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INFLUENCE OF MATHEMATICAL ABILITY AND ENGLISH PROFICIENCY ON SENIOR SECONDARY SCHOOL STUDENT ACHIEVEMENT IN PHYSICS IN ADAMAWA STATE, NIGERIA

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ABSTRACT

The study investigated the influence of mathematical ability and English language proficiency on physics student achievement in Adamawa. The frequent mass failure in physics subject among secondary school students necessitate more research in physics achievement. Problem of language of instruction is identify as one of the problems in physics study. Three research question and three hypotheses guided this study. The target population of the study consisted of all the SSII science students of public senior secondary schools located in Adamawa state, comprising 5 Education zone which approximately constitute 19800 students. Using Taro Yamani sampling method, a total of 400 student (80 student from each educational zone) across the state formed the sample of this study. An expo-facto design which involved nonequivalent group was used. Three reliable instruments were used for data collection. Mathematical ability test (MAT), was adopted from Otis-Lennon. English Language Proficiency Test (ELPT), was adapted from Yeditepe University Istanbul, and Physics Achievement Test (PAT) was drawn from West African Examination Council (WAEC) past objective questions of years from 2006 to 2016. The reliability coefficient of 0.80, 0.89, and 0.85 was obtained for PAT, MAT, and ELPT respectively Croanbach Alpha. Mean and standard deviation were used to answer the research questions while ANOVA was used to test the hypotheses at 0.05 alpha level. The findings of the study showed that: there are significant influence of mathematical ability [F (1, 198) = 5. 272, $p<0.05$]. There is significant influence of English language proficiency on physics achievement [F (1, 198) = 6.548, $p<0.05$]. there is no significant influence of combined mathematical ability and English language proficiency [F (1, 398) = 0.799, $p>0.05$]. It was concluded that, there is significant influence of the individual independent variables to physics achievement, that is mathematical ability and English language proficiency. While there is no significant influence of the combine mathematical ability and English language proficiency on physics achievement.

KEYWORDS: Mathematics ability, English proficiency, secondary school students, Physics

INTRODUCTION

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In recent years, students' performance in science subjects especially physics has been on the decline. This was evidenced in the 2014 and 2015 May/June West African school certificate Examination. Bakare (2014) described this situation as worrisome which happens to be the misfortune in the history of Nigeria education. No nation can survive technologically if her future generations are performing poorly in science and science related subjects. United Nations Educational, Scientific and Cultural Organization (UNESCO), has led international efforts towards scientific literacy, particularly in developing countries, cognizant of the crucial role of science and technology in national development.

Knowledge of science and technology is required in all countries of the world. This is because of many challenges that are facing the global communities. These challenges include emergence of new drug resistant diseases, effect of genetic experimentation and engineering, ecological impact of modern technology, danger of nuclear war and explosion, global warming among others (Mutai, Mwangasha, Omolo, & Munyeke, 2004).

Physics is believed to be one of the oldest and probably the most developed of all the sciences (Keith1996). This suggested that other science need the knowledge obtained through the study of physics. Physics is therefore an important base in science and technology since it studies the essence of natural phenomenon and help people understand the increasingly technology changing society (Zhoyao 2002).

Physics as a science course of study is perceived generally to be very interesting, vast, mathematical and experimental. The study of Physics at any level of study requires a good understanding of Mathematics, this is because Mathematics is the tool for solving problems in Physics. The application of Mathematics in solving physical problems through the knowledge of Physics is very essential. Some researchers in their study affirmed that there is strong interrelationship between Physics and Mathematics (Gifford & Harpole, 1986; Hart & Cottle, 1993 & Alters, 1995). However, the performance of a student in Physics might not necessarily be hinged on the knowledge of the students in Mathematics but on other factors. Research has shown that many teachers use difficult terms and concepts that are often beyond the level of the learners (Bennett, 2003). Bennett (2003) observes that there is need to be careful with the use of conceptual words of science, e.g. power, energy and work because they are used in other contexts to mean different things. Other factors that were found to contribute to students' performance in Physics are teachers' method of teaching students' communication skills, learning facilities, proper guidance and family stress. (;Mushtaq & Nawaz , 2012, Bello, 2011, Kibett & Kathuri, 2005, Orora, Wachanga & Keraro, 2005,).

