ASSESSING THE INFLUENCE OF KNOWLEDGE OF MATHEMATICS ON STUDENTS' LEARNING IN PHYSICS

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY. IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE IN EDUCATION B. Sc. (Ed) IN PHYSICS EDUCATION, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA

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CERTIFICATION

We, the undersigned, certify that this work was written by **Emmanuel Eshioke LUCKY** with the matriculation number **EDU2202784** in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City, Nigeria.

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DEDICATION

This Study is dedicated to God almighty and to the students who struggle through school.

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I would like to express my sincere gratitude to God for bringing me this far, may His name be praised. I would like to appreciate my project supervisor Prof. F .O IDEHEN for his fatherly love, guidance and support throughout the duration of this project. His insightful feedback and encouragement were crucial in the completion of this work.

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ABSTRACT

This study was carried out to determine the influence of knowledge of mathematics on students' learning in physics in University of Benin. Four research questions were raised and answered. The descriptive survey research design was adopted for this study. The research instrument used for this study was the structured questionnaire which was administered to the respondents. The questionnaire was administered to respondents by the researcher, aided by trained research assistants who were thoroughly briefed on the administration procedure. The assistants facilitated the distribution and collection of the questionnaires from the respondents. Upon completion, each questionnaire was reviewed to ensure a high level of completeness. Notably, the response rate was 120, indicating successful data collection process.

Data was analysed using mean and standard deviation. It was revealed from the finding that that student need some level of mathematical knowledge to study physics. student have a great perception on the role of mathematics in their ability to learn and solve problems in physics. That students without proper mathematical training and knowledge face lots of challenges when mathematical knowledge to solve physics.

It was concluded that mathematics knowledge plays a fundamental role in students' understanding and performance in physics. The two subjects are closely interrelated, and deficiencies in mathematics directly hinder students' ability to comprehend and solve physics problems effectively. It was recommended that Schools should encourage collaboration between mathematics and physics teachers to ensure that mathematical concepts taught are immediately applied in physics lessons. Professional development programs should be provided to teachers to enhance their ability to connect mathematical principles with physical phenomena effectively.

CHAPTER ONE

INTRODUCTION

Background to the Study

Mathematics is the creation, representation analysis, interpretation of numbers and symbols affects all aspects of the human environment significantly, but at varying degrees. The social, economic, political, geographical, scientific and technological aspects of man's life centre on number. One very important fact is that all other disciplines of numbers- Arithmetic, statistics,

accounts etc. are integral parts of mathematics, (Ogunleye, Awofala and Adekoya). Civilization is also traceable to the knowledge of Mathematics.

The earliest civilization of mankind came through mathematical manipulation. The pyramid of Egypt constructed several years ago still remains tourist attraction to date. The construction of the pyramids involved sound and intelligent mathematical calculation. Owing to its numeral and symbolic nature, it is more married to the scientific and technology facets of our world than to any other aspect. It occurs and reoccurs in physical and natural sciences which are mainly represented by physics and chemistry in our secondary schools. Based on this circumstance, it is an established fact that mathematics is and remains a dominant contributing factor to the performance of students in physics and the control tool of mathematics remains the basic skills underlying all scientific and technological skills (Akinsola, 2019). Mathematics is a subject that is related to other science subjects such as physics and chemistry in areas like Number and numeration–fractions, logarithms indices, Algebraic processes solution of equations, variation, graph, and also in volume and students often perform poorly in the sciences (Jegede, Okota, and Eniayeju, 2012; Mkpananga, 2015).

Student's knowledge of mathematics can be classified into three categories; conceptual understanding, procedural knowledge, and problem solving (National Assessment of Educational Progress, 2003). Students demonstrate conceptual understanding when they provide evidence that they can recognize, label and generate examples of concepts, use and interrelate models,

diagrams, manipulative and varied representation of concepts; identify and apply principles, know and apply facts and definitions; compare and contrast, and integrate related concepts and principles; recognize, interpret and apply the signs, symbols and terms used to represent concepts, conceptual understanding reflects a student's ability to reason in settings involving the careful application of concepts definition, relations or representations of either.

Students demonstrate procedural knowledge when they select and apply appropriate procedures correctly; verify the correctness of a procedure using concrete models or symbolic methods; or extend or modify procedures to deal with factors inherent in problem settings. Procedural knowledge encompasses the abilities to read and produce graphs and tables, execute geometric constructions, and perform non computational skills such as rounding and ordering. Procedural knowledge is often reflected in a student's ability to connect an algorithmic process with a given problem situation, to employ that algorithm correctly, and to communicate the results of the algorithm in the context of the problem setting. Problem solving in mathematics is demonstrated by students when they recognize and formulate problems, determine the consistency of the data; use strategies, data, models; generate, extend and modify procedures; use reasoning in new settings; and judge the reasonableness and correctness of solutions. Problem solving situations require students to connect all their mathematical knowledge of concepts, procedures, reasoning, and communication skills to solve problems.

Mathematics forms a strong foundation for the study of physics. Mathematics serves as a symbolic expression in physics to show the structure of relationship between different factors (Terigue, 2005). Similarly, Jia (2013) asserts that symbolic expression allows learners to have a better understanding of physics contents and improve their procedural knowledge to inter-relate various symbols during solving of physics problems.

Physics is a physical science which is the study of matter in relation to energy and motion. Charles-Organ and Okey (2017) conceptualized Physics as the study of systematized knowledge produced by careful observation, measurement and experiment with the motive of establishing basic physical laws and explanations of basic physical phenomenon. Physics has been identified as the bedrock of technological development of any nation; because of the application of its principles, theories and laws in the technological world (Awodun and Ojo, 2013). In another dimension, Obafemi and Ogunkunle (2013) submitted that Physics is an interesting subject which used Mathematics as it official language to link the principles leant in the classroom and experimental results obtained in the laboratories with the practical applications in every human endeavour.

