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EFFECT OF REQUISITE MATHEMATICS CONCEPTS' KNOWLEDGE ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN PHYSICS IN OHAFIA LOCAL GOVERNMENT AREA ABIA STATE

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Abstract
This study investigated the effect of requisite mathematics concepts on senior secondary school students' academic achievement in Physics. The area of the study is Abia State, Nigeria. The study adopted quasi-experimental design of the pretest- posttest non randomized groups. The population of the study was 3250 Public Secondary School two SS2 Students' in Abia State. The sample size was 50 (SS2) Physics students from two intact classes purposively selected from two Public Secondary Schools in Ohafia Local Government Area of Abia state, Nigeria. The instruments for data collection were adapted Physics Achievement Test (PAT) with reliability coefficient of 0.82 and Mathematics Achievement Test (MAT) with reliability coefficient of 0.76. Three research questions Q_1, Q_2 and Q_3 and three hypotheses Ho_1, Ho_2 and Ho_3 guided the study. Means and standard deviation were used to answer the research questions while the t-test analysis and analysis of correlation coefficient of covariance (Y_c) were used to test the research hypotheses at 0.05-level of significance. The results of the study revealed that there is no significant difference between the pretest achievement mean scores of the Experiment group (EG) and the Control group (CG). The results also showed that (EG) exposed to pre-treatment in requisite mathematics concepts before actual teaching in physics (EG) had higher post-test achievement mean score in Physics more than the (CG) taught Physics without pre-treatment in Mathematics. Furthermore, the correlation analysis showed there was positive correlation-coefficient of covariance between the achievement mean scores in Mathematics and Physics. The Findings also showed that Ho_1 with t_{1comp} was not rejected since t_{1comp} = 0.14 was not significant while Ho_2 with t_2comp = 6.49 was rejected since t_2comp = 6.49 was significant. Furthermore, the Ho_3 was rejected as the correlation coefficient of covariance Yc = 0.72 was high and significant. The study concluded that prior requisite mathematics concepts knowledge and problem solving skills enhanced positively students' academic achievement in physics. In addition, the high positive correlation coefficient of covariance revealed that high achievement in Mathematics leads to high achievement in Physics. The study recommended that Physics teachers should adopt problem solving techniques in Physics teaching, always probe the level of students' background knowledge in mathematics before actual teaching in Physics. Also, government and relevant agencies should ensure secondary school libraries are equipped with adequate and good general and further mathematics textbooks to make the books accessible to the students and include learning of further mathematics into the senior secondary science students' curriculum to broaden their scope of mathematics knowledge and their cognitive skills needed for effective knowledge transfer and better academic achievement in Physics, technological innovation and socio-economic advancement of the society.

Key words: Physics, Mathematics, Achievement, Knowledge-transfer, Correlation-Coefficient of Covariance

Introduction

The subject Physics, its nature and importance are the pivot of the socio- economic development of any nation. Physics is a branch of science that deals with natural phenomena at their fundamental levels. Physics is also an experimental science of measurement. (Bauraktar, 2002). Physicist observe the phenomena of nature and try to find patterns that relate these phenomena, these patterns are called physics theories and when generally established are called Physics laws (Young & Fredman, 2004). Scientist of all disciplines such as chemist who study chemical compositions of matter, Physicist who study the crystal structure of solids and liquids, climatologist who study how human activities affect the atmosphere and oceans depends to a large extent on the ideas and principles of Physics. Physics is also the foundation of all engineering and technological innovations. No engineer could have designed a flat screen TV, an interplanetary spacecraft or even a better mouse trap without first understanding the basic laws and principles of physics. However, the study of Physics is a challenging adventure and often richly rewarding. If you have ever wondered why radio waves can travel through empty space or how satellites stay and orbit the Earth; you can find the answers by using fundamentals of physics. Physics is an embodiment of human achievement in its quest to understand the world and its inherent natural phenomena.