In this scientific Age, the importance of Mathematics cannot be underestimated because it has its limb in virtually all fields of study either Mathematical or non-Mathematical, not to discuss its influence in the Mathematical related fields. In fact, 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 from senior secondary school students who seek admission to study various courses in their institutions. Mathematics is the language of Science and Technology, because it is the tool for solving problem in science subjects like Physics and Chemistry, hence prioritization of Mathematics teaching and learning in the bid for national development is inevitable. Mathematics is a compulsory subject at basic and secondary levels of education in Nigeria. This is important for the production of science and technological literate citizens who can think critically about complex issues, analyze and adapt to new situations, solve problems of various kinds and communicate their thinking effectively for the economy growth of the nation economy, this can only be achieved by improving on the science and mathematical process skills starting from the basic level (Bello & Ariyo 2014). The capacity or ability to use mathematics in other disciplines and solve problem is generally expected of all science and engineering students. This is regarded as mathematical ability (Britton, 2006). Mathematics and physics pose a threat to some students where as mathematics may be regarded as fearful because it involves use of symbols and mathematics proofs.

Mathematics has an important role in physics teaching and learning due to the obvious relation between the two subjects. Mathematical expression forms are often used to describe models of physical events in the real world. The models are then manipulated mathematically and analyzed to make sense in relation to physical theories and the hypothesis of situation at hand that is, explanations of physical phenomena are organized through theories and theoretical models (Adúriz-Bravo, 2012). Mathematics serves as symbol expression in physics to show the structure of the relationship between different variables. Similarly, symbol expression allows learners to have a better understanding of physics content and improve their procedural knowledge to interrelate various symbols during solving of physics problem. Physics involves a lot of representation like experiments, formulas and calculation, graph, and concept explanation. A student who is excellent in mathematics is expected to be excellent in physics as well.

A complete understanding of a concept in physics requires some level of mathematical ability in which these concepts are couched. However, many introductory algebra-based physics student perform poorly on mathematical problem solving task in physics. According to Jonathan and Edward (2004) there are at least two possible distinct reasons for such poor performance:

1. Student simply lack the mathematical skills needed to solve problems in physics or

2. Student does not know how to apply the mathematical skills to a particular problem situation in physics.

It has been shown in a number of studies that students in introductory physics classes in both college and secondary school have difficulty using mathematics (Akatugba & Wallace, 1999; Mountcastle, Morgan, & Kaback, 2002). It has also been shown that fluency in mathematics language is an

important factor of conceptual learning in Physics (Meltzer, 2002). Students have taken mathematics courses through their entire academic careers, yet have great difficulty utilizing that training. Student poor performance in mathematical problem solving tasks in physics has led many Physics Departments and Instructors to adopt conceptual physics courses which dilute mathematical problem solving or simply remove it from the curriculum (Kathuri, 2005). If students simply do not possess the requisite mathematical knowledge, the conceptual physics courses provide them with exposure to many important physics concepts to which they would otherwise not have access. However, if students have the relevant mathematical resources, the dilution or removal of mathematical solving problem task in physics does not help them learn to apply these mathematical resources appropriately instead, it robs them of the opportunity to do so. Thus as physic teacher, we are often surprised by how little Mathematics our students seem to know, despite successful performances recorded in their mathematics classes when students appear to have trouble with Mathematic in physics classes they might be ask to study more mathematics, but using Mathematics in science (and particularly in physics) is not just doing Mathematics. It has a different purpose representing meaning about physical systems rather than expressing abstract relationship that is the way meaning is put into symbols from pure mathematics (Edward, 2004).

Problem solving in Physics, as influenced by mathematical learning theories, is mystified as difficult over the years as students hold negative stereotype images towards the subject (Wambagu 2006, Bautista, 2012a). These stereotypical tendencies had hampered its efficacy over the years and became a concomitant factor to be addressed properly. This calls for a sound technique of decontextualized set of skills on convergent reasoning in engaging students to higher cognition activities towards the subject (Bautista, 2013). Students' success on constructed response tasks is the result of their mastery on procedural fluency and written-mathematical explanation to problem solving skills and strategies. This helps them hone their negative stereotype images that were drawn over the years in Physics instruction. Physics instruction, if it is to be responsive, needs a development of students' competence in problem solving skills and strategies and explaining mathematical ideas in a scientific perspective. The students' procedural fluency in problem solving must complement their mathematical-scientific explanations in their decision making. This uses an accurate mathematical language in the teaching and learning as their knowledge and skills in problem solving, which are developed in Mathematics, are of great implication especially on the peculiarities of problems both in science, engineering and industry. Their ability to solve problems with understanding and communicate mathematical ideas must be nurtured enabling the student-learners acquire the skills to evaluate information, to compare, to make decisions and justify effectively (Pugalee, 2004).

