

Good Mathematics Background: A Key Factor towards Enhanced Students Achievement in Chemistry in Senior Secondary Schools in Rivers State

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Abstract

Researchers evaluated if good mathematics background is a key factor towards enhanced students' achievement in chemistry in senior secondary schools in Rivers State, using good understanding of mathematics, mathematics laboratory influences, gender influence and parental background in mathematics as benchmark. The study adopted a survey and a descriptive research design. The study's respondents comprised 350 SS2 & SS3 students from five randomly selected schools in four local government areas of Rivers State. They responded to a 5-point Likert scale. Descriptive statistics (mean, standard deviation, percentages) and One-Way Analysis of Variance (ANOVA) was used to determine if relationships exist in the variables. The study discovered that there are significant relationships between good understanding of mathematics, mathematics laboratory, achievement in mathematics based on gender and parental background in mathematics and students' achievement in chemistry. The study recommends that chemistry students should be made to understand the important connections between good mathematics background and achievement in chemistry right from the inception of the study of chemistry in senior secondary school classes and should be better advised on the need to put effort in studying mathematics if they desire to be proficient in chemistry and other science related subjects.

Keywords: Mathematics Background, Mathematics Laboratory, Enhanced Achievement, Gender, Secondary School, Chemistry, Students, Parental Background, Nigeria.

INTRODUCTION

Mathematics is one of the key subjects in the sciences and it is taken very seriously in the school systems, irrespective of the country's background or level of education. It has been described as a model of thinking, as such, it has encouraged students to observe, reflect and reason logically about problems, and making mathematics the central intellectual discipline and a vital tool in science education (Ihendinihu, 2013). According to Godpower-Echie and Amadi (2013), mathematics is the originator of scientific discoveries and inventions, and the basis for any meaningful scientific innovations in science and technology.

Permitting Adesoji and Ibraheem (2009) argument, the last two decades has witnessed a turning point in research on the difficulties students at the secondary school level have in coping with certain chemistry concepts. Such studies (e.g., Godpower-Echie & Amadi, 2013, Iji, 2008; Ihendinihu, 2013) have revealed among other things that good background in mathematics and the ability to handle mathematics concepts needed in solving chemistry problems seems to be eroding us and the matter is worrisome.

Elekwa (2010) who studied the effects of collaborative teaching/learning strategies on the mathematics achievement of senior secondary school students in Abia State of Nigeria found that Student's that exhibit carefree attitude towards mathematics, even when they know that they need mathematics to forge ahead in their studies and in life always perform poorly in it and other science subjects. It would be safe to say that since chemistry is one of the science subjects, a good knowledge of mathematics will enhance chemistry achievement.

Giving Adigwe (2012) affirmation, the study of chemistry in our educational systems and at all levels requires the knowledge, thought-process and skills of mathematics. Mathematics has been found to be imperative in the study of chemistry including its role in the development of other sciences and technological innovations.

Adesoji and Ibraheem (2009) in their study the effects of student teams-achievement divisions' strategy and mathematics knowledge on learning outcomes in chemical kinetics, and using ANCOVA analysis on three hundred (300) students (110 male and 190 female from 6 senior secondary schools in Epe division of Lagos State, Nigeria), found that a good mathematical background has great influence on chemistry achievement. They further stated that there are certain mathematical abilities that are tied to success in chemistry and these mathematical concepts are cognitive entry characteristics for success in chemistry, and the ability to manipulate symbols and the capacity, usage and the competence to maneuver algebraic symbols is critical and essential for success in chemistry.

Poor achievement in chemistry by students has continued to be of major problem to researchers, teachers, government, particularly to those in mainstream chemistry education in Nigeria. This deplorable situation no doubt has triggered research efforts directed towards the factors responsible for this deplorable circumstance and the efforts made to remedy the situation. A foremost factor that has been attributed to being responsible for the low poor achievement of students in chemistry is poor mathematics background (Adesoji & Ibraheem, 2009; Godpower-Echie & Amadi, 2013). Iji (2008) and Ihendinihu (2013) were of the view that a good background in mathematics is essential for the study of all science and technology based courses.