Physics educators have identified several factors which are responsible for the poor achievement in Physics, few of which are: poor method of instruction (Adegoke, 2009; Babajide, 2013) misconception about the nature of Physics (Babajide, Adeyemo&Ogunleye,2018); poor home and classroom environment (Adeyemo, 2010) and students' poor attitude towards Physics

(Adeyemo, 2012). Suggested solutions to the affirmative problems were provided such as the use of students centred approaches that will correct students' misconceptions, improved classroom environment, and students' positive attitudes towards Physics etc. Yet the problem has not been totally eradicated; this implies that there are still other factors. Consequently, the poor performance of students in Physics may be due to poor mathematical knowledge of Physics students who sat for the external examination. A poor mathematical knowledge may prevent Physics students from engaging in any career in Physics science related field such as Engineering, Computer Science, Marine Science etc., as Physics remains a pre-requisite for studying such courses. Gender and type of schools are moderator variables whose influence was investigated in this study. The choice of these variables is due to the fact that the issue of gender in science and Physics in particular in Africa is still debatable, some authors identified Physics and Mathematics as a male subject while arts and humanities are ascribed to female (Okigbe & Okeke, 2011; Babajide, 2010).

Hence, Physics students must possess adequate knowledge of Mathematics, the language of Physics before such a student can perform excellently in the subject. Although some individuals may argue that students who is not grounded in Mathematical knowledge but grounded in English language will be able to define, explain and apply Physics concepts to practical situations but will not be able to calculate can still pass Physics at the level of ordinary pass or average since Physics concepts can both be expressed in English language and

Mathematics, but this is not a good foundation for engineering, medicine and technological inventions and other related science professions. This is in agreement with Thanormsuay, (2010) that science and Engineering students need strong Mathematics background to succeed in the area of specialization.

However, Physics was considered as a difficult subject and was not attracted by students because of its mathematical nature (Obafemi, 2013; 2015). In the same vein, Owolabi (2010) discovered that students are deficient in mathematical concepts; hence, they perform poorly in Physics. Also, Ighomereho (2015) found that students who perform poorly in Physics have inadequate mathematical background. Also, the West Africa Examination Council (WAEC) Chief examiner's report (2015) showed that students lost marks in Physics based on their Mathematics error. It is pertinent to note that Mathematics being the language of Physics does not mean that all Physics concepts are expressed in Mathematics, but are both expressed in English and in Mathematics but the mathematical expression supersedes the English expression because any English language error committed by students in Physics is pardonable but mathematical expression error committed is not pardonable in Physics. It therefore follows that students who are well knowledgeable in Mathematics will do well in the calculation aspect and those who are good in English language will do well in the non-calculation aspect of Physics (Ighomereho, 2015). The overall performance in Physics may probably be affected by

mathematical knowledge. Therefore, this study is an Assessment of the Influence of Knowledge of Mathematics on Students' Learning Physics.

Statement of the Problem

Physics, as a core science subject, is deeply rooted in mathematical principles. The study of concepts such as motion, energy, electricity, and waves often requires a solid understanding of mathematical operations, including algebra, trigonometry, and calculus. However, many students struggle with physics not because of the conceptual difficulty of the subject itself, but due to a weak foundation in mathematics. This has raised concerns among educators and researchers about the extent to which mathematical competence influences students' ability to understand and apply physics concepts. In many secondary and tertiary institutions, a persistent gap is observed between students' performance in mathematics and their achievement in physics. Despite efforts to improve teaching methods in both subjects, students often underperform in physics examinations, and preliminary investigations suggest that poor mathematical skills could be a contributing factor.

The problem this study seeks to address is the unclear relationship between students' knowledge of mathematics and their performance in physics. Specifically, it aims to investigate whether proficiency in mathematics significantly enhances the learning and understanding of physics concepts among students, or whether other factors may be more influential. Without a clear understanding of this relationship, interventions designed to improve physics learning

outcomes may fall short or be misdirected. It is against this background, the researcher choose to investigate an Assessment of the Influence of Knowledge of Mathematics on Students' Learning Physics.

Research Questions

The following research questions were raised for this study, which are:

1. What mathematical knowledge students need to study physics?
2. How do students perceive the role of mathematics in their ability to learn and solve problems in physics?
3. What challenges do students face when applying mathematical knowledge to solve physics problems?
4. How does the availability of instructional materials or resources in mathematics affect students' learning of physics?

Purpose of the Study

The purposes of this study are:

1. to determine the mathematical knowledge students need to study physics2.
2. to examine how students perceive the role of mathematics in their ability to learn and solve problems in physics?

3. to identify the challenges do students face when applying mathematical knowledge to solve physics problems?
4. to evaluate the extent availability of instructional materials or resources in mathematics affect students' learning of physics?

Significance of Study

The significance of the study on Assessment of the Influence of Knowledge of Mathematics on Students' Learning Physics. This study will be beneficial to Student, Lecturer and Ministry of Education. The findings of this study could help highlights the essential role that mathematical knowledge plays in learning and understanding physics.

For Students, by investigating the impact of mathematics proficiency on physics performance, students will become more aware of the interconnectedness between these two subjects. This awareness can encourage them to take their mathematics studies more seriously, knowing that it directly influences their ability to grasp and apply physics concepts effectively.

Secondly, the study will be of immense benefit to lecturers, particularly those involved in the teaching of physics and mathematics at the secondary and tertiary levels. By examining the relationship between students' mathematical knowledge and their ability to learn physics, the findings can help lecturers better understand the root causes of students' struggles in physics and adjust their teaching approaches accordingly.

This study holds significant value for the Ministry of Education, as it provides data-driven insights that can inform policy development, curriculum planning, teacher training, and educational resource allocation. Understanding the relationship between mathematics proficiency and physics learning can help the Ministry design more effective strategies to improve science and mathematics education nationwide. The study highlights the interdisciplinary nature of the curriculum, demonstrating that mathematics is not just a standalone subject but a foundational tool for success in other core subjects like physics. This insight can prompt the Ministry to review and revise curricula to ensure better alignment between the mathematics and physics syllabi, making sure that students are introduced to key mathematical concepts before they are expected to apply them in physics. The findings can guide the Ministry in strengthening teacher training programs. If the study shows that students struggle with physics due to weak mathematical backgrounds, the Ministry may consider implementing professional development programs that train physics teachers to better integrate and reinforce relevant mathematical concepts during instruction. Similarly, math teachers can be trained to highlight the real-world applications of mathematics in sciences like physics.