The scope of physics can be understood if one looks at its various disciplines such as mechanics, Acoustics, thermodynamics, electromagnetism, optics and modern physics. Mechanics deals with the motion of objects, work and energy. Mechanics is governed by laws such as Newton's laws of motion and Newton's law of gravitation. Acoustics deals with sound wave, optics is concerned with the nature and propagation of light. Optics also found its application in working of telescopes, properties and application of lenses, thermodynamics deals with heat and temperature and the thermal properties of matter, pressure-volume changes that take place in gases. Electromagnetism deals with phenomena of charge particles and magnetic properties of matter while modern physics deals with the concepts of X-ray and photo- electric effect, wave-particle duality of matter, atomic structure and nuclear physics which is concerned with the nature of atom and phenomenon of radioactivity which have shaped the world today in areas of warfare and energy. According to Jone (2004), the laws of physics help man to understand the course-effect relationship in observed physics phenomena. Physics education gives students' creative thinking ability and help students acquire positive attitude towards science and technology which is the foundation of modern engineering and scientific innovation needed for economic advancement of any nation (Christmann, 1999). Most of the benefits of science which makes life more comfortable are made possible by the application of physics knowledge and principles (Onwiodu, 2006). The innovations in the social life of human beings that virtually were non-existence were made possible by the application of Physics principles.

Today, man watch at the comfort of his home places in different continents of the world through satellite communication. It is the exploit of Physics that made possible; electricity, air conditioning, refrigeration, radio, wireless telephone, telegraph, computers and fiber optics technology which have added synergy to societal lives. Physics also is beneficial in transportation as man today can travel thousands of kilometers in minutes and seconds-through the road, air and sea. Physics helps in space exploration and astronomy as man today can travel to the moon and other planets and also with satellite technology. Also, man through the use of powerful electron microscope have been able to view micro particles such as atoms, protons, electrons, and through telescopes observed farthest stars and galaxies. The world of energy was not an exception. Energy plays a vital role in human life and Physics has made it possible to achieve energy not only from coal, and petrol but has also extracted energy from the core of the atom and the sun (Udousoro, 2001). Physics also have redefined security and military warfare through computer technologies and nuclear energy development.

Physics and Mathematics are interrelated that one may be compelled to say that Mathematics is the language of Physics. Mathematics is described as a science of counting, measuring and describing shapes of objects. It deals with relationship among quantities. According to British National Curriculum (2004), Mathematics equips students with uniquely powerful tools to understand science in areas of computational skills to change the world. Mathematics is a science that draws necessary conclusions, provides learners with special skills required to solve their day to day problems, communicate effectively, reasons accurately and make necessary connections (Obodo, 2000; kolawole & Oluwatayo 2005). Apart from the application of Mathematics in general science and technology, medicine, economy and public decision makings, it is most implicitly useful in physics. This is evidence as the laws and principles of Physics found explanation in Mathematics.

Thus, mathematics is found to be a vital tool in concretizing Physics concepts. Mathematics as a field of study in education deals with contents scope such as numerical techniques and analysis, algebra, trigonometry, calculus which deals with integration and differentiation, coordinate and circle geometry, vectors, tensors and matrices which are integral parts of Physics learning. However, Students' ability to make meaningful achievement in physics to a large extent depend on their foundational knowledge and ability in Mathematics. In retrospect, De Corte (1990) opined that the amount and quality of prior knowledge in Mathematics positively influences both knowledge acquisition and the capacity to apply higher order cognitive problem solving skills in science.

Achievement, on the other hand is described as the students' ability to study and remember facts and being able to communicate same orally or in written form even in an examination condition. Academic achievement is the outcome of educational activities; as it indicates the extents to which the students, teachers, the curriculum and indeed the educational institution has achieved its predetermined educational goals as commonly measured with examinations that assess important procedural knowledge such as skills, facts which students have learnt (Benett, 2003). Academic achievement can also be defined as the observed and measured aspect of a student's mastery of skills and subject contents as measured with valid and reliable test. Good knowledge of Mathematics plays a crucial role in laying good foundation for academic achievement in Physics in secondary schools. If good foundation of Mathematics is laid at the secondary school level, students can cope better with the challenges of life, and encourage students' enrolment into tertiary institutions to study science and engineering courses including physics as a discipline. Academic achievement of students in Physics is not without constraints. According to Carbone, Hurst, Mitchell and Gunstone (2009), factors that influence students' academic achievement include attitude of the student, school's resources, leaderships quality of the school administration, skills and abilities of the teachers, classroom environment, role of the parents, social circle, psychological and health related factors, motivation and reinforcement of students' desired behaviors, development of good study skill, counseling and guardian services, home and school environment, teaching and learning strategies, approachability and professionalism of the teachers. In Physics education, apart from this factors some of the factors observed to influence student's academic achievement are adequate understanding of concepts taught, possession of prerequisite skills such as spatial orientation, Mathematics computational skills, observational skills, cognitive ability, visual and hearing impairment; which positively or negatively contribute to their academic achievement in school measured in term of valid and reliable test with examination scores.

