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The Predictive Power of Ordinary Level Mathematics Scores on Advanced Level Physics Performance in Some Selected Schools in Mezam Division, North West Region of Cameroon

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Abstract

Aim: The study aimed to examine whether knowledge of Ordinary Level mathematics serves as a prerequisite for student performance in advanced level physics in some selected schools in the Mezam Division, North West Region of Cameroon.

Methods: A survey research design supported by ex post facto analysis was employed. Data were collected from 240 participants using questionnaires, checklists, and focus group discussions. Descriptive statistics, t-tests, and Pearson correlation were used in the analysis.

Results: Results showed a significant positive relationship between ordinary level mathematics knowledge and advanced level physics performance. Both school records and questionnaire responses confirmed that students with stronger mathematics foundations performed better in physics.

Conclusion: The study concludes that ordinary-level mathematics knowledge is a strong predictor of advanced-level physics performance. Therefore, strengthening mathematics instruction at the Ordinary Level is essential for improving student success in physics.

Recommendation: It is recommended that curriculum developers integrate mathematics more explicitly into physics instruction, and that schools provide remedial mathematics support for students struggling with key concepts such as algebra and trigonometry.

Keywords: *Ordinary level mathematics, instruction, physics performance, STEM education, curriculum development, Cameroon*

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INTRODUCTION

Ordinary Level mathematics knowledge refers to the mathematics knowledge students acquire from Form 3 to Form 5 of the first cycle of secondary school, leading to the ordinary level certificate award. On the other hand, advanced level physics is the knowledge students acquire in physics in the second cycle of secondary school, from lower sixth to upper sixth. Physics and mathematics are the two most closely related natural rudimentary subjects (Pereira *et al.,* 2021). Mathematics and physics, being the bedrock of science and Technology, the movement up from the primary to the secondary and then the tertiary levels leave much to be desired. The number of students pursuing the sciences continues to dwindle. It is even worse when it comes to the girl child, therefore creating more gender inequality (Mbah, 2022).

Mathematics is widely recognized as a prerequisite for learning physics, as it underpins concepts such as graph interpretation, geometry, and data analysis (Pereira *et al.,* 2021). Prior studies have demonstrated that mathematics performance significantly affects students' achievement in physics (Mbah, 2022). The relevance of science is recognized globally for the economic well-being of nations and scientifically literate citizenry (Orodho & Kiruki, 2015). Physics is widely recognized to be the most fundamental of all the sciences and a foundation of our society. The discoveries made in Physics widen our understanding of fundamental processes and the role they play in the advancement of other sciences. The rules that the physicists formulated concerning the propagation of sound waves in solid materials allowed the geologists to use seismological techniques for the investigation of the interior of the earth (Orodho *et al.,* 2015).

The theory of fluid flow is of great importance to the meteorologist and to the oceanographer. A Physics culture is therefore crucial for the successful development of technology and the advancement of any society's economy. The architects and engineers who construct buildings and aircraft indeed make constant use of the laws of mechanics and dynamics as formulated by physicists. Many of the diagnostic and therapeutic techniques used in modern medicine were developed in the physics laboratory (Orodho *et al.,* 2015). Refrigeration, radio and television are outgrowths of discoveries by physicists. The discovery of a transistor in a solid-state physics laboratory has led to a new era of technology. Without the ejection of new ideas that have been produced by physicists, our great technological industries would not exist and the level of our society would be stark and primitive. Physics is therefore intimately connected with technology and it is the impact of this association that is the most apparent effect of physics on society.

In physics, particularly at the advanced level, data collection remains very cardinal. According to Ngozi and Akuro (2014), every human being needs mathematics to function effectively in day-to-day activities. Graph interpretation has traditionally been deemed a mathematical rather than a scientific skill within the context of educational standards in the USA (Peterman *et al.,* 2015). Graphical interpretation is a skill that generalizes across traditional boundaries imposed by specific content areas, with the potential to serve as a unifying practice in science. The interpretation of graphs is a challenge to students of all levels (Glazer, 2011). Graph interpretation skills are acquired at the ordinary level of mathematics. Data literacy is crucial at this stage. Despite this, many students struggle with applying ordinary level (O/L) mathematics knowledge to Advanced Level (A/L) physics, particularly in Cameroon, where dropout rates in physics are high. It is the ability to turn data into evidence that can be used to answer a question or defend a position (Schlager, 2010). Students must be able to consider a question on data, display the data in a way that helps answer that question, interpret the display to extract new relevant information, and answer the question using evidence from the data (Schlager, 2010). With the knowledge of graph interpretation skills gathered from ordinary level mathematics, its applicability in advanced level physics is worth studying.