Purpose of Study

There are a number of factors that determine students' achievement in chemistry aside from mathematical skills and abilities. However, the intellectual capacity of students may have a larger causal factor of succeeding in chemistry than those with less or without intellectual abilities. Nevertheless, Spencer in Adesoji and Ibraheem (2009) study has shown that comprehending basic geometry and algebra are important for achievement in chemistry. None the less, this current study is guided and directed at finding out whether good mathematics background (good mathematics knowledge, mathematics lab, gender and parental background) is key towards enhanced chemistry achievement in senior secondary school students in Rivers State, Nigeria. Specifically, the purpose of this study is to:

- Determine if good understanding of mathematics influences students' achievement in chemistry?
- Determine if mathematics lab influences students' achievement in chemistry?
- Determine if the achievement in mathematics based on gender influences achievement in chemistry?
- Determine if parental background in mathematics influences students' achievement in chemistry?

Research Questions

The under listed research questions guided this study:

- Does good understanding of mathematics influence students' achievement in chemistry?
- Does mathematics lab influence students' achievement in chemistry?
- Does the achievement in mathematics based on gender influence achievement in chemistry?
- Does parental background in mathematics influence students' achievement in chemistry?

Hypotheses

Four null hypotheses were formulated to test the relationships between the variables, and the hypotheses state that:

- There is no significant relationship between good understanding of mathematics and students' achievement in chemistry.
- There is no significant relationship between mathematics lab and students' achievement in chemistry.
- There is no significant relationship between achievement in mathematics based on gender and achievement in chemistry.
- There is no significant relationship between parental background in mathematics and students' achievement in chemistry.

LITERATURE REVIEW

Good Understanding of Mathematics/Students' Achievement in Chemistry

Mathematics is an indispensable skill that must be mastered by chemistry students. However, there is a mismatch between staff and student understanding of its importance (Grove, 2015). Grove further revealed that in a study survey, over a quarter of respondents argued that the relevance of mathematics with reference to chemistry had not been explained to them. However, the study showed that ill-prepared students in mathematics performed poorly in chemistry, more than half of the students surveyed agreed that the mathematics they did prepared them very well for chemistry.

Interaction between different science subjects has increased following the advancement of science and technology. Chemistry is sister to all science subjects and is also an important subject in the medical and engineering sciences. Owing to the widespread applications and

complexity of chemistry, it embraces mathematics as a foremost partner in achieving its goals. Mathematics is used widely in chemistry as well as other natural and physical sciences. As such, mathematical calculations are unequivocally required to explore important concepts in chemistry. Without certain rudimentary mathematical skills, calculations in chemistry will be extremely difficult. Because of mathematics skills, many complicated problems are solved and the results are reached in a simple but logical way, which otherwise would prove extremely difficult (Offiah & Samuel, 2012).

Etukodo and Nnaobi found that mathematical skills are needed in the teaching of chemistry for sustainable academic achievement in chemistry. The lack of requisite mathematical skills makes it impossible to produce chemistry graduates (Etukodo & Nnaobi, 2002).

Mathematics Laboratory/Students' Achievement in Chemistry

The mathematics laboratory is a place where students can experiment and discover configurations and ideas. It comprised of collection of games, puzzles, and other mathematics teaching and learning material. These materials are destined to be used by students on their own and with the help of the teacher to explore the world of mathematics to enhance interest in mathematics.

According to Mathematica (2011), mathematics laboratory is a place rich in manipulation materials where students have ready access to handle them, perform mathematical experimental games, solve mathematical puzzles and become involved in other activities. The more the students get involved in mathematical laboratory work the more they are helped in satisfying the creative and constructive urges for the students to do well in other sciences.