This study however, is guided by the following theories of learning propounded by psychologist such as operant conditioning theory of learning by B. F Skinner (1904-1919), Gestalt theory of insight, need achievement theory of learning and Ausuble theory of meaningful learning .Based on the B. F. Skinner (1904-1990) theory of learning, students are made to learn by reinforcement of their successful operational or instrumental activities in their environment. The implication of the skinner theory of learning in education is the importance of reinforcement in learning processes. The theory showed that positive behaviour can be strengthened by sustaining the reinforcement that increases its occurrence. Based on this, in the learning of physics, students should be encouraged by teachers to make effort toward acquiring supportive skills necessary to perform well in the learning of physics and science in general. Such skills include mathematical skills, drawing skills, understanding of geometry which the teacher should reinforce during teaching learning situations to act as motivation and strive to achieve the desired goal as set by the philosophy of physics education which is inspired to help students' become intellectually informed in Physics, make them competent and effective with good mastery of content, methods, knowledge and development of the learners which will ensure learner's application of acquired knowledge to real life situations.

The Gestalt theory also known as theory of insight advocated for formation of pattern and understanding of the whole nature of a concept before its actual study. The theory also supports trial and error method of learning with understanding. The theory implied that the teacher should make simple the concept to be taught for the learner to gain insight, pattern and understanding of the whole nature of the concept before administering it to them unit by unit. The Gestalt theory advocated for the importance of instrument in learning toward achieving a set goal. In Physics however, students should be made to understand the important tools toward successful and meaningful achievement in Physics. Mathematics knowledge and skills act as a telescope for the students' to view, gain insight, form patterns and have understanding of the whole of any concept taught in Physics. The need achievement theory according to Mc Cleland cited in parhi (2013) opined that motivation is the expectancy of finding satisfaction in mastering challenging and difficult performance. Motivation according to Parhi (2013) is classified into intrinsic and extrinsic motivation. Intrinsic motivation is referred as the internal force not tired to the external environment which push individual to perform some task and is influenced by curiosity and levels of aspiration of the learner while extrinsic motivation implies force external to the leaner which pulls the learner towards achieving a set goal. However, Concepts learned extrinsically provide its own reward to motivate the individual towards achieving enduring behaviour; while extrinsic motivation arises when the learner strives to achieve for reasons which are external to the individual. Since motivation can arise intrinsically and extrinsically, learning environment should be created that will enhance students' motivation to pursue academic goal activities over a long period of time. The need achievement theory is pivoted on the ground that most persons want to achieve and experience levels of aspiration in a given environment. According to Ngwoke and Eze (2004), individuals set themselves standards to participate in learning activities. This standard is called aspiration. Ngwoke and Eze (2004) further pointed out that aspiration is a longing for what is above one with advancement as a goal. Based on the need achievement theory, the teacher should ensure students' acquire requisite Mathematics concepts knowledge and skills which will serve as a source of motivation to the students' to learn and understand concepts taught in Physics. The theory also opined that the learner should be self-oriented, disciplined and always engage in activities such as problem solving in mathematics which will arouse interest and motivation and ensure effective transfer of learning in Physics.

The importance of prerequisite Mathematics knowledge to achievement in Physics is in line with Ausubel (1990) theory of meaningful learning which states that student's prior knowledge of a subject should serve as a formidable anchor to learning new knowledge in the subject or related subjects. This also were supported by Dochy (1992) and De Corte (1990) who affirmed that the amount and quality of prior knowledge of an individual positively influence both knowledge acquisition and the capacity to apply higher order cognitive problem solving skills. Effects of Mathematics knowledge on students' performance in Physics had being investigated by many researchers. The findings of Charles, Ogan, Gladdys and Okey (2017) in their study of the effect of Mathematics knowledge on Physics students' achievement in electromagnetism as a branch of Physics showed that Mathematics knowledge, skill and ability has significant effect on enhancing students' achievement in electromagnetism.