Scope and Delimitation of Study

The study focused on Assessment of the Influence of Knowledge of Mathematics on Students' Learning Physics. Therefore, this study is delimitated to all physics students.

Operational Definition of Terms

The following are the definition of terms for this study:

Technologies: the application of scientific knowledge for practical purposes, especially in industry.

Interdisciplinary: studies involves the combination of multiple academic disciplines into one activity

Ministry of Education: The Federal Ministry of Education is a part of the Federal Ministries of Nigeria. It regulates secondary and tertiary education in Nigeria.

Proficiency: advancement in knowledge or skill in a particular field

Knowledge: an awareness of facts, a familiarity with individuals and situations, or a practical skill. Knowledge of facts, also called propositional knowledge, is often characterized as true belief that is distinct from opinion or guesswork by virtue of justification.

Awareness: knowledge or perception of a situation or fact in a subject matter

Students: a person who is studying at a university or other place of higher education.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The review of the related literature for this study was carried out under the following sub-headings:

- Concept of Mathematics

- Concept of Physics
- Similarities between the Learning of Physics and Mathematics
- Roles of the knowledge of Mathematics on Student Learning Physics
- Challenges Face by Students Learning Physics
- Instructional Materials needed by Students for Learning of Physics
- Summary of Reviewed Literature

Concept of Mathematics

Mathematics is a field of study that discovers and organizes methods, theories, and theorems that are developed and proved for the needs of empirical sciences and mathematics itself (Devlin, 2000). There are many areas of mathematics, which include number theory (the study of numbers), algebra (the study of formulas and related structures), geometry (the study of shapes and spaces that contain them), analysis (the study of continuous changes), and set theory, which is presently used as a foundation for all mathematics (Stewart & Tall, 2014).

Mathematics involves the description and manipulation of abstract objects that consist of either abstractions from nature or, in modern mathematics, purely abstract entities that are stipulated to have certain properties, called axioms (Courant & Robbins, 1996). Mathematics uses pure reason to prove properties of objects, a proof consisting of a succession of applications of deductive rules to already established results. These results include previously proved theorems, axioms,

and, in the case of abstraction from nature, some basic properties that are considered true starting points of the theory under consideration (Russell, 1919).

Mathematics is essential in the natural sciences, engineering, medicine, finance, computer science, and the social sciences. Although mathematics is extensively used for modeling phenomena, the fundamental truths of mathematics are independent of any scientific experimentation (Kline, 1972). Some areas of mathematics, such as statistics and game theory, are developed in close correlation with their applications and are often grouped under applied mathematics. Other areas are developed independently from any application (and are therefore called pure mathematics) but often later find practical applications (Courant & Robbins, 1996).

Historically, the concept of a proof and its associated mathematical rigour first appeared in Greek mathematics, most notably in Euclid's Elements (Heath, 1956). Since its beginning, mathematics was primarily divided into geometry and arithmetic (the manipulation of natural numbers and fractions), until the 16th and 17th centuries, when algebra and infinitesimal calculus were introduced as new fields (Boyer, 1991). Since then, the interaction between mathematical innovations and scientific discoveries has led to a correlated increase in the development of both. At the end of the 19th century, the foundational crisis of mathematics led to the systematization of the axiomatic method, which heralded a dramatic increase in the number of mathematical areas and their fields of application (Stillwell, 2010). The contemporary

Mathematics Subject Classification lists more than sixty first-level areas of mathematics (American Mathematical Society, 2020).

Concept of Physics

Physics is a branch of science and one of the most fundamental scientific disciplines. The main goal of physics is to explain how things move in space and time and to understand how the universe behaves. It studies matter, forces, and their effects. The word physics comes from the Greek word physis (φύσις), meaning "nature" (Halliday, Resnick, & Walker, 2014).

Physics is crucial in engineering and in the development of new technologies, such as aviation, electronics, and weapons (Tipler & Mosca, 2008). One of the motivations for developing calculus, a major field in mathematics, was to address problems in mechanics, a branch of physics (Stewart, 2015). Modern physics connects ideas about the four conservation laws: energy, momentum, charge, and parity, along with the principles of symmetry (Feynman, Leighton, & Sands, 2010).

Physics became a distinct field of study following the Scientific Revolution. Galileo Galilei's experiments laid the groundwork for classical physics. Although he did not invent the telescope, he significantly improved it and used it to observe the night sky. Galileo supported Copernicus' heliocentric model that the Earth moves around the Sun and made significant contributions to the study of gravity (Drake, 2001). Isaac Newton later built upon Galileo's ideas to formulate his

three laws of motion and the law of universal gravitation, which explained both falling objects and planetary motion (Westfall, 1980).

By the 18th and 19th centuries, during the Industrial Revolution, more scientific discoveries accelerated progress in physics and other fields. Classical physics is adequate for studying objects moving much slower than the speed of light and that are not on a microscopic scale. However, with the discovery of quantum mechanics in the early 20th century, a new framework modern physics was necessary to explain phenomena at atomic and subatomic scales (Griffiths, 2018). Physics is considered a quantitative science because it relies heavily on numerical measurement. Mathematics is used to construct models in physics that predict outcomes in the natural world. These predictions are tested against empirical observations, and physicists continuously refine their models to improve accuracy (Giambattista, Richardson, & Richardson, 2009).

Similarities between the Learning of Physics and Mathematics

Physics and mathematics are deeply interconnected disciplines, and their learning processes share several fundamental similarities. These similarities stem from the fact that both subjects rely heavily on logical reasoning, abstract thinking, and problem-solving. Below are some key areas where the learning of physics and mathematics overlap:

Use of Abstract Concepts

Both physics and mathematics rely heavily on abstract concepts to describe, explain, and predict phenomena. While mathematics develops abstract ideas as a language and method of reasoning, physics applies these ideas to understand the physical world. The use of abstract concepts allows learners to move beyond concrete experiences and work with symbolic representations, models, and generalized principles.

Problem-Solving Approach

The problem-solving approach is a systematic method used in both physics and mathematics to analyze situations, apply principles, and arrive at accurate solutions. It helps students think logically, organize their ideas, and connect concepts to real-life situations.