The mathematics Laboratory is a distinctive concept in the field of mathematics education introduced in the year 1994 and has gone a long way in enriching mathematics at primary, secondary and senior secondary schools. In developed countries, mathematics Laboratory is an integral part of regular curriculum as against what is obtainable in the developing world. The functional role of mathematics in science and technology is multidimensional and diverse because no area of the physical sciences (e.g., chemistry, physics, etc.) escapes its application. Mathematics is the mirror of civilization because of its painstaking calculations. It is the basic subject for any person to be truly educated in any of the sciences and other endeavours (Okigbo & Osuafor, 2006).

Achievement in Mathematics Based on Gender/Students' Achievement in Chemistry

Gender is the state of being male or female. It is biological characteristics of women and men. It is characteristically used with reference to social and cultural differences and distinguishes the roles, behaviour, mental and emotional characteristics between being a man and a woman. Gender is typically believed to have immense influence on academic performance.

Badru (2004) study revealed that the choice of science subjects in Nigerian schools is dependent on learners' ability in mathematics because proficiency in mathematics is the basis for the study of other science subjects. As a result, students with poor mathematics knowledge cannot be presumed to be capable of solving calculation problems in chemistry (Okwon, 2005). Equally, in a study by Busolo revealed that gender differences play a significant role in chemistry (Busolo, 2010). Exploring reasons behind the differences between gender in chemistry

and mathematics, Hudson (2011) found that differences in mathematical ability were a very important consideration in determining achievement.

Chemistry is believed to be the one of the core subjects among the physical sciences. In spite of the importance of chemistry to modernity, the choice and interest of students are greatly influenced by a number of factors with gender and mathematics ability playing major role in the academic achievement of it. Conversely, in a study conducted by Udousoro (2011), which evaluated the effects of gender and mathematics ability on academic performance of students in chemistry revealed that gender does not have any significant effect on the academic achievement of students in Chemistry, but also found that students with high mathematics ability performed significantly better than those with low mathematics ability in chemistry.

Parental Background in Mathematics/Students' Achievement in Chemistry

Mathematics as well as science education according to Olatoye and Agbatogun (2009) play great contribution towards the growth, development and the survival of human existence. Mathematics prearranges other Sciences and forms the avenue through which humans interact and explain our existence. Mathematics cannot be detached from other physical sciences where chemistry play prominent role in the advancement of mankind (Olutusin, 2007). Olutusin further asserts that mathematics facilitates the learning of other science subjects and the importance of mathematics permeates all aspects of human learning.

Research from Iran indicated that there is a positive association between students' achievement in mathematics and other sciences and home background such as parents' level of education (Kiamanesh & Kherei, 2001; Ojimba, 2013). Oloruntegbe (2013) is of the view that parents' science background has significant relationship in their children achievement in the sciences. Parents' involvement in their children's learning according Fan and Chen in Olatoye and Agbatogun (2009) show positive relationship in their children's academic performance.

Experts (e.g., Olatoye & Ogunkola, 2008a, b; Kiamanesh & Kherei, 2001; Ojimba, 2013; Udousoro, 2011) in mathematics and science education agree on the important linkages between parental background and achievement in science education, however, there are limited research in developing countries that studied the direct link between parental background in mathematics and students' achievement in chemistry. Thus, rigorous studies to help educators predict the precise outcomes of the implication of parental background in mathematics and students' achievement in chemistry should be encouraged. This study is a groundbreaking research in this domain.

METHODOLOGY

Study Design

This study is a survey and a descriptive research design. The study attempts to describe the outcome of the challenges faced by chemistry students as a result of their deficiencies in mathematics and how it is related to their achievement in chemistry. Thus, it is aimed at finding out whether good mathematics background is key towards enhanced chemistry achievement in senior secondary school students in Rivers State, Nigeria. The design identifies four mathematical group variables (good mathematics knowledge, mathematics lab, gender and

parental background), which may have been detected, adjudged or described to possess certain relationship to chemistry achievement in Nigeria.

