type which is greater than .05 α (.177 > .05). The value of p here is greater than .05, our hypothesis is, therefore, not rejected. This means that the type of school did not significantly impact the prediction between physics and further mathematics ability of respondents.

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .978 | 2201.651[b] | 2.000 | 100.000 | .000 |
| | Wilks' Lambda | .022 | 2201.651[b] | 2.000 | 100.000 | .000 |
| | Hotelling's Trace | 44.033 | 2201.651[b] | 2.000 | 100.000 | .000 |
| | Roy's Largest Root | 44.033 | 2201.651[b] | 2.000 | 100.000 | .000 |
| School type | Pillai's Trace | .034 | 1.762[b] | 2.000 | 100.000 | .177 |
| | Wilks' Lambda | .966 | 1.762[b] | 2.000 | 100.000 | . 177 |
| | Hotelling's Trace | .035 | 1.762[b] | 2.000 | 100.000 | .177 |
| | Roy's Largest Root | .035 | 1.762[b] | 2.000 | 100.000 | .177 |

Table 4. MANOVA of School Type on Further Mathematical Ability and physics performance

## 7. Discussion

There exists a strong relationship between further mathematics ability and physics performance in this study. The relationship between these two variables is significant. Consequently, high scorers in physics also scored high in further mathematics and the same can be said of other level of abilities. From the reviewed literature, the difficulty experiences in learning physics are often linked to the inadequacies of learners in mathematics' (Yuliati, 2018; Nakakoji & Wilson, 2018). The inter-relatedness of the curriculum content of further mathematics and physics at senior secondary school level as espoused in the studies of Ahmed et al (2015), Bowyer & Darlington (2016), Michelsen (2015) and Rossdy et al (2019) lay credence to the outcome of this study. In addition, Burkholder et al (2021), Nakakoji and Wilson (2018), Oluwatusin and Dele-Rotimi (2017) and Abubakar et al (2015) also reported further/advance mathematics as correlate of physics performance in their studies. However, what topics in further mathematics are most related, which skills are specifically transferred, and the context of the transfer require further research as the subject remains wide yet difficult.

Students with high ability level in Further Mathematics were high performers in Physics, students with medium ability level in Further Mathematics had medium performance score while low ability students in

mathematics had low performance in physics. This trend confirmed a significant correlation between FMA and students' performance in physics as exposed in the analysis and further substantiated by the works of Okye and Gladysibibo (2015) and Abubakar et al (2015). The state of affairs in research parlance have posited fairly in the ability of both male and female learner (Badmus & Jita, 2022; Baldwin et al., 2016). In this study, more male students offered further mathematics than female students in this study. From the mean score of students, male participants also had better mean score when compared to their female counterpart in both physics and further mathematics. The corresponding however hypothesis confirmed no significant influence of gender in the performance of students in further mathematics and physics. This study further confirms the earlier position the that gender is not a significant factor in the abilities of learners in both mathematics and physics. 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 .

Researchers have argued for and against the performance of students in both public and private schools. The study of Badmus et al (2020) reported that private schools out-perform public school in physics. Contrarily, Olatoye and Agbatogun (2009) in their study posited insignificance difference in the performance of students from both private and public schools. In this study, private schools had higher number of Further mathematics students than the public schools. This position may have arisen from the standard upheld by private schools in terms of staffing and teaching which appears to be the alternative in public schools. Private school students had higher mean score in both FMA and performance in Physics in this study. However, type of school had no significant influence on the prediction between performance and ability of students in both physics and further mathematics in this study. The curriculum of both physics and further mathematics are the same with reference to objectives and expected outcome. Similarly, the mode of training for teachers are often similar with comparable qualification. It is deducible that, the syllabus, teaching and learning of the subjects are similar for the types of schools which may account for this outcome. The findings of this study agreed with the studies of Alimi et al (2012), Olasehinde and Olatoye (2014) who reported no significant difference in the performance of students of Public and Private schools and contrary to the study of Joseph (2014) who reported that private school students out-perform their public-school counterpart.

## 8. Conclusion

This study concludes that Further mathematics is a strong predictor of students' performance in physics. This position advised that students should be encouraged to undertake further mathematics as studies have found it to be useful in tertiary education, especially in STEM fields. Unlike several studies cited, gender and type of school had no significant influence the prediction between further mathematics ability and physics performance amongst participants in this study.

## 9. Recommendation

For improved performance in physics, students should offer further mathematics. 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. Public school should be exposed to the same resources available in private schools to bridge the gap in their performance.

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