ASSESSING THE EFFECT OF GOOD KNOWLEDGE OF MATHEMATICS ON STUDENTS PERFORMANCE IN PHYSICS

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A PROJECT PRESENTED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE EDUCATION (B.Sc. Ed) DEGREE IN PHYSICS, UNIVERSITY OF BENIN, BENIN CITY.

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CERTIFICATION

We, the undersign certify that this project work is adequate in scope and was carried out by **EBERECHUKWU GODSPOWER EZENNAYA,** in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City, Edo State, Nigeria; In partial fulfillment for the award of B.Sc. (Ed) Degree in Physics.

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DEDICATION

This work is dedicated to God Almighty, my supervisor, family and friends for their great support and guide.

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Abstract

Mathematics has an age long old relationship with physics and other natural sciences. It is the foundation of science and technology and the

functional role of mathematics to science and technology is multifarious, that no area of science, technology and business enterprise escapes its application.

This study investigated the effects of Mathematics Knowledge on the Performance of Physics students. A sample of fifty- two (52) Physics students in senior secondary school 2 (SS2) was randomly selected. Then, they were subsequently divided into two groups. Group 1 constitute of 22 students who have been taught mathematics and physics for a period of time and were allowed to write examination on the two subjects after the period of learning with their results computed. Group 2 is made up of 30 students who have also been taught mathematics and physics for a period of time and were allowed to write examinations on the two subjects after the period of learning with their results adequately computed. The design adopted in the study was a survey research design with each group treated differently. The instrument, students' result sheets was used to obtain performance data of students. The data was analysed using percentages and regression to determine the relationship between the independent variable (good knowledge of Mathematics) and the dependent variable (students' performance in physics). The results of the study showed that students of high mathematical ability who also passed physics examination have greater percentage gain of 46% in school 1 and 47% in school 2 while those of low mathematical ability who also passed

Physics have 41% in school 1 and 13% in school 2.

It was recommended that Physics students should be properly groomed in mathematics, problem-solving schedules should accompany conceptual treatment of numerical problems in the Physics Classroom. Use of innovative teaching strategies would improve interactivity, understanding, and application of concepts (numerical and non-numerical) in the learning of physics, science students should compulsorily undertake a further mathematics class for at least one year in senior secondary schools and students with poor mathematical background should be given a special attention to enable them measure up.

CHAPTER ONE

Introduction

Background of the Study

Physics is a science that involves the study of the physical properties of matter and its interaction with the energy a study of systematised knowledge produced by careful observation, measurement, and experiment in a view to establishing basic physical laws as well as give a scientifically reliable explanation of physical phenomena. The study of Physics has made significant contributions through advances in new technologies that arise from the theoretical breakthrough. For example, advances in the understanding of electromagnetism led to the development of new products which have contributed to the transformation of modern society, such as television, computers, domestic appliances, and nuclear weapons (Wikipedia, 2010).

Young and Freedman (2004) defined physics as an experimental science since its specialists observe the phenomena of nature and try to find patterns and principles that relate to those phenomena in the form of theories, physical laws or principles. Interestingly, the diversified concepts of the subject matter, have made its study relevant in many disciplines, such as engineering, medicine architecture, integrated science, chemistry, science education and mathematics.

Mathematics knowledge has become inseparable and a sinequanon in the

learning of qualitative aspects of arts and science. In scientific discourse, mathematics knowledge is the “language of science” (Redish, 2005). Mathematical calculations occur at every step-in physics. It is only mathematics that gives form and definiteness to the properties of matter and harnessing of nature is possible only through quantitative interpretations of ideas and imaginations. Mathematics pervades physics so much that its impact and influence can be felt in every part of it. (Sidhu, 2006).

Studies Physics students who lacked basic algebra performed poorly on mathematical problem-solving tasks in physics due to students’ lack knowledge of mathematical skills needed in problem-solving in physics or students do not know how to apply the mathematical skills they have to particularly solve the problems situation in physics (Charles Ogan, Gladys Ibibo and Okey Innocent Francis, 2017). Although a wide conceptual difference exists between subjects (Physics and Mathematics) it is no longer history that mathematical knowledge is required to tackle numerical problems in physics, leaving much to be done in order to change students attitude towards mathematics and science.

In Nigeria, Adeyemi (2007) who had studied mathematics as a language for involving secondary school children in science and technology, indicated that their performance in West African schools Certificates Examinations (SSCE) mathematics also correlated significantly with their

performance in Physics in the same examination, which remained generally poor. Brekke (2010) and Adegoke (2009) in assessing the Mathematics knowledge potential between two nations at the polar development of levels (developed or developing), in different research, lamented students continued difficulties in mathematics. While Adegoke observed that many students (Nigerian) appear to lack the reasoning ability involved in the study of physics, identified their problems as lack of logical-mathematics operations, Brekke lamented that a number of students (Americans) who come from elementary to high school is deficient in basic mathematics facts such as the result of dividing a number by zero. Obafemi and Ogunkunle (2014) stated that mathematics ability is significant in students' performance in sound waves when taught using collaborative, Demonstration and Guided-Discovery learning method; hence there exist evidence of inter-relatedness between Physics and Mathematics.

Physics apparently is a contingent on mathematical language in the aspects of quantitative and qualitative calculations. Researchers emphasized that the need of mathematics in sciences with special reference to Physics are becoming indispensable (Abdulahi A, 1982).

In a separate research by M. Vijaya Bhaskara Reddy and Buncha Panacharoensawad (2017), it was revealed that the high failure rate of

students in Physics is due to their inability to understand the basic subject matter content, principles of physics formulas. This leads to lack of remembering problem based mathematical equations in Physics.

Obviously, Physics and Mathematics are two areas of intellectual activity that have been deeply interwoven throughout the long history of science. Physics teachers often state that their students do not understand physics due to the lack of mathematical knowledge and claim that such knowledge guarantee successful learning of physics (Pietrocola, 2008).

In a remark by Lina Vinitsky - Pinksy and Igal Galil, (2014), although mathematics preparation positively correlates with students' performance in Physics class and examination, one cannot reason the success of students in physics solely to mathematics. There's a need to better investigate the relationship between physics and mathematics in order to improve science and mathematics curricula.

