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Mathematical Ability as a Correlate of Students Academic Achievement in Mathematics: A Study of Secondary Schools in Edo and Delta States

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ABSTRACT

This study investigated the relationship between mathematical ability and academic achievement in mathematics among secondary school students in Edo and Delta States. Two research questions were raised and answered. Two hypotheses were also formulated and tested at the 0.05 level of significance. The study used a correlational research design. The population for this research consisted of 51,526 senior secondary school II (SSII) students from all 792 public secondary schools in Edo and Delta states. The study's sample consisted of 800 SS2 students selected from 80 public secondary schools located in Edo and Delta states. The instruments that were used for data collection in this study are the Student Scholastic Ability Test (SAT) and the Mathematics Achievement Test (MAT). The content validity of the Mathematics Achievement Test (MAT) was also carried out by the use of a table of specifications. The reliability of the Scholastic Ability Test (SAT) and Mathematics Achievement Test (MAT) was carried out using the Kuder-Richardson-21. This yielded a reliability index of 0.76 for the Scholastic Ability Test (SAT) and 0.73 for the Mathematics Achievement Test (MAT). 800 copies of the instrument were administered, and a total of 760 copies of the returned instrument were returned and used for data analysis. The data were analysed using the correlation coefficient (r) and regression at the 0.05 level of significance. The findings of the study revealed that there is a relationship between mathematical ability and mathematics achievement among secondary school students in the Edo and Delta States, and there is no moderating impact of sex on the correlation between mathematical ability and mathematics achievement among secondary school students in the Edo and Delta States. Based on the findings, it was concluded that there is a considerable correlation between mathematical ability and mathematical achievement, and the students' sex does not have a significant impact on the influence of mathematical ability on mathematical achievement. Based on the findings of this study, it was recommended, among others, that mathematics teachers should strive to recognise and cater to the varying mathematical abilities of students and endeavour to implement teaching strategies that accommodate diverse learning needs.

Keywords: Mathematical Ability, Academic Achievement, Mathematics, Sex.

1. Introduction

Mathematics is a subject that deals with numbers, shapes, and patterns. It involves the use of logical reasoning and problem-solving techniques to find solutions to mathematical problems. Mathematics is an essential component of various disciplines, including science, engineering, and economics. Mathematics plays a crucial role in our lives and in the world around us. It is the foundation of many scientific investigations, technological advancements, and everyday decision-making. Mathematics is the backbone of many scientific theories, providing a framework for understanding the natural world. It helps scientists analyze data, model complex systems, and make predictions. Mathematics is essential for designing and analyzing structures, bridges, and machines. It helps engineers calculate forces, optimize designs, and ensure safety and reliability. Mathematics is used to analyze market trends, make financial decisions, and evaluate investments. It helps economists understand market dynamics, calculate inflation, and develop economic policies. Mathematics is at the core of computer science, helping programmers design algorithms, solve problems, and develop computational systems. It is used to create software, databases, and artificial intelligence. Mathematics is an indispensable subject in education, providing students with essential critical thinking and problem-solving skills. It helps develop logical reasoning, logical thinking, and problem-solving skills.

In order to realize these lofty objectives, there is a need for better academic achievement among students. The level of academic achievement of students gives a clear indication of whether a school is realizing these objectives or not. Academic achievement refers to how far a learner or school has progressed toward short-term or long-term teaching methods. Students' achievement can be assessed by their grade, point, average. While schools' achievement can be assessed by their pass rate. Academic achievement is the outcome of education. It constitutes the extent to which a student, teacher or institution has achieved his/her educational goal. Bell (2012) described academic achievement as the tendency to strive for success and to participate in activities in which success is dependent on a person's effort, skills, courage, perseverance and ability. Academic achievement is a crucial aspect of learning. It is regarded as the focal point around which the educational system revolves and determines whether an academic institution will succeed or fail (Amalu & Ndifon, 2017).

Due to the importance of education in public service, everybody wants public school students' achievement to be of higher quality because people who did not earn higher outcomes or grades cannot contribute effectively to national development due to a lack of the necessary abilities. Poor academic achievement not only leads to a negative image of the student, but it also puts an enormous strain on the parents. Given the dynamic role mathematics plays in any society, as discussed above, it is quite appalling and unfortunate to see students fail in mathematics examinations. The abysmal achievement of students in both internal and external senior school examinations has not gone unnoticed. What has continued to perplex the hearts of all those interested in the education of children is the question of what would have been the cause of this failure?