Does language shape thought? The answer yes would call for a reviewing of some foundational theories that have guided cognitive science for decades. Yet despite unreserved belief among the general public that, people who talk differently also think differently, it has remained widely agreed among linguistic and psychologist, that they do not think diffrently (Olga & David, 2004). English language occupies a vital and indispensable position in education in Nigeria. Apart from the fact that

it is the language of business, mass media, literature as well as those of internal and external communications, it is also the medium of instruction in school all over the country. The role of English language in Nigeria has been well described by spear (1971). He sees English as a temporality borrowed language, which, is by now has become part of the linguistic property of those who use it. Nigerians English language now determines success or failure in education and life in the Nigerian society. All school subjects except the mother tongues are taught in English. The implication of this is that a student must be proficient in English language before he or she can perform creditably well in other school subjects. Most students fail in most school certificate subjects because they have problem of proficiency in English Language. This makes it inevitable for students to be proficient in English language in order to achieve the goal of their studies. Bachman (1990) defines language proficiency as the language ability or ability in language use. Many educationists are of the view that participation in verbal interaction provides language learners with the opportunity to follow-up on language items they are exposed to during classroom lessons and to practice them in contexts.

Studies that compared the significant relationship between English and Physics achievement was illustrated by Lemke (2005). He stated that the primary activity that students encounter and participate in, in a Physics course, was representation. The use of language is one of the many ways of representation. Therefore, the first ability that the students have to develop is the ability to represent ideas and physical processes in different ways and to move between representations which can only happen if one is equipped with enough communication skills. English language is now widely used and can be considered as one of the most effective medium of communication in international business and technology based industries. It is believed that language learning has a pivotal role in helping human to express his opinions (Zainol Abidin, Pour-Mohammad, 2012). It is also stated that attitude towards language learning plays a crucial role in language learning as it influences learners' success or failure (Zainol Abidin, et al., 2012& Finch, 2008). Students are identified as having Limited English Proficiency if they do not speak English as their primary language and have limited ability to read, speak, or understand English. The number of these students in public schools has increased substantially over time (Bui, 2011). Additionally, studies in the area of English fluency suggest the size of one's language group affects one's English proficiency. Lazear (1999) theorizes and finds evidence in the 1900 and 1990 US censuses that immigrants from groups with large proportions in the local population learn English more slowly than immigrants from groups with smaller proportions in the local population. In order to provide effective instruction in the academic language needed for success in the content areas, teachers must be prepared to integrate academic language teaching into the teaching of the disciplines (Silva & Pierce, 2007). Research shows that anxiety has a negative effect on achievement and can hinder language acquisition, specifically because anxiety is likely to lead to diminished desire to communicate (Horowitz, Tallon, & Luo, 2010). Students may feel anxious because they perceive their language competencies as low and are hesitant about communicating and being understood. Horowitz, Tallon and Luo (2010) recommend that teachers should explicitly address language learning anxiety in the classroom and frame it as a normal part of second language acquisition.

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Taylor (2007) found out that students‟ achievement would improve when the curriculum was restructured through strengthening the relationship among science, Mathematics and English both in terms of how the formal curriculum was expressed and day-to-day teaching and learning practices. Language-focused activities could either be incorporated into the science or Mathematics instruction or students may work on parallel activities. The separate language-based units of work, using science and Mathematics content, could be taught as part of the English language integrated with content - teaching curriculum. Frykholm and Meyer (2003) found out that in terms of the content structure, the relationship seems to be asymmetric between mathematics, physics and English subject. Unlike the Mathematics teacher who can choose to avoid science, the science teacher is not able to cover most topics without calling on mathematical concepts and skills, and not using English as the medium of instruction. The unbalanced structure between the subjects‟ curricula may result to low or high student achievement. At this point it will be clear that mathematics ability, English language proficiency are very critical in the learning or studying of physics.