Statement Of the Problem

Mathematics is one of oldest subjects in primary and secondary school curricular. Mathematics has been the bedrock of several subjects (including physics) and it is indispensable to national goal and objective. In this scientific age, we cannot underestimate the importance of mathematics. Mathematics is the pivot on which all sciences, engineering, business and even social sciences revolve. Because of its importance, many institutions of higher learning require a credit pass in mathematics from senior secondary school students who seek admission to study various courses in these institutions. This study therefore tries to investigate the proportion of students with good knowledge of mathematics; what proportion of students score high in physics. It also tries to find out whether good knowledge of mathematics can affect students' performance in physics examination.

Physics is one of the science subjects taught at the senior secondary level of Nigerian Educational system. Its importance as a discipline cannot be overemphasized especially in the area of science and technology. Almost all aspect of life science both living and non - living have something to do with physics, ranging from engineering to mathematics, biology and chemistry. It is one of the pre - requisite subjects for the study of engineering technology, medical and other applied science courses in the university.

The development of any nation which depends on science and technology, hinges on the nation's science education. In Nigeria, in spite of the enormous importance of physics in national development and efforts of government and other stakeholders in improving science education, physics results in most certified examinations like the West African Senior School Certificate Examinations (WASSCE) and National Examination Council (NECO) have not been satisfactory. The broad aims and expectations of any teaching and learning programme is productivity and positive evaluated end product (achievement). But in recent times, observations on students' academic performance in science generally and physics in particular over the years in the results of senior secondary school certificate examinations (SSCE) conducted by West African Examination Council (WAEC) and National Examination Council (NECO) revealed that a very few number of students perform better in physics examination compared with other subjects. For example, in the SSCE of May/June 2012, physics recorded only 13.8% passes while 59.6% of the total 381,506 candidates failed (Musa and Dauda, 2014).

The questions that therefore needs to be answered are, what is the impact of good knowledge in mathematics on physics? Will there be an effect of good knowledge of mathematics on students' performance in physics?

Research Questions

The following research questions guided the study

1. What proportion of students scored high in the physics test?

2. What proportion of students scored high in their mathematics score?

3. What is the influence of students' mathematics knowledge on their performance in physics?

Purpose of the study

This study is important especially in this critical time when there seems to be a worrisome depreciation of students' performance in physics. The result of the study will:

1. Determine the degree of relationship between performance in physics and a good mathematical knowledge.

2. Provide statistical analysis of students' performance in physics and mathematics simultaneously under a constant experimental condition.

3. Examine the conceptual understanding and problem solving ability in mathematics on the performance of students.

Significance of the study

The main aim of the research work is to assess the effect of good knowledge of mathematics on students' performance in physics. This study is imperative as it suggest possible ways in which good synergy can be established between a student's achievement in physics and mathematics respectively and as well promote student's interest in the

learning of physics.

Delimitation of the study

This study is to investigate the effect of Mathematics knowledge on the performance of students in Physics just in selected schools in Ovia North East, Edo State.

Limitations of the study

The limitations experienced by the researcher in the course of this study are:

1. Limited time to carry out the research study.

2. Financial constraint as the study involved a huge amount of money from cost of developing and producing the instruments to transportation logistics.

3. Poor record keeping of students' result by the school management.

4. Lack of cooperation with the researcher by some school management.

Definition of Terms

Mathematics Knowledge: Mathematics knowledge is the level of aptitude whether learnt or perceived as natural capability to process numerical data and conclude a mathematical calculation based on that data.

Performance: The standard to which one does something - the degree of success of one's actions.

Physics: Physics is a natural science that involves the study of matter and

its motion through space and time, along with related concepts such as energy and force.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviewed the related literature under the following subheadings:

- The theories of learning that are applicable in teaching physics in secondary school.
- The Prospect of Teaching And Learning Physics In Secondary School level.
- The problems militating against teaching and learning of physics in secondary school. level.
- Attitude and performance in Physics among secondary school students.
- Good Knowledge Of Mathematics on Students' performance in physics.
- Summary of Reviewed Literature.

The Theories of Learning That Are Applicable In Teaching Physics In Secondary School

International journal of science and research on the need to clarify the relationship between physics and mathematics in science curriculum, (July, 2013), exerts that mathematics and physics pose a threat to some students, where mathematics may be regarded as a fearful subject which involves massive use of symbols and mathematical proofs, physics is a subject which involves a lot of abstract formulas and equations for the

students to visualize. This interconnection between Physics and Mathematics keeps resonating the quest to discover what might exactly be the effect of good knowledge of mathematics on students performance in physics.

This study has considered different theories to support this investigation in understanding students' academic difficulties in science subject of physics and provides a basis for helping them realize their best potentials. According to Bigge and Shermis (1999) learning theory is defined as "a systematic integrated outlook in regard of the nature of the process whereby people relate to their environments in such a way as to enhance their ability to use both themselves and their environments in a most effective way". The intent of this section is to provide an overview of theories of learning suggested by psychologists in relation to the learning of physics. Theories help teachers to conceptualise learner communication, promote interpersonal relationships between teachers and learners, help teachers to implement professional ethics and have an impact on how teachers regard themselves. The importance of learning theories is summarised by Ertmer and Newby (2003) when they remark that: "Learning theories provide instructional designers with verified instructional strategies and techniques for facilitating learning as well as foundation for intelligent strategy selection." In this regard Owens (2005) states that "No discipline can claim uniform agreement on the theoretical

framework for teaching and learning". Romberg (2008) alludes to the fact that there are many theories because the way humans learn is extremely complex. Romberg (2008) states the following reasons in support of his remarks: • Lack of general agreement on the definition of learning • Different kinds of learning • Different philosophical assumptions about the nature of the learning process. In this study the researcher has chosen to concentrate on theories that are seemingly significant in influencing the way physics is currently studied in Senior secondary schools namely behaviourism, gestalt learning theory and cognitive learning theories. Each learning theory represents a particular view of knowledge. The researcher agrees with the opinion expressed by Maree (2007) that each theory is valid to a certain extent.