Population and Sample

The research population for this study included all students in Rivers State, Nigeria. The population is aimed at defining the limits within which this research finding would be applicable. Thus, it illustrates the limit to which the results of this study might be generalizable unto it. In this study, the respondents comprised 350 students from five randomly selected secondary schools in four local government areas of Rivers State. Out of the 370 questionnaires distributed only 350 questionnaires were returned representing 96% response rate. The categories of respondents based on age revealed that the respondents were aged between 15-18 years. The information on respondent's gender showed that male respondents were 190(54.3%), while 160(45.7%) were female. Respondents information based on class revealed that 200(57.1%) were in senior secondary school three (SS3), whereas 150(42.9%) were in senior secondary school two (SS2). On the type of schools—2 were federal government colleges, while 3 were state own schools (see figure 1-4 for column chart representations).

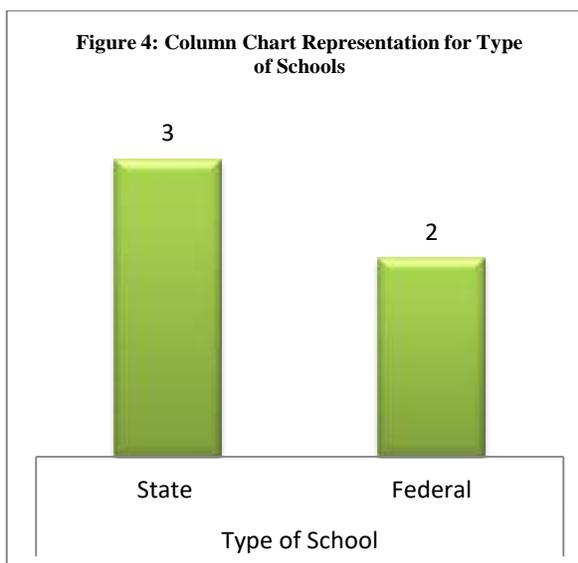
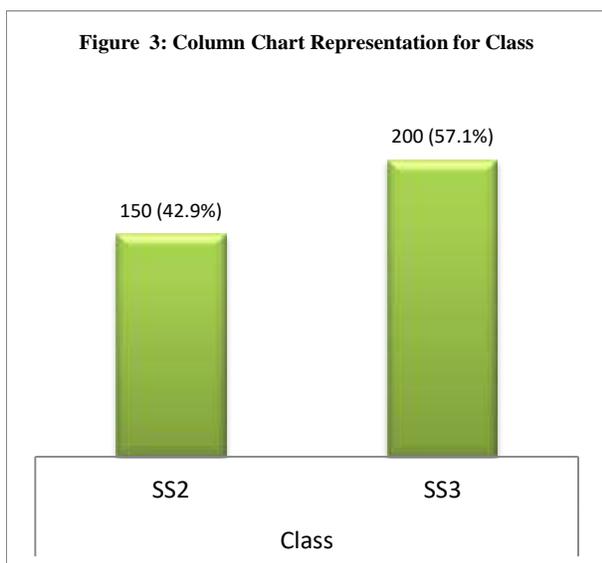
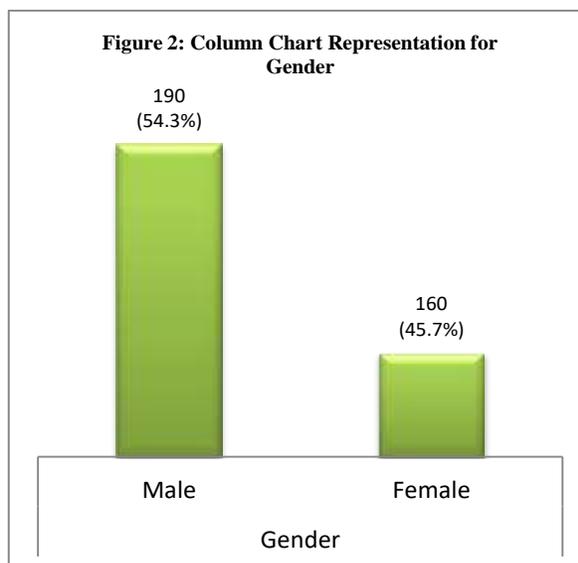
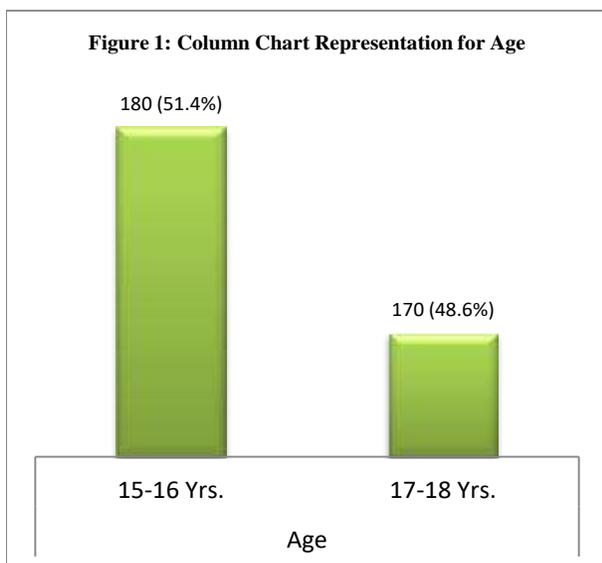
Instrumentation (Questionnaire)