Dependence on Formulas and Symbols

Both physics and mathematics rely heavily on formulas and symbols as essential tools for expressing ideas, solving problems, and communicating concepts. These symbols and formulas create a universal language that makes complex information easier to understand and apply.

Importance of Graphical Interpretation

Graphical interpretation refers to understanding and analyzing information presented in the form of graphs, charts, and diagrams. In both physics and mathematics, graphs are powerful tools for visualizing relationships, identifying patterns, and making predictions.

Logical and Analytical Thinking

Success in both physics and mathematics requires strong analytical skills.

Learners must understand how to build arguments, make inferences, and check for consistency and accuracy.

Progressive Learning Structure

Both disciplines are cumulative in nature; concepts build on each other. For example, understanding algebra is necessary before tackling calculus in math, just as understanding motion is essential before learning dynamics in physics.

Application to Real-World Problems

Physics and mathematics play a vital role in solving real-world problems. Their concepts, formulas, and methods help explain natural phenomena, guide technological development, and support decision-making in everyday life.

Precision and Accuracy

Precision and accuracy are essential concepts in both physics and mathematics because they ensure reliability and correctness in measurements, calculations, and problem-solving. Learning physics and mathematics requires a shared foundation of logical reasoning, abstract thinking, and

problem-solving skills. The close relationship between the two makes them mutually reinforcing; a strong grasp of mathematical concepts often leads to better understanding in physics, and vice versa. This interdependence highlights the importance of integrating the teaching and learning of both disciplines, especially in science and engineering education.

Roles of the knowledge of Mathematics on Student Learning Physics

Mathematics serves as the foundational language of physics. A solid understanding of mathematical principles is crucial for students to grasp physical concepts, analyze data, and solve physics problems effectively. The relationship between mathematics and physics is so intertwined that success in physics education often depends heavily on the student's competence in mathematics.

Mathematics as the Language of Physics

Mathematics provides the symbols, structures, and notations that allow for the precise description of physical phenomena. According to Redish (2005), "Mathematics is not just a tool used in physics; it is a way of representing and understanding the physical world." Without mathematics, the concise formulation of physical laws (such as Newton's laws or Ohm's law) would not be possible.

Enhances Quantitative Problem-Solving

Physics problems often involve calculations with variables, units, and functions. A strong mathematical background equips students with the skills needed to approach these problems methodically. Studies have shown that students with higher mathematical proficiency perform significantly better in physics problem-solving tasks (Karam & Koliopoulos, 2017).

Supports Conceptual Understanding

Mathematical knowledge aids in the visualization and comprehension of abstract physics concepts. For example, understanding calculus helps in grasping concepts like acceleration and wave motion. Research by Hudson and Henderson (2010) highlights that mathematical representations help students to better connect theoretical physics concepts to real-world phenomena.

Facilitates Graphical and Data Interpretation

Many physics topics involve the interpretation of graphs and data tables, skills that are rooted in mathematics. Concepts like gradients, areas under curves, and trends over time are taught in mathematics and directly applied in topics like kinematics and thermodynamics.

Encourages Logical and Analytical Thinking

Mathematics trains students in logical reasoning and pattern recognition, which are also essential in physics. This analytical mindset enables learners to construct arguments, validate physical laws, and apply critical thinking when evaluating experimental results (Niss, 2011).

Strengthens Academic Performance in Physics

Empirical studies have consistently shown a positive correlation between students' mathematics achievement and their performance in physics. For instance, Tai et al. (2006) found that students' prior knowledge in mathematics significantly predicted their success in college-level physics courses.

Challenges Face by Students Learning Physics

Physics, as a core science subject, plays a critical role in technological advancement and scientific literacy. However, students often face numerous challenges that hinder their effective learning and performance in the subject. These challenges are multifaceted, ranging from conceptual difficulties to institutional and pedagogical barriers.

Abstract Nature and Complexity of Physics Concepts

One of the most prominent challenges students face in learning physics is its abstract and mathematical nature. Many core physics concepts such as electromagnetism, quantum mechanics,

and relativity are not directly observable and require a high level of cognitive abstraction. According to Duit and Treagust (2003), students struggle with understanding phenomena that they cannot physically experience or visualize, which leads to misconceptions and rote memorization instead of deep understanding.

Poor Mathematical Background

Physics relies heavily on mathematical reasoning, formulas, and problem-solving skills. Students with weak mathematical foundations often find it difficult to grasp physics concepts and solve numerical problems effectively. Studies have shown that students' performance in mathematics correlates strongly with their achievement in physics (Ogbonnaya & Mogari, 2014). Without adequate math skills, students are unable to understand the quantitative aspects of physics theories.

Ineffective Teaching Methods

Traditional lecture-based and teacher-centered teaching methods dominate physics classrooms in many schools, particularly in developing countries. This approach often fails to engage students actively or connect theoretical knowledge with practical experiences. According to Aina (2013), ineffective teaching strategies that neglect the use of visual aids, simulations, and hands-on experiments contribute to students' lack of interest and poor comprehension.

Lack of Laboratory Equipment and Facilities

Practical experimentation is essential for students to test hypotheses and understand physics concepts. Unfortunately, many schools, especially in low-income and rural areas, lack adequate laboratory facilities. The absence of functional laboratories restricts experiential learning and contributes to poor academic performance (Ezeliora & George, 2012). Students learn better when they can manipulate apparatus and observe physical phenomena directly.

Negative Attitude and Low Interest

Students often develop a negative attitude toward physics due to its perceived difficulty and lack of relevance to everyday life. This low interest can be attributed to previous failures, societal stereotypes, and peer influence. Research by Oon and Subramaniam (2013) indicates that students' attitudes significantly affect their engagement and achievement in physics. When students perceive physics as a difficult subject, they are less motivated to study it.

Language Barrier

The language used in physics is often technical and filled with specific terminologies that may not be easily understood by students, particularly those who are not proficient in the language of instruction (usually English). This creates an additional layer of difficulty for learners in interpreting and understanding physics texts and exam questions (Rollnick, 2000).