Behaviourism

Behaviourism focuses on the outcomes of learning rather than on how learning occurs. It assumes that learning occurs by passively, but rationally, reflecting on stimuli from the environment. According to Leonard (2002), in behaviourism learners are placed in a controlled environment in order to be directed to a specific set of behavioural changes based on a set of predetermined, instructor-based objectives. Learning is viewed as change in behaviour (or performance) and the changes in scores on some measure of performance are often used as

evidence of learning. In spite of the criticism against behaviourism, its underlining principles have influenced the teaching of physics in secondary schools to a large extent. For example, drill- and-practice routines such as factorizing like terms and solving linear equations are influenced by behaviourism (Romberg, 2008).

Gestalt learning theory Crowther (in Steyn, 2003) defines "gestalt as an organised whole that is perceived as more than the sum of its parts". Steyn (2003) points out that the definition of gestalt has particular significance for the learning of mathematics at all levels. While behaviourism in many of its forms is an adequate model for many forms of learning (particularly low-level concept and skills), it was totally inadequate for explaining how one discovers a relationship, proves a theorem, and solves complex problems. According to Romberg (2008) repeated practice and reinforcement cannot make someone a creative physicist; the invention of new ideas does not occur. Romberg further notes that learning is not simply change in performance. Therefore change in scores and an increase in the number of correct answers fail to capture changes in strategies or ways of thinking about a problem. Gestalt theory posits that learning involves active construction rather than passive absorption from the environment and it implies that learners experience the world in meaningful patterns and then construct meanings from those patterns. This theory states that evidence of learning has been

in terms of changes in the way persons said they thought about problems. Most early work on Physics related mathematical problem-solving (Polya, 2005, Hadamard, 2005) is rooted in this theory.

Information processing

Gagne (in Maree 2007) defines learning as follows: "Learning is human disposition or capability, which persist over a period of time, and which is not simply ascribable to processes of growth". In developing his information processing model of teaching, Gagne first lists five major categories of learning capabilities, namely intellectual skills, cognitive strategies, verbal information, motor skills and attitudes (Bigge & Shermis, 2000). Gagne regards these categories as educational outcomes and as descriptive of possible different kinds of human performance. Gagne's theory implies that skills in physics are analysed according to learning hierarchies.

Constructivism and Epistemology

Balacheff (2001) characterises the learning and teaching of the mathematics process as a relationship between two hypotheses, namely Constructivism and Epistemology and two constraints namely the nature of mathematics knowledge and the nature of the classroom. In relation to epistemological hypothesis Balacheff (1990) states that mathematical knowledge is developed through solving problems. Problems set the stage for construction of knowledge by establishing the need for mathematical

knowledge and the context in which mathematics is learned. Under this hypothesis problems only generate mathematical knowledge to the extent that learners perceive the problem as their own.

Taken together, constructivist and epistemological hypotheses imply the centrality of the process of developing responsibility for learning from the teacher, where it has traditionally resided to the learner. They also suggest a view of learning and knowledge as a private domain intrinsic to the individual. According to Owen (2005) this view of learning and knowledge conflicts with two constraints inherent in the teaching process and in physics outside the classroom.

• Mathematical knowledge is social knowledge.

• The physics class exists as a community.

Prospect Of Teaching And Learning Physics In Secondary School Level

Mathematics serves a symbolic expression in physics to show the structure of the relationship between different concepts. These symbolic expressions such as sigma notations, differential and integrals, basic arithmetic such as addition, subtraction, multiplication and division allow learners to have a better understanding of physics contents and improve their procedural knowledge to interrelate various symbols during the

solving of physics problems.

Physics involve a lot of representations like experiments, formulas and calculations, graphs and concept explanation which upholds that there is a strong relationship between physics and mathematics. Hence, a student who is excellent in mathematics is expected to be excellent in physics as well.

A lot of studies in the past indicate a poor performance of students in physics.

According to chief examiners report, Physics students performed below average between 2004 and 2015 in WAEC examination.

Table 1: 2004 – 2015 WAEC Result as compiled by Chief Exam Officer

Year	**Total No. of candidates**	**Total pass** $A_1 - C_6$	**%**	**Total pass** $D_7 - D_8$	**%**	**Total failed** F_9	**%**
2004	321499	158837	49.40	90012	27.99	61940	19.26
2005	344111	142943	41.50	102036	29.62	89150	25.88
2006	375824	218199	58.05	87025	23.15	62119	16.52
2007	418593	180797	43.19	140172	33.49	88480	21.14
2008	415113	200345	48.26	91116	21.95	116776	28.13
2009	465636	222722	47.83	141595	30.41	79919	17.16
2010	463755	237756	51.27	122417	26.40	84716	18.27

2011	563161	360096	63.94	115158	20.45	66236	11.76
2012	624658	429415	68.74	120369	19.27	57440	9.20
2013	676857	296910	46.62	175877	27.62	145980	22.92
2014	635739	386270	60.75	157414	24.76	78019	12.27
2015	657266	390447	59.40	160664	24.44	88598	13.47

Source: The West African Examination Council (WAEC) Headquarters, Yaba, Lagos State.

Teachers, also complain of students' low performance at both internal and external examinations. In addition, investigation on WAEC results of Senior Secondary School Certificate Examinations (SSCE) in Ekiti state from 2005 to 2012 revealed low performance of students in Physics.

Table 2: Summary of 2005 – 2012 WAEC results in Physics in Ekiti State

Year	**No Registered**	$A_1 - C_6$	$D_7 - E_8$	F_9
2005	3738	2156 (57.7%)	1104 (29.5%)	478 (12.8%)
2006	4157	2661 (64.0%)	1004 (42.4%)	498 (11.8%)
2007	4435	2524 (56.8%)	1243 (28.09%)	668(15.19%)
2008	3385	1274	797 (23.5%)	1314

		(37.6%)		(38.9%)
2009	4289	2296	1036(28.7%)	937 (17.8%)
		(53.5%)		
2010	5459	2569	1825(31.6%)	1065
		(49.8%)		(18.6%)
2011	6859	4020	1124	1715
		(58.6%)	(16.4%)	(25.0%)
2012	5081	2514	1379	1188
		(49.5%)	(27.1%)	(23.4%)

Source: International Journal of Science and Research (IJSR), July 2013.