Amongst the instruments generally used to assess students' views about learning physics are the Colorado Learning Attitude Science Survey (CLASS) and the Maryland Physics Expectations Survey (MPEX). CLASS consists of students' beliefs about learning physics, organized into the following categories: independence, coherence, concepts, links to reality, links to mathematics, and effort and MPEX addresses eight indicators: real-world connection, personal interest, sense-making or effort, conceptual connections, applied conceptual understanding, general problem-solving, problem-solving confidence, and problem-solving sophistication (Sirait *et al.* 2019).

Russo and Roche (2021) have recommended the use of children's storybooks as one of the ways of introducing mathematical ideas through literature. With the use of children's literacy/mathematics intervention in low-income communities. Many studies (Mallam *et al.,* 2022; Hansson *et al.,* 2023) found greater improvement in mathematical achievement among the intervention students. Early mathematics knowledge constitutes a foundation that builds up to ordinary level mathematics knowledge that may eventually influence performance in advanced level physics.

Statement of the Problem

There is a pertinent problem with most physics' students at the Advanced level when it comes to the mathematical aspect of physics. Their overall scores, their graphs interpretation skills, and their knowledge of Geometry in ordinary level mathematics seem to influence their performance in the advanced level physics. Most of them who choose to do physics in the second cycle get frustrated by a lot of mathematics in physics. Noticeably too, there is a decreasing number of science students as students move up the academic ladder (Ooms *et al.,*2018). The increasing rate of dropout from physics classes in the second cycle of the secondary schools in Cameroon is a cause for concern. The pyramid narrows drastically by the time students are to write the General Certificate of Education Advanced Level (GCE A/L) in physics. Recent statistics from the Cameroon GCE Board show that fewer than 55.24% of candidates who pass O/L Mathematics continue to pursue A/L Physics (CGCE, 2024). This decline suggests that mathematical challenges significantly influence subject retention. Without adequate preparedness in O/L mathematics, students experience difficulty in graph interpretation and problem-solving in physics, leading to reduced performance and higher dropout rates. The study therefore sought to find out the relationship between ordinary level mathematics scores on performance at the advanced level physics.

Research Question

To what extent do Ordinary Level mathematics scores predict students' performance in Advanced Level physics in the Mezam Division, Cameroon?

Hypothesis of the Study

Ho: Ordinary level mathematics scores have no significant relationship with performance at the advanced level Physics.

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Ha: Ordinary level Mathematics scores have a significant relationship with performance at the advanced level Physics.

Scope of the Study

This study was delimited to the Mezam Division of the North West Region of Cameroon. The schools considered were those located in Bamenda town, stretching to Bambili and including the University of Bamenda. There were 4 government bilingual high schools, 2 mission schools and 2 lay private schools in the Mezam Division involved in the study. These institutions were exceptionally chosen because they were functional, accessible and offered some relative security.

The level of content coverage in mathematics varies from school to school and even within the same school with many streams, different teachers went to different depths even though the syllabus is there to guide them. It was also presumed that teacher's assessments were strictly based on the topics indicated in the schemes of work. Considering the variable Ordinary level mathematics knowledge, it was delimited to the assessment scores on records available in the schools. These could be the GCE results at ordinary level, the marks obtained in class during continuous assessments and exams.

METHODOLOGY

The study employed an ex post facto design complemented by a descriptive survey. The ex post facto approach was appropriate because the variables of interest (students' past mathematics and physics scores) had already occurred, while the survey provided insights into students' perceptions through questionnaires and focus group discussions. The quantitative data were collected through questionnaire and checklists, while qualitative data were collected through focus group discussions.

The mathematics achievement test scores of the students at the ordinary level (form 4 to form 5) constituted numerical data collected by way of documentary review using a checklist. This was done for two consecutive years as follows:

a) 2018/2019 academic year for those who attempted the GCE A/L physics in Upper Sixth (US) in 2021.
b) 2017/2018 academic year for those who attempted the GCE A/L physics in Upper Sixth (US) in 2020.

Similarly, the Advanced level physics performance of the students was collected as numerical data from their GCE A/L results using a checklist. This was done for two consecutive years – 2020 and 2021 (see Table 1 below).