Furthermore, Charles, etal,(2017) opined that adequate knowledge of Mathematics is compulsorily required for understanding and application of the concepts of electromagnetism in Physics and recommended that students' should endeavor to improve on their mathematics skill if they expect a positive learning outcome in Physics. In a similar study, Oguneye, Awofala, Adeneye and Adekoya (2014) who investigated the effect of students' background in Mathematics on senior secondary school student's achievement in Physics, found that there were positive relationships between students' achievement scores in Physics and Mathematics ability and affirmed that the teaching of prerequisite mathematics knowledge before Physics teaching when adopted as instructional technique would enhance meaningful learning and students' achievement in Physics. Also, Redish, 2005; Supardi, Leonard, Suhendoi and Rismudiyati(2002) in their findings on the use of problem solving technique and Mathematics knowledge in Physics learning showed that Mathematics knowledge and problem solving techniques enhance students' achievement in Pysics. Furthermore, their findings showed that problem solving techniques have the effect of developing the transformation skills of students including problem-observation, proposing questions, formulating hypotheses, planning examination, conducting examination, analyses and interpretation of data and communicating the result. This is also in line with the assertion of young and Fredman (2004) on the nature of Physics study. In terms of the relationship between Mathematics learning and Physics achievement, Melzer (2002) opined there is positive correlation between mathematics acquisition and success in Physics study while Wanhar (2008) affirmed from the findings of his study that there is a linear relation between comprehension of Mathematics concepts and the ability to solve Physics problems; implying Mathematics concepts comprehensions enhances positively students' ability to solve physics problems.

However, apart from the teaching strategies and techniques employed by teachersl; the teaching of Physics had experienced innovation in recent times such as the introduction of information and computer technology ICT in the form of interactive white board technology and computer simulation in the class room in teaching learning situations to support teachers' teaching strategies and to aid Physics understanding. But in spite of this efforts, the performance of secondary school students in physics in both internal and external examinations had remained poor (SEMB, 2017). The problem has major implication in university admissions into Physics and physics related courses as Physics is one of the prerequisite core science subjects (Physics, Chemistry, Mathematics) for admission into science, engineering and science related courses in the tertiary institution of Nigeria. According to Young and Fredman (2004), the best approach for students' to study the subject Physics is summarized with the acronym: I – SEE; short for Identify, Set – up, Execute and Evaluate. Students most often found the set up and execute stage which involves the use of mathematics really tasking, prompting them saying that physics is difficult. But the question that comes to mind is can Physics be studied without mathematics? Hence this study focused on the effect of requisite Mathematics sconcepts knowledge in the academic achievement of students' in Physics

Purpose of the Study

The major purpose of the study was to investigate the effect of requisite Mathematics concepts knowledge on students' academic achievement in Physics in Ohafia Local Government Area, Nigeria. Specifically, the study aims to:

1. determine if there is significant difference in the pre-test achievement mean scores in physics between students exposed to mathematics treatment before physics teaching (Experimental group) and those taught physics without pre-exposure to mathematics teaching (Control group).
2. determine if there is significant difference in the posttest achievement mean scores of the experiment group and the control group.
3. determine if there is significant correlation of covariance between the achievement mean scores of the experiment group in Physics and Mathematics

Research questions

1. What are the pre-test achievement mean scores of the Experimental Group and the Control Group in Physics?
2. What are the difference in posttest achievement mean scores in Physics between the Experimental Group and the Control Group students?
3. What are the posttest achievement mean scores of the Experiment Group students in Mathematics and Physics?

Hypotheses

1. There is no significant difference between the pre-test achievement mean scores of the Experimental Group and the Control Group in Physics.

2. There is no significant difference between the Experimental Group and the Control Group students' posttest achievement mean scores in Physics.

3. There is no significant correlation coefficient of covariance between the Experimental Group students' posttest achievement mean scores in Physics and Mathematics

Methodology

The study adopted pretest posttest quasi-experimental design involving intact classes of two groups: The Experimental Group exposed to pre-treatment in requisite mathematics concepts before actual teaching in physics and the Control Group without pre-exposure to Mathematics concepts before actual teaching in physics.