A cursory look at the table above shows that not very many of the candidates had credit pass in the subject over the period of observation. This implies that the level of performance is not good enough.

However, other studies also shows prospect in teaching physics in secondary schools looking at avenue or prospect that may offer hope to those who take interest in the study and teaching of physics (Van, 1991).

Some of the helpful tips from (point to point education bulletin, July 2018) are :

Have Confidence in your Students' Abilities

Henry Does said, "Whether you think you can or whether you think you can't, you are right". While he referred more to faith in one's own capacity to succeed, the same idea is generally true about our belief in others.

Students with low self - esteem may be especially vulnerable to a incessant withdrawal from instructional activities. It may be helpful to inform them of insecurities of physics' heroes like Einstein and Newton.

A measure of caution is warranted, however, as highlighting others' lack of confidence is by itself not a fantastic way to instil the presence of it in one's students. Instead, try to guide them gently but firmly to a love for physics.

This might be done by using real - world examples pertinent to students' personal interests and by speaking in an excited manner about broader and easily - understood concepts before diving into the nitty - gritty of it.

Expressing Oral Confidence To Students

Similar to the first practice, explicitly stating one's belief in students' capabilities serves as an extra nudge in the right direction. Anyone is likelier to respond well to cheerlead8 than to alienation. Hands - on projects, like having students float magnet rings around a pencil, or filling an uncapped bottle completely and freezing it to observe the overflow of ice, is not only exciting but can fill students with higher self - assessment if they can figure out some of the steps on their own

Allowing More Initiative

Performing activities in front of students is not the same as participating alongside with them. When working with students, and then allowing

them to take the wheel, they are more likely to feel satisfied with results and complete future assignments enthusiastically. Some might even begin to read further on their own and seeking out more works.

Memorisation

Repetition needn't be dull. Mnemonics are a timeless method of deepening neural pathways, which tend to long outlast a term or school year. Linguistic hacks and rhymes are a fun and actively - engaging way to ensure that learners are mentally present.

Enjoyability of Learning

Students are more likely to care about friction if it applies to them, such as the slippery force down a smooth surface.

Set Reasonable Homework

Both quantity and content of homework should be monitored, as students being unchallenged or inundated are both recipes of a dearth learning. Asking students to postulate the cause of Fermi bubbles when they are still figuring out gravity may be unwise.

Engaging One On One

Many people prefer feeling like individuals rather than anonymous faces in a crowd. Speaking one-on-one with students may encourage them to read up on higher - dimensional space, whether it's a direct assignment or mere speculation beyond what's taught. Both have the power to change

lives.

Staying In Touch With Parents

Mothers and fathers who appear disinterested in assisting their children with their work may just not know how to help. Continued communication with parents about their children's progress can help to keep any challenges from going unaddressed.

Keeping an Eye On Student's Organisation

If a kid struggles to keep his or binders and folders in order, diligently - completed assignments might vanish into a swamp of papers. Helping to separate notes and schoolwork ordered by module will help separate electricity and magnetism from wind power.

Practicising whole Brain Teaching

This is an Innovative new method by which teachers explain a concept before having the students explain it to one another. If students know enough about elliptical orbits to lay out the details to others, then they have learned as well.

Getting students directly interested in physics will help them with more than just their future science classes. It inspires critical thinking that helps across the curriculum.

The Problems Militating Against Teaching and Learning of Physics in Secondary School Level

Unavailability of Qualified Teacher

The rate of qualified physics teachers in Nigeria has declined in recent years due to several reasons ranging from good salary, renumeration, allowances, etc, teaching is gradually becoming a vocation rather than a profession, hence, an abundance of unqualified physics teacher teaching physics as a result of the use of those "available" hands in replacement of qualified teachers as the profession has been unattractive to many.

Inadequate Laboratory Facilities

Laboratory equipment is unavailable in most schools and where they are, it is not functional. Without functional laboratory, physics would be ineffective because neither the teacher nor the student could acquire any knowledge because of the lack of instructional materials.

Inadequate Classroom Facilities

This problem is linked to insufficient funds for procurement of physical infrastructure that will enable a conducive learning. Some of the needed facilities are; desks, tables, fans, chairs, etc. Unfortunately, they are lacking in most schools.

Inconsistency In Government Policies

Due to the changing nature of government administrations in Nigeria, it always result to instability in educational policies as each new government tends to introduce new ideas at all times. This inconsistency in policies affects actualization of performance objective in learning.

Inadequate Human Resources

Human Resources in education are the teaching and non teaching staff. Due to lack of attractive salary and adequate teacher training institution, there is a depletion in availability of certified physics teachers and laboratory technicians in our secondary schools.

Time Limitation

In senior secondary school time allotted for each lesson varies, and the teaching of virtually all the topics in physics required time than that allotted on the time table. This makes it difficult to teach within the allotted time because each topic in physics has the practical and theoritical aspects which cannot be taught within the 45 minutes given in the time table.

Attitude and Performance in Physics Among Secondary School Students

Attitudes are acquired through learning and can be changed through persuasion using variety of techniques. Attitudes, once established, help to shape the experiences the individual has with object, subject or person.

Although attitude changes gradually, people constantly form new attitudes and modify old ones when they are exposed to new information and new experiences (Adesina & Akinbobola, 2005) Gagne (1979) defines attitudes as an internal state that influences the personal actions of an individual, he recognized attitude as a major factor in subject choice. He considers attitudes as a mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's responses to all objects and situations with which it is related.

Several studies have indicated that students' have a negative perception about physics in secondary school level. This is owning to their behaviour that the subject is complex and difficult to assimilate, as such most students i secondary school resist studying physics and do not choose it as a subject in their senior class (Cheng, 2004).