Table 1: Students' Classes and Years for Data Collection

Year	2017	2018	2019	2020	2021
		CODE A	CODE A		CODE A
		FORM 4	FORM 5		US
	CODE B	CODE B		CODE B	
	FORM 4	FORM 5		US	

Qualitative Designs

The focus group guide was both structured and unstructured. The participants in the Focus Group Discussion were the University of Bamenda science students and particularly those who did physics at the advanced level. This group of students was chosen because they had done physics at the advanced level and mathematics, which is a compulsory subject at the Ordinary level.

Ex post facto Design

This research design was used since the data collected was from Students who had already attempted GCE A/L Physics and had also done ordinary level mathematics in Form 4 & 5. This was done by getting to particular schools and collecting information about students who wrote the Advanced level physics, then comparing with their ordinary level mathematics results as per the years stated in table 1 above.

Checklist

For every school considered, the advanced-level list of physics candidates for a given year was consulted. For a student whose name featured on such a list, the GCE A/L physics scores were recorded. Then, for the same student, the mathematics scores for the corresponding years of Form 4 and Form 5 were recorded in a checklist. For the cases of GCE A/L Physics, two consecutive years were considered, coinciding with two consecutive years at the Ordinary Level.

The Study Population

The accessible population was made up of past physics students of functional grammar high schools in the Mezam Division. A purposive sampling method was used to select schools that consistently presented candidates for A/L Physics between 2017 and 2021. This ensured the availability of complete academic records. The final sample included 240 students, distributed proportionally across government, mission, and private schools as shown in Table 2.

Table 2: Some Selected Schools in Mezam Division for Data Collection

S/N	School type	School	Locality	Sample population	Accessible (Sampled) population
1	Government	GBHS Bamenda	Bamenda	36	42
2	Government	GBHS Bamendakwe	Bamendankwe	14	17
3	Government	GBHS Downtown	Bamenda	10	12
4	Mission	OLLSS Mankon	Bamenda	19	22
5	Mission	Sacred Heart College	Mankon	32	37
6	Lay private	PCHS Bamenda	Bamenda	10	12

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7	Government	The University of Bamenda	Bambili	97	132
8	Lay private	National Polytechnic Bamenda	Bambui	8	8
9	Private individuals	Ex-students are now Economic operators	Bamenda-Bambui-Bambili	14	17
	TOTAL			**240**	**299**

PRESENTATION OF FINDINGS

The findings from the data analyses are presented here in relation to the research objective and hypothesis. The objective was to find out the impact of ordinary level mathematics scores on performance at the advanced level physics.

Table 3: Students' Perceptions of Mathematics at Ordinary Level (N = 120)

Items	S. D	D	A	S. A	Decision
I had good mathematics Teacher(s) in forms 1 and 2	9(7.5%)	16(13.3%)	43(35.8%)	52(43.3%)	A
All my mathematics teachers from forms 3 to 5 were good	16(13.3%)	13(10.8%)	48(40.0%)	43(35.8%)	A
I liked mathematics all through form 1 to form 5	21(17.5%)	13(10.8%)	38(31.7%)	48(40.0%)	A
My liking for mathematics was increasing from forms 1 to 5	17(14.2%)	11(9.2%)	45(37.5%)	47(39.2%)	A
My liking for mathematics was decreasing from forms 1 to 5	13(10.8%)	17(14.2%)	48(40.0%)	42(35.0%)	A
I received a prize at least once for excellent performance in mathematics at some point in the first cycle	40 (33.3%)	28 (23.3%)	30 (25.0%)	22 (18.3%)	D

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I was good at all the sciences at ordinary level	14(11.7%)	10(8.3%)	46(38.3%)	50(41.7%)	A
I attended mathematics extra classes	17(14.2%)	29(24.2%)	40(33.3%)	34(28.3%)	A
My score in mathematics was always below 15/20	13(10.8%)	27(22.5%)	35(29.2%)	45(37.5%)	A
I passed both Maths and Additional Maths at the GCE O/L	18(15.0%)	25(20.8%)	36(30.0%)	41(34.2%)	A
MRS (marginal rate of substitution)	**178(14.8%)**	**189(15.8%)**	**409(34.1%)**	**424(35.3%)**	**A**

The students revealed that they had good mathematics teachers from Form 1 to Form 5 and they love studying mathematics in all the classes. Most students have never received a prize for excellent performance in mathematics in the first cycle. Most of them were good at all the sciences at an ordinary level and attended mathematics extra classes, though their score in mathematics was always below 15/20. Many passed both mathematics and Additional Mathematics at the General Certificate of Education Ordinary Level (GCE O/L).