Curriculum Overload

The physics curriculum in many secondary schools is often overloaded with topics, leaving little time for thorough exploration or reinforcement of concepts. Teachers rush through syllabi to meet examination timelines, which undermines deep learning. As noted by Eshach (2006), overly dense curricula discourage critical thinking and reduce the opportunity for hands-on activities.

The challenges faced by students learning physics are deeply rooted in both individual and systemic factors. Addressing these issues requires a holistic approach that includes curriculum reform, teacher training, provision of resources, and innovative teaching methods. Improving students' learning experiences in physics is crucial for fostering scientific literacy and preparing a technologically competent workforce.

Instructional Materials needed by Students for Learning of Physics

Instructional material is an aid to teaching and learning. It helps to raise learning from verbalization to practical aspect of teaching and learning. Instructional materials make teaching and learning interesting, easy and amusing. It makes learning more effective (Clerk, 1997). An instructional material makes students understand physics more easily when the teacher makes use of working model. It makes the teacher task easier and more effective. Olardi,(1990) highlighted the impact of instructional materials that teachers use to improve the students

understanding and perception of the subject. It brings clarity and creates recognition that allows them to have a realistic hand and total knowledge of the student. It enhanced learning, improve the competence of the learners and makes learning more meaningful to the students.

In Onitsha Educational Zone of Anambra state, teaching and learning of physics through the use of instructional materials facilitates, stimulates and aids student to take active interest in the topic introduced by the teacher. An instructional material has emotional impact on physics student and affects their attitude towards what is presented as the topic to study by the teacher. It provides both physics students and physics teachers with relevance and meaningful source of information.

Kay (2008), Instructional materials stimulate the students desire to learn, it assist learning process by making assimilation and memorization of materials easy. Also it helps to hold attention of the student. Finally instructional materials makes learning available to a wider audience, control the pace of learning, promote better understanding of physics concepts and helps to overcome difficulties in presenting physics lesson. Therefore, instructional materials needed by students when learning physics include:

Laboratory Equipment: Physics is an experimental science, and hands-on practical help students see theories in action. When students use laboratory instruments, they learn how to measure physical quantities, observe phenomena, and verify laws (e.g., Hooke's law, Ohm's

law). This improves conceptual understanding, scientific reasoning, and problem-solving skills. Examples of laboratory equipment are needed by students are meter rule, stop clock, vernier caliper, micrometer screw gauge, spring balance, lenses, prisms, ammeter, voltmeter

Instructional Charts and Diagrams Examples includes Circuit diagrams, electromagnetic spectrum charts, ray diagrams, force diagrams. Charts simplify complex concepts by presenting them visually. They serve as constant reference materials that help students quickly recall relationships and physical laws. Diagrams also reinforce memory and help learners visualize abstract ideas like electric fields, wave propagation, or motion.

Models and Apparatus: Examples includes Model of a solar system, atom models, motors and generator models, inclined plane setup, pulley systems. Models make abstract or invisible concepts more concrete. For instance, atomic models help students visualize subatomic structure, while mechanical models demonstrate motion, forces, and energy transformations. They boost comprehension by turning theory into tangible learning experiences.

Multimedia Resources: Examples includes Physics simulations, animations, educational videos, interactive whiteboards, computer-based tutorials.

Some physics concepts such as wave interference, relativity, or magnetic fields are difficult to observe directly. Multimedia tools offer dynamic and interactive representations that allow

students to manipulate variables, observe results instantly, and learn at their own pace. This enhances motivation, engagement, and retention.

Summary of Reviewed Literature

Mathematics is often referred to as the "language of physics," and this relationship is especially evident in tertiary institutions such as the University of Benin, where physics courses demand high levels of mathematical competence. Several studies (e.g., Redish, 2005; Tai et al., 2006) emphasize that students who possess a strong mathematical foundation are more likely to excel in physics. This is because mathematics aids in abstract reasoning, symbolic manipulation, and analytical problem-solving skills that are central to mastering physics concepts such as motion, force, energy, and electricity.

The study also points out that many difficulties faced by students in learning physics stem from poor mathematical skills, particularly in areas like algebra, trigonometry, calculus, and graph interpretation (Karam & Koliopoulos, 2017). These skills are crucial for solving numerical problems and understanding the quantitative aspects of physics. Furthermore, several authors argue for a more integrated teaching approach at the university level, suggesting that synchronized instruction in mathematics and physics can lead to improved learning outcomes. In conclusion, the literature affirms that mathematics is not only a tool but a core component of physics learning. Strengthening mathematical instruction and support at the University of Benin

is essential for improving students' conceptual understanding and academic performance in physics.

CHAPTER THREE

METHODOLOGY

This chapter examines in details the procedures and methods that were employed in collecting and analyzing the data for this study. They are treated under the following sub headings;

- Design of the study
- Population of the Study
- Sample Size and Sampling Technique
- Research Instrument
- Validity of the Instrument
- Method of Data Collection

- Method of Data Analysis

Design of the study

Descriptive survey research design was adopted for the study. The choice of the study stems from its strength as a useful means of fact finding and an acknowledged means of obtaining social facts and opinions for the existing conditions (Nwogu, 2006).This chosen research design method considered appropriate, especially for seeking individuals opinions, attitudes, and perceptions in their natural setting and it enables the researcher to make generalization concerning population of study.

Population of the Study

The population of the study consists of all Undergraduate students Physic Students in the Department of Physic, University of Benin.

Sample and Sampling Technique

In this research work, the random sampling techniques was used to select a sample size of 120 students from the total population of all undergraduate Students in the Department of Physic, University of Benin, making it a total of 120 respondents.

Research Instrument

The research instrument for this study is a structured questionnaire. The questionnaire consist of two (2) sections labeled Section A and Section B. Section A will consist of questions

on the socio- demographic profile of respondents while Section B comprises of 20 items to elicit the data to be analysed to answer the research questions. Items 1-5 mathematical knowledge students need to study physics, items 6-10 are about students perceive the role of mathematics in their ability to learn and solve problems in physics, items 11-15 are about the challenges students face when applying mathematical knowledge to solve physics problems, and item 16-20 are about the availability of instructional materials or resources in mathematics affect students' learning of physics. All items in the Section B-are a 4 point likert scale of Strongly Agree (SA=4 points) Agree (a =3 points), Disagree (d= 2 points) and Strongly Disagree (SD - 1 point)

Validity of the Instrument

The instrument was validated by three experts. The supervisor and two other experts from the Department of Curriculum and Instructional Technology, University of Benin, Benin City. Their suggestions and criticisms will guide the formulation of the final draft of the instrument.