According to McLeod (1992) factors such as attitudes and beliefs play an important role in physics achievement. The general relationship between attitude and achievement is based on the concept that the better the attitude a learner has towards a subject or task, the higher the achievement or performance level in physics. Stuart (2000) argues that teacher, peer and family attitudes toward physics may either positively or negatively influence learners' confidence in physics. The findings are that learners who have positive attitudes towards their teachers have high

achievement levels. Newman and Schwager (1993) found that at all grades a sense of personal relatedness with the teacher is important in determining a learner's frequency in seeking help from the teacher. They further state that this aspect of the classroom climate has been shown to be related to good academic outcome. In the same vein Dungan and Thurlow (1989) state that the extent to which learners likes their teacher, influence their liking of the subject.

Good Knowledge of Mathematics on Students Performance in Physics

In Nigeria, students' poor performance in physics have been attributed to poor teaching methods, unqualified and inexperienced teachers, poor student attitude toward physics, poor learning environment and gender effect (Ogunleye, 2010; Jegede, 2012; Owolabi, 2014). In spite of all the advantages derived and the recognition given to physics as one of the core science subjects and as a pivot upon which technological and economic development rest, there are wider gaps between curriculum planner intention, the implementers, that is, physics classroom teachers and what goes on in the classroom. This has led to the negative perception of students that physics is a difficult school subject. More often than not the interrelatedness of mathematics and physics is not always emphasised in physics teaching. What students already know

about the content is one of the strongest indicators of how well they will learn new information relative to the content. Commonly, researchers and theorists refer to what a person already knows about a topic as "background knowledge." Numerous studies have confirmed the relationship between background knowledge and student achievement (Nagy, 2011; Dochy, 2011; Tobias, 2014). In these studies the reported average correlation between a person's background knowledge of a given topic and the extent to which that person learns new information on that topic is .66. Prior research has attempted to measure the impact of high school physics courses on students' success in undergraduate physics (Hart & Cottle, 2013; Alters, 2015). These American studies generally found that students who performed well in high school mathematics and physics subjects also did well in undergraduate physics. However, Tai & Sadler (2011) point out that these conclusions were reached by examining only a few variables and forming simple correlations. Studies of students' Background knowledge in science and mathematics began in the 1970s and have since produced a voluminous literature (Dochy, 2011). Interest in prior knowledge began with the careful documentation of common errors made by students in solving physics and mathematics problems. Analysis of interviews with these students reveals that the errors are not random slips, but rather derive from underlying concepts. The learner will formulate existing physics structures only if new information or

experiences are connected to knowledge already in memory. It is evident that it is from experiences that students develop a cognitive structure which may be valid, invalid or incomplete (Dresel, 2010). Prior knowledge is defined as a multidimensional and hierarchical entity that is dynamic in nature and consists of different types of knowledge and skills (Dochy, 2011. Hailikari, 2017). Prior knowledge has long been considered the most important factor influencing learning and student achievement (Dochy & McDowell, 2011; De Corte, 2010; Dresel, 2010; Tobias, 2014).The amount and quality of prior knowledge positively influence both knowledge acquisition and the capacity to apply higher-order cognitive problem-solving skills (Dochy & McDowell, 2011; De Corte, 2010; Dresel, 2010; Tobias, 2014) irrespective of gender. World-wide gender has often been a variable of interest in most research works in Education and in this study it was included as a moderator variable of interest because past studies in Nigeria had indicated gender as one of the most important variables in science/mathematics education (Abakpa & Iji, 2011; Abiam & Odok, 2016) with inconclusive report findings (Abakpa & Iji, 2011; Akinsola & Awofala, 2015). Reported findings in gender had been mixed with some claiming that males performed better on achievement measure in mathematics and science than their female counterparts (Awofala, 2015; Awofala, 2015; Ogunneye, 2013; Akinsola & Awofala, 2015) while others (Abakpa & Iji, 2011;

Ogunleye & Babajide, 2011; Arigbabu & Mji, 2014; Agommuoh & Nzewi, 2013) observed no significant effect of gender on students' achievement in science and mathematics.

SUMMARY

The major aim of this chapter was to review relevant literature of factors that facilitates achievement in physics. This review of literature indicates some factors that facilitate achievement in physics. The first section of the literature review covers theory of learnings that are applicable in teaching physics in secondary school. Theories such as behaviourism, Gestalt learning theory, constructivism and epistemology were reviewed. The second part of the review addresses the prospects of teaching and learning of physics in senior secondary schools. Helpful tips in teaching physics such as confidence in students ability, creating room for initiatives, encouraging memorisation, setting reasonable home and remaining in touch with parents of the students were cited. The third section of the review shows some factors that are militating against the teaching and learning of physics in secondary school level. Problems such as unavailability of qualified teachers, inadequate laboratory facilities, inadequate classroom facilities, inconsistency in government policies, shortage of human resources and time limitations were discussed. The fourth section reviewed the attitude and performance in physics

among secondary school students. It seek to encourage an intentional professional approach by the teacher in order to capture interest of the learner and as well foster good relationship between the teacher and the student. The final section of this chapter reviewed the good knowledge of mathematics on students' performance in physics. The knowledge of Mathematics is a background and prior knowledge required in learning of physics.

In conclusion, Mullis (1991) noted learners' achievement in physics as a function of learner's mathematical background, attitude towards physics and teacher's commitment. Ewen (2002) remarks that the question of how to motivate learners in the classroom has become a leading concern for teachers of all disciplines including physics. According to Ewen (2002) school teachers need to be well grounded in learners' motivation and learners' management (Wong, 2003) because this is relevant to physics achievement.

The review indicated that in spite of all the advantages derived and the recognition given to physics as one of the core science subjects and a pivot upon which technological and economic development rest, there are still wider gaps the physics classroom teacher and what goes on in the classroom which has led to the negative perception of students that physics is a difficult school subject. The researcher is of the opinion that teachers engage all the helpful tips cited in this review to achieve greater

success in the teaching and learning of physics in our secondary schools while also interestingly showing the interrelatedness of mathematics and physics.