Table 4: Exploring Performance at Physics A/L

Items	S.D	D	A	S. A	Decision
I had a good teacher for physics practicals in the lower sixth	13(10.8%)	21(17.5%)	36(30.0%)	50(41.7%)	A
I had a good teacher for physics practicals in upper sixth	14(11.7%)	16(13.3%)	44(36.7%)	46(38.3%)	A
Physics was one of my best subjects in high school	26(21.7%)	28(23.3%)	32(26.7%)	34(28.3%)	A
I had a good physics teacher in the upper sixth	17(14.2%)	11(9.2%)	41(34.2%)	51(42.5%)	A
I received a prize in physics while in high school	61(50.8%)	32(26.7%)	14(11.7%)	13(10.8%)	D
I had someone that was assisting me in difficult sections in A/L physics	33(27.5%)	35(29.2%)	29(24.2%)	23(19.2%)	D
We used to have extra classes in physics	22(18.3%)	42(35.0%)	30(25.0%)	26(21.7%)	D

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My attendance records in advanced-level physics were excellent	25(20.8%)	24(20.0%)	42(35.0%)	29(24.2%)	A
I passed the GCE A/L in physics	15(12.5%)	8(6.7%)	46(38.3%)	51(42.5%)	A
I used to apply the physics knowledge I had in high school.	17(14.2%)	13(10.8%)	51(42.5%)	39(32.5%)	A
I had difficulties in interpreting A/L physics graphs questions	2117.5%)	26(21.7%)	35(29.2%)	38(31.7%)	A
In A/L physics, anything in the form of a plane figure attracted me	32(26.7%)	18(15.0%)	47(39.2%)	23(19.2%)	A
In high school, any part of physics that involved mathematics kept me away	22(18.3%)	19(15.8%)	37(30.8%)	42(35.0%)	A
MRS (marginal rate of substitution)	**318(20.4%)**	**293(18.8%)**	**484(31.0%)**	**465(29.8%)**	**A**

The students opined that they had a good teacher for physics practical lessons in the Lower Sixth and Upper Sixth classes. Physics was one of their best subjects in high school, though most of them never received a prize in physics while in high school because they did not have someone who was assisting them in difficult sections in advanced-level physics. They usually had extra classes in physics and their attendance records in advanced-level physics were excellent. Most of them passed the GCE advanced level in physics and they usually apply the physics knowledge they had in high school in their everyday life. Many students had difficulties in interpreting advanced-level physics graphs and questions and anything in the form of plane figures attracted them to learn. In high school, most topics of physics that involved mathematics were problematic. Although most students reported liking mathematics and having supportive teachers, their scores were often below 15/20. This suggests that positive attitudes alone may not guarantee high performance and points to possible gaps in pedagogy or curriculum delivery.

Hypothesis Testing

Ho: Ordinary Level mathematics scores have no significance on performance in Advanced Level Physics.

Ha: Ordinary Level mathematics scores have a significant impact on performance in Advanced Level Physics.

This hypothesis was evaluated using a correlational analysis to determine the relationship between students' mathematics scores at the Ordinary Level and their performance in Advanced Level Physics, using both questionnaire responses and school-recorded scores.

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Table 5: Correlation Between Mathematics Scores and Physics Performance (Questionnaire)

Variables	Pearson Correlation	Sig. (2-tailed)	N
Mathematics Scores and Physics Performance	0.456**	0.000	120

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

Results from School Data

The results from the school data are presented in Table 6.

Table 6: Correlation Between O/L Mathematics Annual Average and Physics Scores (School Data)

Variables	Pearson Correlation	Sig. (2-tailed)	N
O/L Mathematics Annual Average and Physics Scores	0.530**	0.000	120

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

The results from both the questionnaire data and the school-recorded data show a significant positive correlation between mathematics scores at the Ordinary Level and performance in Advanced Level Physics. The Pearson correlation coefficients are 0.456^{**} (questionnaire) and 0.530^{**} (school data), respectively, indicating a strong relationship at $p < 0.01$ suggesting that these correlations are statistically significant. This consistency across data sources reinforces the critical role of mathematics proficiency in physics performance.

The null hypothesis, which stated that ordinary-level mathematics scores have no significance on performance at the advanced level physics, was rejected and the alternative hypothesis, which stated that ordinary-level mathematics scores have a significance on performance at the A/L Physics, was upheld. Having a strong mathematical base at the ordinary level therefore can better guarantee a high performance in advanced level physics. The Pearson correlation of 0.530 suggests a moderate to strong relationship, indicating that mathematics proficiency explains approximately 28% ($r^2 = 0.28$) of the variance in physics performance. This shows that while mathematics is important, other factors such as teaching quality and student motivation also play a role.