1.3 Purpose of the Study

The purpose of the study is to determine the influence of mathematical ability and English language proficiency on senior secondary school student achievement in physics in Adamawa State. Specifically, the study seeks to determine the following objectives:

(i) Examine the influence of mathematical ability on student's achievement in physics.
(ii) Examine English language proficiency influence on student's achievement in physics.
(iii) Examine the combined influence of mathematical ability and English language proficiency on student's achievement in physics.

Research Question

Based on problems of the study, this study seeks to answer the following questions:

i. To what extent does mathematical ability influence student's achievement in physics
ii. To what extent does English language proficiency influence student's achievement in

Physics?

iii. To what extent does the mathematical ability and English language proficiency combine influence student's achievement in physics?

Research Hypothesis

The following null hypotheses are formulated and will be tested at 0.05 level of significance:

HO_1: There is no significant influence of mathematical ability on students' achievement in

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Physics

HO2: There is no significant influence of English language proficiency on students' achievement in physics.

HO3: There is no significant influence of the combined of mathematical ability and English language proficiency on students' achievement in physics.

METHODOLOGY

This study employed a 2 × 2 factorial ex post facto design, which involved non-equivalent group.

Sample and Sample Technique

Using Taro Yamani sampling method. a total of 400 student (80 student from each educational zone) across the state formed the sample of this study. 2 classes of 2 secondary schools is selected by simple random sampling method, and 40 student have also be selected by simple random method from the 2 selected school classes.

Instrument for Data Collection

The instruments that was used for data collection in this study are all standardized instrument. These include; physics achievement test (PAT), Mathematics achievement test (MAT), and English Language Proficiency Test (ELPT). The PAT is adapted from west African senior secondary school certificate extermination (WASSCE) containing 30 multiple choice question has four option (A to D) from 2006 to 2016.The MAT is adopted from Otis-Lennon, contained 26 items of multiple choice (A to E). The ELPT was adopted from Yeditape university Istanbul, which was used to test English language proficiency of the subject and categorize them into high and low levels. It contained 25 items of multiple choice (A to D). The ELPT will test students reading, comprehension, grammar as well as vocabulary.

The PAT is revalidated by three experts, two from MAUTECH Yola, from physics and science Education department, the other from physics department Adamawa state polytechnic Yola., The MAT instrument is revalidated by two expert, one from science education department of MAUTECH Yola and one from mathematics department Adamawa state polytechnic Yola. The standardized ELPT was also validated as in Adamu's work by three experts. The recommendations and suggestions of these experts were taken into considerations and all necessary corrections were affected. All the instruments are subjected to revalidation by the experts, to ensure more content and face validity, and base on recommendation of the expert the MAT and ELPT maintained the original number as 26, 25 items respectively, while PAT is reduced to 30 items.

For the reliability of the three instrument croanbach Alpha is used to determine the co-efficient from the pilot testing. PAT contain 40 items and it administer to 30 student of SSII General Murtala

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Mohammed Collage Yola, (GMMC Yola). MAT contain 26 Items and it administer to 30 student of SSII of Aliyu Mustapha Collage Yola (AMC Yola). The ELPT contain 25 items and it also administer to 54 students of SSII from AMC Yola, GMMC Yola, and GDSS Namtari. The reliability coefficient of 0.80, 0.89, and 0.85 was obtained for PAT, MAT, and ELPT respectively.

Method of Data Collection

The scores of students in the MAT and ELPT is used to decide their mathematical ability level and English language proficiency level. Then, the academic achievement in physics was determined by the scores of PAT in relation to the ELPT, MAT scores toward physics study. In both the two instrument (MAT & ELPT) score of 50% above is consider high level, and score less than 50% will be consider as low-level achievement.

Method of data analysis

The data collected is analyzed using spss. (Statistical package for social sciences). The mean and standard deviation is used to answer the research questions while ANOVA was used to test the hypotheses at 0.05 level of significance. If the p – value is less than 0.05 we reject the null hypothesis, otherwise we do not reject the null hypothesis.

RESULT AND DISCUSSION

Research Question 1

To what extent does mathematical ability influence student's achievement in physics?