Area of the study is Abia state Nigeria. Abia State is one of the states among the five states in the South East Zone of Nigeria with three education zones: Aba education zone, Umuahia education zone, and Ohafia education zone. Ohafia education zone is divided into four sub-zones: Bende LGA, Ohafia LGA, Arochukwu L.G.A, Isiukwuato LGA with the head quarter located at Ohafia LGA education zonal board (SEMB, 2017). The Ohafia Education zone is also made up of 86 public secondary schools distributed by zone with Bende LGA (25), Ohafia LGA (28), Arochukwu LGA (17), and Isuikwuato LGA (16).

The population of the study consisted of 3250 senior secondary school two (SS2) physics students' in all the 160 public secondary schools in Abia State (SEMB, 2017). The sample size for the study is 50 senior secondary school (SS2) students of the two intact classes from two schools purposively selected in Ohafia Local Government Area Abia State. The sample size of 50 (SS2) students selected were all pure science students with good foundation knowledge in physics haven passed SS1 class. A Simple random sampling technique by (Balloting) was used to assign the two equivalent schools into the experimental and control groups involving intact classes.

The instruments for the data collection were adapted Physics achievement test PAT and Mathematics achievement test MAT and was face and content validated by three experts; one from field of Physics , one from the field of Mathematics and the third person from measurement and evaluation. Each of the instruments contains multiple options 50 question items. The two instruments were also tested for reliability using 20 students from a neutral school not used for the study and a reliability coefficient of 0.76 for the MAT and 0.82 for Physics using (K-R20) formular was obtained. The instruments for the study were first administered to the students' as a pre-test assessment to ascertain the level of prior knowledge and how equivalent the two groups (Experimental group and control group) were before the treatment. The experimental group was taught for ten (10) weeks by the researcher with the help of an assisting Mathematics teacher from the experimental group school. The experimental group (EG) was first treated with Mathematics for four (4) weeks and assessed accordingly before actual teaching in Physics commenced for both groups (EG & CG) and lasted for six (6) weeks. The PAT was administered to the students' after one week interval preceding to their respective treatments and collected at the spot by the researcher with the help of the assisting physics teachers in the schools used.

Simple mean and standard deviation was used to answer the research questions while t-test analysis and analysis of coefficient of covariance were used to answer the research hypotheses. Through effective class management, intervening variables such as deviant attitudes of the students were controlled to eliminate biases into study. The Physics content scope are mechanics, thermodynamics, thermal properties of matter, elasticity of solids while the content scope of the requisite mathematics concepts are rate, ratio and proportion, transposition of formulae, coordinate geometry and trigonometry; which were purposively selected for the study.

Analysis and presentation of data

The data collected were analyzed and presented in the tables below:

Research question (1): What are the pretest achievement mean scores of Experimental Group (EG) and Control Group (CG) in Physics?

Table (1.1): Pretest achievement mean scores and standard deviations of Experimental Group and Control Group in Physics.

Group Variable	N	Mean	SD	Mean Difference
EG	25	38.28	7.39	0.32
CG	25	37.79	8.94	

Hypotheses (1): There is no significant difference between the pre-test achievement mean scores of the Experimental group and Control group in Physics.

Table (1.2): t-test analysis of the achievement mean scores of the EG and CG students in physics.

Group	N	Mean	Df	P	T_{crit}	T_{comp}	Remark
EG	25	`38.37	48	0.9	1.67	0.14	NS
CG	25	37.70					

Table (1.1) shows that the pretest achievement mean score of the experiment group was 38.28 with standard deviation of 7.39 while that of the control group was 37.96 with standard deviation 8.94. The mean difference in achievement between the two groups (EG and CG) was 0.32. Further analysis of the difference using t-test analysis at 0.05 (α) level of significance and degree of freedom (df) 48 with t-critical (t_{crit}=1.67) gave t-computed (t_{comp} = 0.14). Since the t_{comp} = 0.14 is less than t_{crit} = 1.67, the null hypothesis was not rejected. Hence, there is no statistically significant difference in the pretest achievement mean scores of the experimental group (EG) and the control group (CG). This indicates that the two group used for the study were equivalent in their foundation knowledge in physics before the study commenced.

Research question (2): What are the differences in achievement mean scores of the students taught Physics with pre-treatment in Mathematics and those taught without pretreatment in Mathematics?.

Table(2.1): Mean and standard deviations of the experiment and control groups in Physics.