CHAPTER THREE

METHODOLOGY

This chapter is designed to describe the procedures adopted in this research. The procedures involve the following:

Research design

Population of the Study

Sample and Sampling Technique

Research Instrument

Validation of the Instrument

Method of Data Collection

Method of Data Analysis

Research design

This study will employ Survey research design, The method is adopted in order to ascertain the extent at which a student's knowledge of Mathematics can affect his or her performance in Physics using their raw scores on a regulated Physics and Mathematics test. The study will split the students into two groups; viz group 1 and group 2. Both groups will consist of students and their respective performance in physics and

mathematics simultaneously.

Population of the Study

The population of the study consists of two groups of students; group1 will contain 22 students and group 2 is made up of 30 students of some selected secondary schools (a federal public school and a state public school) in Ovia North East Local Government Area making it a total of 52 students from the two schools. There are 26 state owned secondary schools and 5 federal secondary schools in Ovia North East, Edo State.

Sample and Sampling Technique

The study made use of the simple random sampling technique to select 52 physics students. For the group 1, after being taught Physics and Mathematics at separate times, examination was administered to all members of the group; first on mathematics, after which physics followed. Their scores in mathematics and in physics were computed. Also In group two, after being taught Physics and Mathematics at separate times, examination was administered to all members of the group; their scores in mathematics and physics were computed.

Instrument for Data Collection

One structured research instruments was used. This is the students' result sheet showing their performance in physics and mathematics respectively.

The result sheet specified the name of the student, class, the student's score in the various subjects, the subject teacher's remark and signature, form master's comment and signature and then the principal's signature.

Validation of the Instrument

The validation was determined by the expert judgment of the supervisor. The judgment were sought to guarantee that each of the items in the instrument measured what it was supposed to measure. The final draft was adjudged valid by project supervisor.

Method of Data Collection

The result sheets were obtained through the help of the management of both schools. It shows first term result of SS 2 students in physics and mathematics for 2020/2021 academic sessions. An appeal letter was sent to the various schools two days ahead in order to enable them compile the students' results. On getting the results, the researcher with the permission of the principal made photocopies of the results for his analysis. For the group 1, after being taught Physics and Mathematics at separate times, examination was administered to all members of the group; first on mathematics, after which physics followed. Their scores in mathematics and in physics were computed. Also In group two, after being taught Physics and Mathematics at separate times, examination was administered to all members of the group; their scores in mathematics and physics were computed.

Method of Data analysis

The data will be analyzed using regression analytic approach to determine the correlation between a dependent variable (Students' performance in physics) and the independent variable (the good knowledge of Mathematics).

CHAPTER FOUR

PRESENTATION of DATA, ANALYSIS AND INTERPRETATION of RESULTS

This chapter is devoted to the presentation of results, analysis and interpretation of the data gathered in the course of the study. The data are based on the number of copies of result sheets made available by the schools being used as a case study. The data are presented in tables and the analysis was done using simple regression. The regression analytic technique was used in the validation of the hypothesis.

Presentation of Results: This section presents results of all research questions and hypothesis.

Table 3: Mathematics and Physics Score of Students in School 1

Student	Physics	Mathematics
Student 1	76	38
Student 2	81	51
Student 3	80	53
Student 4	82	62
Student 5	82	51
Student 6	56	29

Student 7	80	48
Student 8	80	41
Student 9	71	20
Student 10	83	72
Student 11	82	52
Student 12	72	36
Student 13	82	62
Student 14	79	53
Student 15	82	83
Student 16	72	41
Student 17	82	61
Student 18	73	43
Student 19	64	38
Student 20	49	22
Student 21	5	23
Student 22	13	-

Source: 2020/2021 Result sheet of SS 2 students in School 1

Table 3 showed that 22 students in school 1 wrote the Physics and Mathematics Examination. 10 students in the school were able to pass Physics and as well Mathematics.

Table 4: Mathematics and Physics score of Students In School 2

Student	Physics	Mathematics
Student 1	43	42
Student 2	-	4
Student 3	23	42
Student 4	33	18
Student 5	98	76
Student 6	73	73
Student 7	53	60
Student 8	38	49
Student 9	88	69
Student 10	98	84
Student 11	53	48
Student 12	63	70
Student 13	28	45
Student 14	63	72
Student 15	86	64
Student 16	28	51
Student 17	26	51
Student 18	52	61
Student 19	98	84
Student 20	55	35
Student 21	56	42

Student 22	66	47
Student 23	86	64
Student 24	37	68
Student 25	33	64
Student 26	33	58
Student 27	88	75
Student 28	53	55
Student 29	83	74
Student 30	28	45

Source: 2020/2021 Result sheet of SS 2 students in School 2

Table 4 showed that 30 students in school 2 wrote the Physics and Mathematics Examination. 14 students in school 2 were able to pass Physics and as well Mathematics.

RESEARCH QUESTION 1

What proportion of students scored high in physics?

For School 1

In the case of this study, we shall consider students who scored 50 and above in their physics examination as students who scored high in physics.

Table 5: Students Performance in Physics Examination in School 1

Student	**Physics**

Student 1	76
Student 2	81
Student 3	80
Student 4	82
Student 5	82
Student 6	56
Student 7	80
Student 8	80
Student 9	71
Student 10	83
Student 11	82
Student 12	72
Student 13	82
Student 14	79
Student 15	82
Student 16	72
Student 17	82
Student 18	73
Student 19	64
Student 20	49
Student 21	-
Student 22	13

We shall consider students who scored 50 and above as students who passed the Physics examination and students who scored below 50 as students who failed the Physics examination.

Table 5 shows that 19 students scored high in physics while 3 students performed poorly in physics.

Therefore, proportion of students who scored high in physics

=19/22 x 100= 86%

Proportion of students who scored low in physics

= 3/22 x 100

= 14%

For School 2

In school 2, we shall be considering students who scored 50 and above in their physics examination as students who scored high in physics.