Table 1: Mean and Standard deviation of physics achievement scores of High and low mathematical ability students'

Mathematical ability	N	Mean	Std. Deviation
High Mathematical ability	122	12.45	4.51
Low mathematical ability	88	11.09	3.62
Mean difference		1.36	
Total	200	11.85	4.19

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Descriptive statistics Results in Table 1 shows mean and standard deviation of physics achievement scores of high and low mathematical ability students. The high mathematical ability students have mean achievement scores of 12.45 and standard deviation 4.51. The low mathematical ability students have mean score of 11.09 and standard deviation 3.62. The mean difference of the groups is 1.36. This means that mathematical ability of students to some extent has influence on their achievement in physics.

4.1.2 Research Question 2

To what extent does English language proficiency influence student's achievement in Physics?

Table 2: Mean and Standard deviation of physics achievement scores of High and low English language proficiency students

English language proficiency	N	Mean	Std. Deviation
High proficiency in English language	80	12.41	4.71
Low proficiency in English language	120	10.84	3.92
Mean difference		1.57	
Total	200	11.47	4.31

Descriptive statistics Results in Table 2 shows mean and standard deviation of physics achievement scores of high and low English language proficiency student. The high proficiency students have mean achievement score of 12.41 and standard deviation 0f 4.71. The low proficiency students have mean achievement score of 10.84 and standard deviation of 3.92. The mean difference of the scores is 1.57 and this shows that to some extend English language proficiency has influence in physics student achievement.

Research Question 3

To what extent does the mathematical ability and English language proficiency combined influence student's achievement in physics?

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Table 3: Mean and Standard deviation of physics achievement scores of mathematical ability and English language proficiency students'

	N	Mean	Std. Deviation
Mathematical ability	200	11.47	4.31
English language proficiency	200	11.85	4.19
Mean difference		-0.38	
Total	400	11.66	4.25

Descriptive statistics Result in Table 3 shows mean and standard deviation of physics achievement scores of mathematical ability and English language proficiency students. The mathematical ability students have mean achievement score of 11.47 and standard deviation of 4.31. The English language proficiency student have mean achievement score of 11.85 and standard deviation of 4.19. The mean difference of the score is -0.38, and this indicate that, to some extend both the mathematical ability and English language proficiency have similar influence on physics student's achievement.

Ho_1: There is no significant influence of mathematical ability on students' achievement in Physics

Table 4: Summary of ANOVA of High and Low mathematical ability students' achievement in physics

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	90.549	1	90.549	5.272	.023
Within Groups	3400.951	198	17.177		
Total	3491.500	199			

Table 4 shows summary of Analysis of Variance conducted to determine the influence of students' mathematical ability on physics achievement. The results show that there is significant influence of mathematical ability on students' achievement in physics [$F_{(1, 198)} = 5.272$, $p<0.05$]. Since the p – value is less than 0.05 level of significant, we reject the null hypothesis.

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H_{o2}: There is no significant influence of English language proficiency on students' achievement in physics.

Table 5: summary of ANOVA of High and Low English language proficiency students' achievement in physics

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	118.441	1	118.441	6.548	.011
Within Groups	3581.379	198	18.088		
Total	3699.820	199			

Table 5 shows summary of Analysis of Variance conducted to determine the influence of students' English language proficiency on physics achievement. The result shows that, there is significant influence of English language proficiency on students' achievement in physics [$F_{(1, 198)} = 6.548$, $p<0.05$]. since the P- value is less than 0.05 level of significant, we reject the null hypothesis.

H_{o3}: There is no significant influence of the combined of mathematical ability and English language proficiency on students' achievement in physics.

Table 6: summary of ANOVA of Mathematical Ability and English language proficiency students' achievement in physics

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	14.440	1	14.440	.799	.372
Within Groups	7191.320	398	18.069		
Total	7205.760	399			

Table 6 shows summary of Analysis of Variance conducted to determine the influence of students' Mathematical Ability and English language proficiency on physics achievement. The result shows that, there is no significant influence of the combined Mathematical Ability and English language

proficiency on students' achievement in physics [F (1, 398) = 0.799, p>0.05]. Since the P- value is greater than 0.05 level of significant, we do not reject the null hypothesis.

DISCUSSION

This study determined the influence of mathematical ability and English language proficiency on physics students' achievement in physics. The findings of the study revealed that there is significant influence of mathematical ability on students' achievement in physics. Also, there is significant influence of English language proficiency on students' achievement in physics and finally there is no significant influence of the combined Mathematical Ability and English language proficiency on students' achievement in physics.

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