The questionnaire used for data assemblage was designed by the researchers and validated by experts in survey measuring and evaluation. The purpose of the study and the importance of conducting this research and the instruction on how to complete the questionnaires were explicit in the front page. The questionnaire comprised five sections: section 1 had information on respondents demographic data: age, gender, class and type of school; section 2 contained information on good mathematics knowledge and chemistry achievement; section 3 comprised of information on mathematics laboratory and how it relates to students achievement in chemistry; section 4 talked about knowledge of mathematics based on gender and achievement in chemistry; while section 5 deals with issues of parental background in mathematics and students achievement in chemistry.

The questionnaire was fashioned along a 5-point Likert scale numbered 1, 2, 3, 4 and 5. The rating system adopted followed the subsequence of: 1=Totally Disagree (TD), 2=Disagree (D), 3=Neither Agree nor Disagree (NAD) 4= Agree (A) and 5=Totally Agree (TA). Section 2-5 consisted of 6 items each with the sections Cronbach's alpha reliability analysis was .777, .978, .817, and .882 respectively. The agreement or disagreements were calculated thus: $1+2+3+4+5=15/5=3$. Therefore, any mean that is less than 3 were rejected.

Data Analysis

The statistical analyses in this study were carried out using SPSS version "21". Descriptive statistics (mean, standard deviation, percentages) and One-Way Analysis of Variance (ANOVA) were used to determine if relationships exist between good mathematics background and students' achievement in chemistry. The ANOVA analysis was set at $p < 0.05$ level of significance. To answer the research questions, the mean results were tallied along agree and disagree.



RESULTS AND DISCUSSION

Research Question 1 and Hypothesis 1

Research question one was aimed at determining the extent to which good understanding of mathematics can influence the achievement in chemistry. The means (3.5684) and standard deviation ($.91852$) depicts that students agree that good understanding of mathematics determine their advancement in chemistry.