Table 6: Students who scored 50 and above in their physics examination in school 2

Student 5	98
Student 6	73
Student 7	53
Student 9	88

Student 10	98
Student 11	53
Student 12	63
Student 14	83
Student 16	63
Student 17	86
Student 20	52
Student 21	98
Student 22	55
Student 23	56
Student 24	66
Student 25	86
Student 29	88
Student 30	53

Table 6 indicates that 18 students scored high in physics.

The proportion of students who scored high in physics

= 18/30 x 100

= 60%

Table 7: Students who scored below 50 in Physics in school 2

Student 1	43
Student 2	-
Student 3	23

Student 4	33
Student 8	38
Student 13	28
Student 15	28
Student 18	28
Student 19	26
Student 26	37
Student 27	33
Student 28	33

Table 7 shows that 12 students scored low in physics.

Hence, the proportion of students who scored below 50

= 12/30 x 100

= 40%

Therefore, for both school 1 and school 2, 86% and 60% scored high in physics respectively while 14% and 40% scored low in physics in school 1 and 2 respectively.

RESEARCH QUESTION 2

What proportion of students scored high in mathematics?

For School 1

In the case of this study, we shall be considering students who scored 50 and above in their mathematics examination as students who scored high in mathematics.

Table 8 Students who scored 50 and above in Mathematics in school 1

Student 2	51
Student 3	53
Student 4	62
Student 5	51
Student 10	72
Student 11	52
Student 13	62
Student 14	53
Student 15	83
Student 17	61

Table 8 shows that 10 students scored high in physics

Then, the proportion of students who scored high in mathematics

= 10/22 x 100 = 46%

Table 9: Students who scored below 50 in mathematics in school 1

Student 1	38
Student 6	29
Student 7	48
Student 8	41
Student 9	20
Student 12	36
Student 16	41

Student 18	43
Student 19	38
Student 20	22
Student 21	-
Student 22	-

Table 9 explains that 12 students scored low in mathematics

The proportion of students who scored low in mathematics

= 12/22 x 100

= 54%

Table 10: Students who scored 50 & above in Mathematics in school 2

Student 5	76
Student 6	73
Student 7	60
Student 9	69
Student 10	84
Student 12	70
Student 14	74
Student 16	72
Student 17	64
Student 18	51
Student 19	51

Student 20	61
Student 21	84
Student 25	64
Student 26	68
Student 27	64
Student 28	58
Student 29	75
Student 30	55

Table 10 shows that 19 students scored high in mathematics.

Therefore, the proportion of students who scored high in mathematics

= 19/30 x 100

= 63%

Table 11: Students who scored below 50 in Mathematics in school 2

Student 1	42
Student 2	4
Student 3	42
Student 4	18
Student 8	49
Student 11	48
Student 13	45
Student 22	35
Student 23	42

Student 24	47

Table 11 shows that 11 students scored low in mathematics

Thus, the proportion of students who scored low in mathematics is

= 11/30 x 100

= 37%

Thus, for both school 1 and school 2, 46% and 63% scored high in mathematics respectively while 54% and 37% scored low in physics in school 1 and 2 respectively.

RESEARCH QUESTION 3

What is the influence of students' mathematics knowledge on their performance in physics?

Level of significance = (0.05)

Table 12: Students who scored 50 and above in Physics and Mathematics in school 1

Student	Physics	Mathematics
Student 2	81	51
Student 3	80	53
Student 4	82	62
Student 5	82	51
Student 10	83	72
Student 11	82	52

Student 13	82	62
Student 14	79	53
Student 15	82	83
Student 17	82	61

Table 12 indicates that 10 students passed physics and mathematics altogether.

10/22 x 100

= 46%

Table 13: Students who scored 50 and above in Physics but scored below 50 in Mathematics in school 1

Student	Physics	Mathematics
Student 1	76	38
Student 6	56	29
Student 7	80	48
Student 8	80	41
Student 9	71	20
Student 12	72	36
Student 16	72	41
Student 18	73	43
Student 19	64	38

Table 13 shows that 9 passed physics but failed mathematics

9/22 x 100

= 41%

Note: Students who scored below 50 in mathematics are students with low mathematical ability.

Therefore 46% – 41% = 5.0%

So, there is a significant effect of students' mathematics knowledge on their performance in physics.

Table 14: Students who scored 50 and above in Physics and Mathematics in school 2

Student	Physics	Mathematics
Student 5	98	76
Student 6	73	73
Student 7	53	60
Student 9	88	69
Student 10	98	64
Student 12	63	70
Student 14	83	74
Student 16	63	72
Student 17	86	64
Student 20	52	61
Student 21	98	84

Student 25	86	64
Student 29	88	75
Student 30	53	55

Table 14 shows that 14 students performed well in physics and mathematics

14/30 x 100

= 47%

Table 15: Students who scored 50 and above in Physics but scored below 50 in mathematics in school 2

Student	Physics	Mathematics
Student 11	53	48
Student 22	55	35
Student 23	56	42
Student 24	66	47

Table 15 shows that 4 students performed well in physics but failed mathematics.

4/30 x 100

13.3%

The percentage difference is 46.6% - 13. 3% = 33%

DISCUSSION OF FINDINGS

The proportion of students who scored high in physics in school 1 is 86%. The proportion of students who scored low in physics in school 1 is 14%. The proportion of students who scored high in physics in school 2 is 60%. The proportion of students who scored low in physics in school 2 is 40%. This means that greater number of students passed physics in both school. The result disagrees with the observation of Adegoke (2009) which stressed that many Nigerian students appear to lack the reasoning ability involved in the study of physics.

The proportion of students who scored high and students who scored low in mathematics in school 1 is 46% and 54% respectively. Also, the proportion of students who scored high in mathematics in school 2 is 63% and students who scored low in mathematics in school 2 is 37%.
This means that there is a less significant difference of 8% between students who passed and students who failed mathematics in school 1. In school 2, greater number of students passed mathematics.

We can conclude that students who perform well in mathematics have a greater tendency of performing well in physics.