Administration of the Instrument

The instrument was administered by the researcher. They will be collected immediately after filling which enabled the achievement of 100% return rate.

Method of Data Analysis

Data collected was analyzed using mean and standard deviation. This statistical tool was used because of their easy computation and understanding by all and sundry.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

This chapter deals with presentation of results and discussion of findings:

- Presentation of Results
- Discussion of Findings

Presentation of Results

Research Question One

What mathematical knowledge students need to study physics?

Table 1: Mean and standard deviation examining mathematical knowledge students need to study physics

S/N	Item	N	Mean	SD	Remarks
1	Concepts of shapes, angles, areas, volumes, and spatial reasoning from mathematics guide students	120	3.85	.496	Agreed

	when studying physic.				
2	The knowledge of interpreting experimental data, uncertainty, error analysis, and probability distributions in mathematics help students to tackle physic problems.	120	3.83	.513	Agreed
3	Representing quantities with both magnitude and direction, vector addition, and dot/cross products sharpen student understanding when studying physic.	120	3.84	.502	Agreed
4	Understanding sine, cosine, tangent, and their use in resolving vectors, waves, and circular motion in mathematics make it easy for student during physics classes.	120	3.84	.485	Agreed
5	Manipulating equations, solving for the unknowns, and working with formulas in mathematics make physic formulars easy use and understand.	120	3.83	.509	Agreed
	Grand Total		**3.84**	**.501**	**Agreed**

Table 1 present data on the analysis of students' on mathematical knowledge students need to study physics based on the sample size of 120 respondents. The mean score and standard deviation indicate general agreement among students regarding the positive aspect of the responses. The highest mean (Mean = 3.85) suggest that the concepts of shapes, angles, areas, volumes, and spatial reasoning from mathematics guide students when studying physic. Additionally, students highlighted (Mean = 3.83) that the knowledge of interpreting experimental data, uncertainty, error analysis, and probability distributions in mathematics help students to tackle physic problems. While other agree (Mean = 3.84) that representing quantities with both magnitude and direction, vector addition, and dot/cross products sharpen student understanding when studying physic. Again, some also agree(Mean = 3.84) that Understanding sine, cosine,

tangent, and their use in resolving vectors, waves, and circular motion in mathematics make it easy for student during physics classes. The grand mean of 3.84 and standard deviation of 0.501 reinforces the overall positive reseponses toward mathematical knowledge students needed to study physics.

Research Question Two

How do students perceive the role of mathematics in their ability to learn and solve problems in physics?

Table 2: Mean and standard deviation examining how students perceive the role of mathematics in their ability to learn and solve problems in physics

S/N	Item	N	Mean	SD	Remarks
6	I view mathematics as an essential for unlocking the meaning behind physical laws and principles.	120	3.73	.635	Agreed
7	Students who get stuck with mathematical problem will be held back from understanding physics.	120	3.72	.611	Agreed
8	I often see mathematics as the "language" through which physics is communicated.	120	3.70	.602	Agreed
9	I acknowledge that mathematics equips me with strategies to approach and solve quantitative physics problems.	120	3.77	.572	Agreed

10	I understand that the knowledge of mathematics help improve students performances in physic.	120	3.71	.666	Agreed
	Grand Total		**3.73**	**.617**	**Agreed**

Table 2 present insight of how students perceive the role of mathematics in their ability to learn and solve problems in physics. Based on the sample size of 120 respondents, the highest mean (Mean = 3.77) highlighted that students acknowledge that mathematics equips me with strategies to approach and solve quantitative physics problems. Secondly, students agree (Mean = 3.73) that they view mathematics as an essential for unlocking the meaning behind physical laws and principles. While other agree (Mean = 3.70) that they often see mathematics as the "language" through which physics is communicated. Lastly, some also agree (Mean = 3.71) that they understand that the knowledge of mathematics help improve students performances in physic. The grand mean of 3.73 and standard deviation of 0.617 highlighted a positive responses toward students perceive the role of mathematics in their ability to learn and solve problems in physics

Research Question Three

What challenges do students face when applying mathematical knowledge to solve physics problems?

Table 3: Mean and standard deviation examining the challenges do students face when applying mathematical knowledge to solve physics problems

S/N	Item	N	Mean	SD	Remarks
11	I often struggle to convert real-world physical	120	2.79	1.250	Agreed

	situations into mathematical models or equations, which is a critical step in solving physics problems				
12	Weaknesses in mathematical skills such as manipulating equations	120	2.38	1.189	Disagreed
13	I can perform mathematical procedures but do not understand the underlying physics concepts.	120	2.41	1.260	Disagreed
14	i get confused by the use of similar symbols in math and physics (e.g., "v" for velocity vs. frequency) or struggle with units and dimensional analysis, leading to errors.	120	2.34	1.267	Disagreed
15	Failures in Mathematical calculations cause me to avoid engaging fully with physics problems.	120	2.41	1.299	Disagreed
	Grand Total		**2.47**	1.253	**Disagreed**

Table 3 present data on the analysis of the challenges do students face when applying mathematical knowledge to solve physics problems based on the sample size of 120 respondents. The mean score and standard deviation indicate general agreement among students regarding the positive aspect of the responses. The highest mean (Mean = 2.79) agree that they often struggle to convert real-world physical situations into mathematical models or equations, which is a critical step in solving physics problems. Again, students also highlighted (Mean = 2.38) that they encounter Weaknesses in mathematical skills such as manipulating equations. Other highlighted (Mean = 2.41) that they can perform mathematical procedures but do not understand the underlying physics concepts. Lastly, some of the student highlighted (Mean = 2.41) that they encounter failures in Mathematical calculations cause me to avoid engaging fully with physics problems. The grand mean of 2.47 and standard deviation of 1.253 highlighted negative

responses toward the challenges do students face when applying mathematical knowledge to solve physics problems.