Group Variable	N	Mean	SD	Mean Difference

EG	25	59.84	8.08	13.8
CG	25	49,04	6.42	

Hypothesis (2): There is no significant difference between the Experimental Group and the Control Group students' posttest achievement mean scores in Physics.

Table (2.2): t- test analysis of the posttest achievement mean scores of the Experimental Group and the Control Group in physics.

Group Variance	N	Mean	SD	Df	P	T_{crit}	T_{comp}	Remark
EG	25	`59.84	8.08	48	0.95	6.49	1.6	Sg
CG	25	46.42	6.42					

Table(2.1) shows that posttest achievement mean score of students taught physics with pre-treatment in mathematics (EG) is 59.84 with standard deviation 8.08 while the students taught physics without pre-treatment in mathematics (CG) had achievement mean score of 46.42 with standard deviation of 6.42. The mean difference between the two groups is 13.8. further analysis of the difference of means using t-test analysis shown in table(2.2) at 0.05 alpha level of significance and 48 degree of freedom gave t-critical (t_{crit}=1.67) while the t-computed (t_{comp} = 6.49). Since the t_{com} = 6.49 is greater than t_{crit} = 1. 67, the null hypotenuse was rejected and the alternate hypothesis which states that there is statistically significant difference between the achievement mean scores of the EG was accepted. This shows that the EG students had higher achievement in physics than the CG students.

Research question (3): What are the achievement mean scores of the experimental group students in Physics and Mathematics?

Table(3.1): Achievement mean scores of the experimental group in Physics and Mathematics.

Subject Variable	N	Group Variable	Mean	SD
Physics	25	EG	59.84	8.08
Mathematics	25	EG	64.08	7.79

Hypothesis (3): There is no statistically significant correlation coefficient of covariance between the achievement mean scores of the experiment group in physics and mathematics.

Table (3.2): Analysis of correlation coefficient of covariance for Experimental Group mean scores in Mathematics and Physics.

Subject Variable	N	V_w	V_{xy}	R_c	Remark
Physics	25	68.45	42.29	+0,72	Sg
Mathematics	25	50.45			

V_w = Within group variance, V_{xy}= Between group covariance, R_c = correlation coefficient of covariance

Table (3.1) showed that the experimental group achievement mean score in physics was 59.84 with standard deviation of 8.08 while that of mathematics was 64.08 with standard deviation 7.79. Further analysis of the mean scores for coefficient of covariance in table (3.2) showed that the experimental group had within group variance of 68.45 in Physics and 50.45 in Mathematics while the covariance score between group is 42.29. Also, the table (3.2) showed that the correlation coefficient of covariance between the mean scores in Physics and Mathematics had value of 0.72. The 0.72 correlation coefficient of covariance is significant. This provides a good platform to reject the null hypothesis and accept the alternate which states that there is significance correlation coefficient of covariance between the achievement mean scores of the experimental group students in Physics and Mathematics. The positive value (+0.72) of the correlation coefficient of covariance showed that high achievement in Mathematics corroborated with and lead to high achievement in Physics.

Summary of finding:

There was no statistically significance difference between the pre-test achievement mean scores of the students taught physics with pre-treatment in requisite Mathematics concepts (EG) and those taught Physics without pre-treatment in requisite Mathematics concepts (CG). This showed that the two groups (EG & CG) had equivalent foundation knowledge in Physics prior to the treatments.

There was significant difference in the post test achievement mean scores between the experimental group and the control group in Physics. The mean difference of 13.8 showed that the students taught Physics with pre-treatment in Mathematics had higher achievement in Physics than their counterpart taught Physics without treatment in Mathematics.

There was a positive correlation coefficient of covariance (+0.72) between the experimental group students' achievement mean scores in Mathematics and Physics. This indicates that high achievement in Mathematics also leads to high achievement in Physics.

Discussion:

Table (1.1) showed that there is small difference on the pre-test achievement mean score of the experimental group (EG) taught physics with pre-treatment in Mathematics and the control group (CG) taught physics without pre-treatment in Mathematics before treatment commenced. Further analysis of the difference of means between the two groups was not significant as the t- computed t_{comp}. 0.67 was not significant . Hence this result showed that the two groups were equivalent in terms of their foundation knowledge in Physics and thus participated in the research process on equal grounds. This finding corroborate with the assertion of Ausobel (1990) theory of meaningful learning which states that student prior knowledge of a subject should be seen as a strong base for learning new knowledge in the subject and other related subjects. Likewise, Mc Dowell (1997) and De Corte (1990) affirmed that the amount and quality of prior knowledge students have in a subject had positively influence with knowledge acquisition and capacity to apply higher order cognitive knowledge in problem solving skills. This also showed prior knowledge of students in a subject can equip them for further knowledge acquisition in the same and othert related subjects.