Test on hypothesis one, which states “there is no significant relationship between good understanding of mathematics and students’ achievement in chemistry” revealed that there is a significant relationship between good understanding of mathematics and students’ achievement in chemistry. The ANOVA present the $F\text{-ratio} = 2.657$ and significant at $p < .045$ (see table 1). Thus hypothesis one was rejected. This study is in line with the observations and findings of

Grove (2015), Offiah and Samuel (2012), and Etukodo and Nnaobi (2002). They were of the view that mathematics is an indispensable skill that must be mastered by chemistry students. Grove’s study showed that ill-prepared students in mathematics performed poorly in chemistry, more than half of the students surveyed agreed that the mathematics they did prepared them very well for chemistry (c.f., Grove, 2015). Similarly, Offiah and Samuel (c.f., 2012) found that without certain rudimentary mathematical skills, calculations in chemistry will be extremely difficult. Because of mathematics skills, many complicated problems are solved and the results are reached in a simple but logical way, which otherwise would prove extremely difficult. In the same vein, Etukodo and Nnaobi (c.f., 2002) found that mathematical skills are needed in the teaching chemistry for sustainable academic achievement of chemistry. The lack of requisite mathematical skills makes it impossible to produce chemistry graduates.

Table 1: ANOVA analysis for good understanding of mathematics and students’ achievement in chemistry

		Sum of Squares	df	Mean Square	F	Sig.
GUM/SAC	Between Groups	9.437	3	3.146	2.657	.048
	Within Groups	409.651	346	1.184		
	Total	419.089	349			

GUM/SAC: Good understanding of mathematics and students’ achievement in chemistry

Research Question 2 and Hypothesis 2

Research question two evaluated the extent to which mathematics laboratory can influence students’ achievement in chemistry. The results obtained from the descriptive statistics showed that the respondents agree that mathematics laboratory influences achievement in chemistry. This is evidenced in the mean (3.5489) and the standard deviation (.67942).

Hypothesis two states “there is no significant relationship between mathematics lab and students’ achievement in chemistry” and the results revealed significant positive relationships between effective use of mathematics laboratory and achievement in chemistry. ANOVA displayed F-ratio =7.230 with a significant level of $p < .000$ (see table 2). Therefore, hypothesis two was rejected because there are significant relationships between the effective use of mathematics laboratory and achievement in chemistry. This study is in line with Mathematica (c.f., 2011). They found that mathematics laboratory is a place rich in manipulation materials where students have ready access to handle them, perform mathematical experimental games, solve mathematical puzzles and become involved in other activities. The more the students get involved in mathematical laboratory work the more they are helped in satisfying the creative and constructive urge of the students to do well in other sciences. The functional role of mathematics in science and technology is multidimensional and diverse because no area of the sciences (e.g., chemistry, physics, etc.) escapes its application. Mathematics is the mirror of civilization because of its painstaking calculations. It is the basic subject for any person to be truly educated in any of the sciences and other endeavours (c.f., Okigbo & Osuafor, 2006).

Table 2: ANOVA analysis for mathematics laboratory and students' achievement in chemistry

		Sum of Squares	df	Mean Square	F	Sig.
ML/SAC	Between Groups	17.852	3	5.951	7.230	.000
	Within Groups	284.788	346	.823		
	Total	302.640	349			

ML/SAC: Mathematics laboratory and students' achievement in chemistry

Research Question 3 and Hypothesis 3

Research question three assessed the extent to which achievement in mathematics based on gender influences achievement in chemistry. The means (3.9659) and standard deviation (.87689) depicts that students agree that good mathematics achievement based on gender determine achievement in chemistry.

Hypothesis three states that “there is no significant relationship between achievement in mathematics based on gender and achievement in chemistry”. In testing if significant positive relationships exist between achievement in mathematics based on gender and achievement in chemistry, ANOVA analysis was employed and the results revealed positive relationships at $F=5.093$ with a $p < .002$ (see table 3). Accordingly, hypothesis three was rejected. This study is in line with Badru (2004), Okwon (2005) and Busolo (2010). The choice of science subjects in Nigerian schools is dependent on learners' ability in mathematics because proficiency in mathematics is the basis for the study of other science subjects (c.f., Badru, 2004) and students with poor mathematics knowledge cannot be presumed to be capable to solve calculation problems in chemistry (c.f., Okwon, 2005). Correspondingly, Busolo (c.f., 2010) revealed that gender differences play a significant role in achievement in chemistry.