Research Question Four

How does the availability of instructional materials or resources in mathematics affect students' learning of physics?

Table 4: Mean and standard deviation examining how availability of instructional materials or resources in mathematics affects students' learning of physics

S/N	Item	N	Mean	SD	Remarks
16	Access to visual aids like graphs, simulations, and geometric models in mathematics helps me grasp abstract physics concepts such as vectors, motion, and force diagrams more clearly	120	3.87	.429	Agreed
17	I use math textbooks, workbooks, and practice software; they strengthen my computational and reasoning abilities, which directly improve their performance in solving physics problems.	120	3.87	.429	Agreed
18	Well-designed mathematics instructional resources often present real-life applications that align with physics topics, helping me see the connection between the two subjects and apply their knowledge across domains.	120	3.82	.449	Agreed

19	Availability of diverse materials like video tutorials, interactive tools, and worksheets enables me with different learning styles and paces to master mathematical skills necessary for physics.	120	3.88	.421	Agreed
20	Engaging and accessible mathematics resources can reduce mathematics-related anxiety, build confidence, and encourage active participation in physics lessons where math is required.	120	3.86	.438	Agreed
	Grand Total		**3.86**	**.433**	**Agreed**

Table 4 present insight of how the availability of instructional materials or resources in mathematics affect students' learning of physics Based on the sample size of 120 respondents, the highest mean (Mean = 3.88) highlighted Availability of diverse materials like video tutorials, interactive tools, and worksheets enables me with different learning styles and paces to master mathematical skills necessary for physics. Secondly, students agree (Mean = 3.87) that students access to visual aids like graphs, simulations, and geometric models in mathematics helps me grasp abstract physics concepts such as vectors, motion, and force diagrams more clearly. While other agree (Mean = 3.87) that they use math textbooks, workbooks, and practice software; they strengthen my computational and reasoning abilities, which directly improve their performance in solving physics problems. Lastly, some also agree (Mean = 3.86) that Engaging and accessible mathematics resources can reduce mathematics-related anxiety, build confidence, and encourage active participation in physics lessons where math is required. The grand mean of 3.86 and standard deviation of 0.433 highlighted positive responses toward how the availability of

instructional materials or resources in mathematics affects students' learning of physics

Discussion of Findings

According to the finding, it was discovered that student need some level of mathematical knowledge to study physics this is inlined with National Assessment of Educational Progress, 2003 which stated that Student's knowledge of mathematics can be classified into three categories; conceptual understanding, procedural knowledge, and problem solving. Students demonstrate conceptual understanding when they provide evidence that they can recognize, label and generate examples of concepts, use and interrelate models, diagrams, manipulative and varied representation of concepts; identify and apply principles, know and apply facts and definitions; compare and contrast, and integrate related concepts and principles; recognize, interpret and apply the signs, symbols and terms used to represent concepts, conceptual understanding reflects a student's ability to reason in settings involving the careful application of concepts definition, relations or representations of either. Most of the respondent agree that The knowledge of interpreting experimental data, uncertainty, error analysis, and probability distributions in mathematics help students to tackle physic problems. Some also agree that Concepts of shapes, angles, areas, volumes, and spatial reasoning from mathematics guide students when studying physic. While some agree that Understanding sine, cosine, tangent, and their use in resolving vectors, waves, and circular motion in mathematics make it easy for student during physics classes.

Furthermore, it was discovered from the finding that student have a great perception on the role of mathematics in their ability to learn and solve problems in physics this is in agreement with Duit and Treagust (2003), which stated that students struggle with understanding phenomena that they cannot physically experience or visualize, which leads to misconceptions and rote memorization instead of deep understanding. Most of the respondent agrees that they view mathematics as an essential for unlocking the meaning behind physical laws and principles. Some also agree that Students who get stuck with mathematical problem will be held back from understanding physics. Again, most of the respondent acknowledges that mathematics equips me with strategies to approach and solve quantitative physics problems.

According to the finding, it was discovered that students without proper mathematical training and knowledge face lots of challenges when mathematical knowledge to solve physics problems this is in agreement Ogbonnaya & Mogari, 2014 who defined that Students with weak mathematical foundations often find it difficult to grasp physics concepts and solve numerical problems effectively. Studies have shown that students' performance in mathematics correlates strongly with their achievement in physics. Some of the respondent agree that they can perform mathematical procedures but do not understand the underlying physics concepts. Other agree that they get confused by the use of similar symbols in math and physics (e.g., "v" for velocity vs. frequency) or struggle with units and dimensional analysis, leading to errors. Lastly, some of the respondent agree that Engaging and accessible mathematics resources can reduce mathematics-

related anxiety, build confidence, and encourage active participation in physics lessons where math is required.

Lastly, it was discovered from the finding that availability of instructional materials or resources in mathematics affects students' learning of physics as most of the respondent agree that Availability of diverse materials like video tutorials, interactive tools, and worksheets enables me with different learning styles and paces to master mathematical skills necessary for physics. Some also agree that Access to visual aids like graphs, simulations, and geometric models in mathematics helps me grasp abstract physics concepts such as vectors, motion, and force diagrams more clearly. Some agree that Well-designed mathematics instructional resources often present real-life applications that align with physics topics, helping me see the connection between the two subjects and apply their knowledge across domains. While others agree that Engaging and accessible mathematics resources can reduce mathematics-related anxiety, build confidence, and encourage active participation in physics lessons where math is required.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter focuses on summary, conclusion and recommendations

Summary

This study investigated the influence of students' knowledge of mathematics on their learning outcomes in physics. The study was motivated by the observed difficulties many students face in understanding physics concepts, which often require mathematical reasoning and problem-solving skills. Four research questions were raised to guide the study.

The sample size of the study was made up of 120 physics Students in the Department of curriculum and instructional technology, Faculty of Education. The research instrument for this study was a structure questionnaire. "Assessing the influence of knowledge of mathematics on students learning in physics". The questionnaire consisted of two (2) sections: A and B. The instrument for data collection was faced validated by the researcher's supervisor and

two other experts in the department of curriculum and instructional technology, Faculty of Education, University of Benin, Benin City, Edo State.