Table (2.1) reveal that the (EG) had higher achievement in Physics with achievement mean score of 59.84 than their counterpart in CG with achievement mean score of 46.04. Similarly, the result of analysis in table (2.2) with respect to the post test achievement mean scores of the two groups (EG & CG) showed that the t-computed (t_{comp} = is 6.49) is greater than t-table (t_{crit}) 1.67 at 48 degree of freedom and 0.05 level of significance. Hence the null hypothesis was rejected and the alternate which stated that there was significant difference between the posttest achievement mean scores of the Experiment Group (EG) taught with pre-treatment in Mathematics and the Control Group (CG) taught without pre-treatment in Mathematics; showing that pre-treatment in Mathematics before actual teaching in physics enhances academic achievement in Physics. This result corroborated with the findings of Charles, Ogan, Gladdys and Okey (2017), who found significant effect of Mathematics knowledge, skill and ability on students' achievement in Physics in their investigation of the effect of mathematics knowledge on students' achievement in Physics. Likewise, Redish (2005), Sapardi, Reonard, Sahendri and Rismudiyati (2002) in their study of the use of problem solving technique and mathematics concepts knowledge in physic learning found that problem solving techniques and mathematics knowledge have significant effect on students' achievement in Physics. In the same vein, Supardi et al (2002) opined that mathematics knowledge and problem solving skills have effect of enhancing students' problem observation, transformation skills, proposing questions, formulating hypothesis, planning examination, conducting examination, analysis of data, interpretation of data and result communication. Also, this supported the assertions of Young and Fredman (2004) on the nature of Physics . Table (2.1) and table (2.2) revealed that for students to hope on having meaningful achievement in Physics, they have to embrace and imbibe mathematics concept skills, problem solving skills as requisites for successful learning and understanding of Physics concepts.

Table (3.1) revealed that the students of the experimental group taught Physics with pre-treatment in Mathematics had higher achievement in Physics and Mathematics with 59.84 achievement mean score in Physics and 64.08 achievement mean score in Mathematics. Table (3.2) showed that there is a positive correction coefficient of covariance between students'' achievement in Mathematics and Physics. Likewise, the findings of Ogunleye, Awofala, et al (2014) on their investigation of the effect of students' background knowledge in mathematics on senior secondary school students' achievement in Physics showed that there was positive relationship between students' achievement in Physics and Mathematics ability. Similarly, the finding in table (3.1) and table (3.2) corroborated with Mertz (2002) who studied the relationship between Mathematics learning and achievement in Physics and found there was positive correction between mathematics knowledge acquisition and students' achievement in Physics. Also, the finding corroborated with the findings of Wanhar (2008) which showed there was linear relationship between comprehension in mathematics concepts and acquisition of problem solving skills in Physics. This affirmed however, that mathematics concept comprehension influences positively the students' ability to solve Physics concept problems and enhance students' achievement in Physics.

Conclusions:

Based on the findings and discussion of results, the study revealed that Students' prior knowledge in Mathematics enhances their ability to learn concepts and solve problems in Physics. Knowledge of requisite Mathematics concepts and problem solving skills had significant effect in enhancing students' achievement in Physics. There is positive correlation between foundation knowledge in Mathematics and achievement in Physics; showing that higher achievement in Mathematics can lead to higher achievement in Physics.

Recommendation:

Based on the findings, the following recommendations were made:

Since the research demonstrated significant effect of prior knowledge in Mathematics and positive correlation between Mathematics achievement and students' achievement in Physics, the teacher is encouraged to adopt the use of problem solving techniques and ensure their students have sound requisite knowledge in Mathematics before embarking on actual teaching in the learning of Physics.

Study of further Mathematics as a subject should be included into the subject curriculum of all science students' in senior secondary schools. This will help to enhance the student's Mathematics ability.
The government should equip the library in schools with good General and Further Mathematics textbooks to make such books available and accessible to the students.

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