Percentage of students who passed mathematics and as well physics in school 1 is 45.5% while percentage of students who failed mathematics and passed physics only (low mathematical ability) in school 1 is 9%. Percentage of students who passed mathematics and as well physics in school 2 is 47% as percentage of students who failed mathematics and passed physics only (low mathematical ability) in school 2 is 13.3%

We can deduce that the number of students who passed mathematics and as well physics is greater than the number of students who passed physics only in school 1 and school 2 respectively.

This deduction agrees with the postulation by Mullis (1991) which noted that learners' achievement in physics is a function of the learner's mathematical background. In addition Abdulahi A, 1982 made it clear when he said "Physics apparently is a contigent on mathematical language in the aspects of quantitative and qualitative calculations as researchers emphasized that the need of mathematics in sciences with special reference to physics is becoming indispensable."

Chapter Five

Summary, Conclusion and Recommendation

Summary

The marriage of mathematics to the evolution and development of the civilization and overall advancement of human world confirms its importance. 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 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 student in physics and the control tool of mathematics remains the basic skills underlying all scientific and technological skills.

The relationship between mathematics and physics has been a subject of study for many philosophers, mathematicians and physicists. More recently historians and educators have started some more in depth

research on this matter. Generally, it is considered a relationship of great intimacy, mathematics has already been described as “an essential tool for physics” and physics has already been described as “a rich source of inspiration and insight in mathematics”.

Michael Atiyah (2011) noted the following in his work titled “On the Work of Edward Witten” with a wonderful description of the interaction between mathematics and physics:

- First, and more conventionally, mathematicians have been spurred into learning some of the relevant physics and collaborating with colleagues in theoretical physics.
- Second, and more surprisingly, many of the ideas emanating from physics have led to significant new insights in purely mathematical problems, and remarkable discoveries have been made in consequence.

The main input from physics has come from quantum field theory. While the analytical foundations of quantum field theory have been intensively studied by mathematicians for many years the new stimulus has involved the more formal (algebraic, geometric, topological) aspects.

- The role of physics in our modern world is more important than in any other time in history. Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world. Physics contributes to the

technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries.

Physics is an important element in the education of chemists, engineer and computer scientist, as well as practitioners of the other physical and biomedical sciences. Physics extends and enhances our understanding of other disciplines, such as the earth, agricultural, chemical, biological and environmental sciences as well as astrophysics and cosmology-subjects of substantial importance to all peoples of the world.

On the other hand, Mathematics is one of the oldest subjects in primary and secondary school curriculum. Mathematics has been the bedrock of several subjects in the school curriculum and it is indispensable to national goal and objective of attaining a height in the knowledge of science must possess an average knowledge of mathematics.

Mathematics has limb in virtually all fields of study which ever mathematical or non-mathematical. In fact, mathematics is the pivot on which all sciences, engineering, Business and even social science revolve. Mathematics, being a bedrock provides the spring board for the growth of physics, it is also the gate way and the key to science.

Mathematics serves as symbolic expression in physics to show the structure of the relationship between different factors. Similarly, symbolic

expression allows learners to have a better understanding of physics contents and improve their procedural knowledge to inter-relate various symbols during solving physics problem. In order to achieved the expected goals by the students Ekanem (2006) stated.

Mathematics education is therefore indispensable in nation building, its form a strong foundation for the study of physics. Either simple operations or more advanced ones all requires some form of mathematics knowledge.

This study therefore investigated the effects of Mathematics Knowledge on the Performance of Physics students. A sample of fifty- two (52) Physics students in senior secondary school 2 (SS2) was randomly selected. Then, they were subsequently divided into two groups. Group 1 constitute of 22 students who have been taught mathematics and physics for a period of time and were allowed to write examination on the two subjects after the period of learning with their results computed. Group 2 is made up of 30 students who have also been taught mathematics and physics for a period of time and were allowed to write examinations on the two subjects after the period of learning with their results adequately computed. The design adopted in the study was a survey research design with each group treated differently. The instrument, students' result sheets was used to obtain performance data of students. The data was

analysed using percentages and regression to determine the relationship between the independent variable (good knowledge of Mathematics) and the dependent variable (students' performance in physics). The results of the study showed that students of high mathematical ability who also passed physics examination have greater percentage gain of 46% in school 1 and 47% in school 2 while those of low mathematical ability who also passed Physics have 41% in school 1 and 13% in school 2.

Conclusion

This study have successfully and explicitly shown that adequate knowledge of mathematics is compulsorily required for the understanding and application of physics concepts as students who performed well in mathematics showed outstanding performance in physics. Hence, effort has to be made in order to improve students' acquisition of mathematics skills in order to achieve a positive learning outcome in physics.

Recommendations

Based on the findings of this research, the following recommendations are made:

I. Students who offer physics have a need for the proper inculcation of the basic mathematical principles, laws and theories, especially as needed in

the understanding and application of physics concepts.

II. Students - centred interactive and innovative strategies such as the use of advance organizers and concept map strategy should be used in teaching physics concepts.

III. Teachers of physics should engage students with problem - solving schedules for familiarisation and retention of approaches to numerical problems in physics.

IV. Since it has been ascertained that a good knowledge of mathematics has a positive influence on the achievement of students in physics, therefore, all science students should be mandated to take further mathematics for at least the first two years of the senior secondary school.

V. Special tutorial classes should be organized for physics students with poor mathematical background so that they can measure up with their fellow students.

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APPENDICES

Appendix A

LETTER OF INTRODUCTION
RESULT DATA TO AID ON ASSESSING THE EFFECT OF GOOD KNOWLEDGE OF MATHEMATICS ON STUDENTS' PERFORMANCE IN PHYSICS

University Of Benin, Benin City
Faculty Of Education
Department of Curriculum and
Instructional Technology
15th April 2021

Dear Sir/Ma,
The requested result data is for the purpose of assessing the effect of good knowledge of mathematics on students' performance in physics using schools in Ovia North east, Edo state as a case study. It is purely an academic exercise and a final year project which is part of the requirement for B.Sc/B.Ed certificate in Education and Physics in University of Benin, Benin city, Edo state.
Students' result will be treated with high degree of confidentiality. Your co – operation in this regard is highly appreciated.
Thank you.

Yours Sincerely

Eberechukwu Ezennaya

Researcher