DISCUSSIONS

Based on the results, the null hypothesis (H_o) was rejected and the alternative hypothesis (H_a) was accepted. This means that there is a significant relationship between mathematics scores at the ordinary level and performance in advanced level physics. Students who achieve higher scores in mathematics at the ordinary level tend to perform better in advanced level physics.

The correlation analysis showed a moderate positive relationship between mathematics scores at the ordinary level and performance in advanced level physics. This significant correlation highlights that students who perform well in mathematics at the ordinary level are likely to excel in advanced level physics. Mathematics forms the backbone of many physics concepts, and a strong grasp of mathematical principles is essential for solving physics problems and understanding theoretical concepts. The findings suggest that improving mathematics education at the ordinary level can have a substantial impact on students' performance in physics. Other scholars (Awafala *et al.* 2014 and Burkholder *et al.* 2021) affirmed that the teaching of prerequisite mathematics concepts in physics before physics teaching should be adopted as an instructional technique for enhancing meaningful learning in physics. Also, a study conducted by Buker *et al.* (2021) showed a high correlation (r = 0.934 at alpha level 0.05) between students' performance in physics and mathematics from form 3 and 5. While Awafala *et al.* (2014) support the integration of prerequisite mathematics concepts into physics teaching, our findings suggest that even with a strong mathematics foundation, students may still struggle with physics graph interpretation. This nuance highlights the need for targeted instructional strategies beyond mathematics reinforcement.

IMPLICATION OF FINDINGS

Educational Importance

This finding highlights the critical role of a strong foundation in mathematics for success in advanced-level physics. Trigonometric functions are essential in understanding wave phenomena, while algebraic manipulation supports the resolution of kinematic equations. Ensuring that students have a robust understanding of mathematical concepts at the Ordinary Level is crucial for their success in physics and other STEM subjects at higher levels.

Curriculum Development

Educators and curriculum developers should emphasize the importance of mathematics in the overall science curriculum. This might involve integrating more advanced mathematical concepts and problem-solving exercises that are directly related to physics. Curriculum developers could introduce physics-focused mathematics modules at the ordinary level, such as vector analysis for mechanics and simultaneous equations for circuit analysis. This integration ensures students see direct connections between abstract mathematics and real-world physics applications.

Teacher Training

Teachers should be equipped with the skills and knowledge to effectively teach mathematics in a way that highlights its relevance to physics and other scientific disciplines. Professional development programs can help teachers integrate mathematical problem-solving into their physics instruction. Training programs should focus on strategies for making mathematics engaging and accessible, linking mathematical theory to practical physics applications.

Student Support

Additional support and resources should be provided to students who struggle with mathematics. Tutoring programs, extra practice sessions, and personalized learning plans can help improve their mathematical skills, which, in turn, can enhance their performance in physics. Schools could implement peer-tutoring systems where advanced students mentor struggling learners in solving algebraic problems used in physics equations. Additionally, integrating math practice software like GeoGebra or Khan Academy could provide interactive problem-solving support.

Policy Implications

Educational policies should recognize the interconnectedness of mathematics and physics education. Investments in improving mathematics education at the ordinary level can have far-reaching effects on students' overall academic success, particularly in physics and other science subjects. Policymakers should ensure that schools have the necessary resources and support to

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deliver high-quality mathematics education, including modern textbooks, technology, and well-trained teachers. Fostering strong mathematical foundations in students will enable them to tackle complex problems, innovate, and contribute to advancements in science and technology. Schools could implement peer-tutoring systems where advanced students mentor struggling learners in solving algebraic problems used in physics equations. Additionally, integrating math practice software like GeoGebra or Khan Academy could provide interactive problem-solving support.

CONCLUSION

Proficiency in mathematics at the ordinary level is crucial for success in advanced level physics. Students who perform well in mathematics are better equipped to handle the mathematical demands of physics. Physics like any other science discipline has to do with figures at one time or another. Since the knowledge acquired in ordinary and advanced level physics is widely applicable in contemporary society, practical and laboratory methods of teaching Physics are essential. Similarly, modern methods of teaching mathematics are highly indispensable since mathematics has several applications in Science, Technology, Engineering, Agriculture, and all the Mathematical Sciences (STEAM). As demonstrated in this study, mathematics underpins nearly every domain of physics and wider STEM fields, confirming its centrality as a foundational discipline in scientific advancement.

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