Findings revealed a significant positive correlation between students' mathematical competence and their ability to grasp and apply physics principles.

1. Students with strong mathematical foundations demonstrated better conceptual understanding, analytical thinking, and
2. problem-solving abilities in physics. Conversely, students with weak mathematics backgrounds found it difficult to interpret formulas, manipulate equations, or apply quantitative reasoning, leading to poor performance in physics.
3. The study also identified that teachers' methods, inadequate instructional materials, and curriculum gaps further compounded students' struggles.
4. It emphasized that since mathematics is the language of physics, proficiency in basic mathematical concepts such as algebra, trigonometry, and calculus is crucial for mastering physics topics.

Conclusion

Based on the findings, the study concludes that mathematics knowledge plays a fundamental role in students' understanding and performance in physics. The two subjects are closely interrelated, and deficiencies in mathematics directly hinder students' ability to comprehend and solve physics problems effectively. Therefore, strengthening students' mathematical skills enhances

not only their confidence but also their capacity to apply theoretical and quantitative reasoning in physics.

The study underscores that improving mathematics education is key to advancing achievement in physics, and that interdisciplinary teaching approaches could significantly benefit learners. Therefore, it should be noted that:

1. Students' knowledge of mathematics significantly influences their learning of physics
2. Weak mathematical skills contribute to poor performance and misconceptions in physics
3. Mastery of mathematical concepts enhances students' ability to apply physics principles
4. Improving students' mathematics proficiency is essential for better learning outcomes in physics

Recommendations

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

1. Schools should encourage collaboration between mathematics and physics teachers to ensure that mathematical concepts taught are immediately applied in physics lessons.

2. The curriculum should emphasize mathematical topics essential for understanding physics, including algebraic manipulation, trigonometric functions, vectors, and graphical analysis.

3. Extra lessons or tutorials should be organized for students with weak mathematical backgrounds before advancing to complex physics topics.

4. Professional development programs should be provided to teachers to enhance their ability to connect mathematical principles with physical phenomena effectively.

Suggestions for Further Studies

This study examined the influence of knowledge of mathematics on students learning in physics. The following suggestions for further research were outlined:

1. Future research could examine the specific mathematical concepts that most significantly influence students' understanding of different branches of physics (e.g., mechanics, electricity, and optics).

2. A comparative study could be conducted on gender differences in the relationship between mathematics achievement and physics performance.

3. Further research could assess the effectiveness of integrated mathematics-physics instructional approaches in improving learning outcomes.

4. Longitudinal studies could be conducted to evaluate how early mathematics proficiency impacts physics achievement at higher educational levels.

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APPENDIX

DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY
FACULTY OF EDUCATION
UNIVERSITY OF BENIN, EDO STATE.

STUDENTS QUESTIONNAIRE

Dear respondents,

The purpose of this questionnaire is to collect data from undergraduate physic students in the University of Benin. **Assessment of the Influence of Knowledge of Mathematics on Students' Learning Physics.** Kindly help me to complete the questionnaire as your sincere and honest response will be of immense assistance. The information obtained shall be kept absolutely confidential. I count in your cooperation thank in advance.

Lucky Emmanuel Eshioke

Researcher

SECTION A

Sex: Male ( ) Female ( )

Level: 100 **Level** ( ) 200 **Level** ( ) 300 **Level** ( ) 400 **Level** ( )

SECTION B

INSTRUCTION: please indicate your answers by ticking (√) in the appropriate space or gap provided.

KEY

SA = Strongly Agree

A= Agree

SD= Strongly Disagree

D= Disagree

S/N	ITEMS				
	What mathematical knowledge students need to study physics?	**SA**	**A**	**SD**	**D**
1	Concepts of shapes, angles, areas, volumes, and spatial reasoning from mathematics guide students when studying physic.				
2	The knowledge of interpreting experimental data, uncertainty, error analysis, and probability distributions in mathematics help students to tackle physic problems.				
3	Representing quantities with both magnitude and direction, vector addition, and dot/cross products sharpen student understanding when studying physic.				
4	Understanding sine, cosine, tangent, and their use in resolving vectors, waves, and circular motion in mathematics make it easy for student during physics classes.				

5	Manipulating equations, solving for the unknowns, and working with formulas in mathematics make physic formulars easy use and understand.				
	How do students perceive the role of mathematics in their ability to learn and solve problems in physics?				
6	I view mathematics as an essential for unlocking the meaning behind physical laws and principles.				
7	I often see mathematics as the "language" through which physics is communicated.				
8	I often see mathematics as the "language" through which physics is communicated.				
9	I acknowledge that mathematics equips me with strategies to approach and solve quantitative physics problems.				
10	I understand that the knowledge of mathematics help improve students performances in physic.				
	What challenges do students face when applying mathematical knowledge to solve physics problems?				
11	I often struggle to convert real-world physical situations into mathematical models or equations, which is a critical step in solving physics problems				
12	Weaknesses in mathematical skills such as manipulating equations.				
13	I can perform mathematical procedures but do not understand the underlying physics concepts.				
14	i get confused by the use of similar symbols in math and physics (e.g., "v" for velocity vs. frequency) or struggle with units and dimensional analysis, leading to errors.				
15	Failure in Mathematical calculations cause me to avoid engaging fully with physics problems.				
	How does the availability of instructional materials in mathematics affect students' learning of physics?				
16	Access to visual aids like graphs, simulations, and geometric models in mathematics helps me grasp abstract physics concepts such as vectors, motion, and force diagrams more clearly				
17	I use math textbooks, workbooks, and practice software, they strengthen my computational and reasoning abilities, which directly improves their performance in solving physics problems.				
18	Well-designed mathematics instructional resources often present real-life applications that align with physics topics, helping me see the connection between the two subjects and apply their knowledge across domains.				

19	Availability of diverse materials like video tutorials, interactive tools, and worksheets enables me with different learning styles and paces to master mathematical skills necessary for physics.				
20	Engaging and accessible mathematics resources can reduce mathematics-related anxiety, build confidence, and encourage active participation in physics lessons where math is required.				