Table 3: ANOVA analysis for achievement in mathematics based on gender and achievement in chemistry

		Sum of Squares	df	Mean Square	F	Sig.
AMBG/SAC	Between Groups	26.343	3	8.781	5.093	.002
	Within Groups	596.526	346	1.724		
	Total	622.869	349			

AMBG/SAC: Achievement in mathematics based on gender and students' achievement in chemistry

Research Question 4 and Hypothesis 4

Research question four was aimed at determining the extent to which parental background in mathematics influence students' achievement in chemistry. The descriptive statistical analysis conducted depicted that students agreed to the fact that parental background in mathematics influences achievement in chemistry with a mean of 3.2353 and standard deviation of .55371.

Hypothesis four states “there is no significant relationship between parental background in mathematics and students' achievement in chemistry”. The rationale for this hypothesis is to test if relationships exist between parental background in mathematics and students' achievement in chemistry. ANOVA analysis set at .05 level of significance exposed that parental background in mathematics is significantly related to students' achievement in chemistry at $F=3.996$ with a

significance of $p < .008$ (see table 4). Hence, hypothesis four was rejected. This study is in line with Kiamanesh and Khereih (2001), Ojimba (2013), Oloruntegbe (2013) and Olatoye and Agbatogun (2009). A study from Iran indicated that there is a positive relationship between students' achievement in mathematics and other sciences and home background such as parents' level of education (c.f., Kiamanesh & Khereih, 2001; Ojimba, 2013). The same is true of Oloruntegbe (c.f., 2013) when he found that parents' science background has significant relationship in their children achievement in the sciences. Udousoro (c.f., 2011) found that mathematics and science subjects have important linkages between parental background and achievement in science.

Table 4: ANOVA analysis for parental background in mathematics and students' achievement in chemistry

		Sum of Squares	df	Mean Square	F	Sig.
PBM/SAC	Between Groups	8.220	3	2.740	3.996	.008
	Within Groups	237.277	346	.686		
	Total	245.497	349			

PBM/SAC: Parental background in mathematics and students' achievement in chemistry

CONCLUSION

In this study, we evaluated if good mathematics background is a key factor towards enhanced students' achievement in chemistry in senior secondary schools in Rivers State, using good understanding of mathematics, mathematics laboratory influences, gender influence and parental background in mathematics as benchmark. The study revealed astonishing results that showed there are significant relationships between good understanding of mathematics, mathematics laboratory, achievement in mathematics based on gender and parental background in mathematics and students' achievement in chemistry. The results of this study have added value to the understanding of the role of good mathematics background and its relationships to students' achievement in chemistry, including the need for early intervention where problem exist, because over eighty percent of the respondents agree that good mathematical background is valuable in students' achievement in chemistry.

We recommend that chemistry students should be made to understand the link between good mathematics background and achievement in chemistry right from the start of the study of chemistry in senior secondary school classes and should be better advised on the need to put effort in studying mathematics if they desire to be proficient in chemistry and other science related subjects.

Implication of the Study

This study has practical and theoretical implications that may reduce the doubt and progress the understanding of the issues surrounding good mathematics background and achievement in chemistry. This study gave considerable focus to components of good mathematics background and its influence on achievement in chemistry. Therefore, this study might fill the intellectual gap in the understanding and misunderstanding surrounding the mystery of science education, quality science education and the achievability and promotion of science education in Nigeria. To this end, this groundbreaking research is maiden study concerning the theme and the

variables used for this study. This study has implications for science education teachers, researchers, science education policymakers, Ministry of Science and Technology, and science education practitioners who might find this work a useful addition to science education effectiveness and improvement in Nigeria.

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