In view of this, several research has been conducted to identify the factors that contribute to students' poor academic achievement in mathematics. Scholars have found that a number of factors affect how well students do in school. These include problems with the school administration, quality assurance practices, school community relationships, students' perceptions, their personalities, their homes, and psychosocial factors (Adeyemi & Adeyemi, 2014). Specifically, Owan (2012) disclosed that learners' disposition, utilisation of teaching aids by educators, parents' education are correlates of students' achievement in mathematics. Although several factors have been outlined in the literature which one would expect to have addressed the issue of students' poor academic achievement in mathematics, the issue of poor academic achievement still persists among students.

The results received by students in WAEC over the last two years demonstrate a consistent pattern of underperformance in mathematics. In the May/June 2018 S.S.C.E, a total of 1,572,396 applicants took the test. Out of these, only 714,380 students, which is 45% of the total, achieved high marks in mathematics, while the other 55% of candidates failed. Out of the 618,119 students who took the June 2019 tests, 43.7% achieved passing grades at the Distinction and Credit levels in Mathematics. The mathematics failure rate for the years 2020 and 2021, as reported by the West African Examinations Council (WAEC), was 56.3%. The motivation for this research arises from the ongoing shortcomings that result in low academic performance in mathematics. As a result, the researcher hypothesised that mathematical competence, aptitude, and attitude towards mathematics may be contributing elements to the issue of low academic performance. The perspective arises from firsthand experience, whereby several pupils have apprehension about mathematics.

Mathematical ability can be defined as a natural or learnt capability to process numerical data and conclude a mathematical calculation based on that data. It is also defined as the capacity to learn and master new mathematical ideas and skills. It is an ability to obtain, process, and retain mathematical information (Vilkomir & O'Donoghue 2019). Furthermore, mathematical ability can be defined as the ability to perform mathematical tasks and to effectively solve given mathematical problems. Mathematical ability is one's capacity to recognize, label, and generate examples of concepts, use and interrelate models, diagrams, manipulatives, and varied representations of concepts, identify and apply principles. It is ability to manipulate ideas about the understanding of a mathematical concept in a variety of ways. It also the capacity to recognize, interpret related concepts and principles. It has to do with one's ability to apply the signs, symbols, and terms used to solve problems in mathematics. Mathematical ability also entails ones' capacity to verify or justify the correctness of a procedure using concrete models or symbolic methods. According to Krutetsk (2017) mathematical ability is a complicated dynamic phenomena made up of the skills to collect, analyses, and remember mathematical data. It is one's capacity to express ideas to others or oneself verbally or in writing, through symbols, graphs, tables, images, equations, concrete objects, or other forms.

Apart from mathematical ability that has been discussed, the researcher is of the view that sex of students could moderate the possible effect of the correlation between the independent variable and academic achievement. Sex refers to the biological characteristics that define males and females. It is a fundamental aspect of human biology and plays a crucial role in many aspects of human life. Sex is one of the most often mentioned demographic variables that have a substantial impact on student learning outcomes. Sex is a significant aspect that determines students' job choices or career interests. While males are portrayed as brave in society, females are portrayed as fearful, gentle, submissive and cooperative Fabunmi (2014) stated that sex composition has a substantial association with students' academic achievement and has a significant impact on secondary school students' academic achievement. Furthermore, data on sex differential in academic achievement has been proven to be conflicting (Dania, 2014). These results suggest that the sex differential in mathematics has yet to be concluded. As a result, it is clear that further research is required.

1.2 Statement of the Problem

The teaching and learning of mathematics in secondary schools have been hindered by several challenges that pose a danger to the attainment of its goals. The substandard academic achievement of learners, especially in secondary schools, in the field of mathematics has caused concern among educators and parents alike. The motivation for this research arises from the consistently low academic achievement in mathematics seen in both Delta and Edo States, despite the substantial investments made by the government and parents in the education system. The statistics regularly published by the West African Examinations Council continuously indicate a low level of academic achievement among students. The results earned by students in WAEC in the past two years of 2018 and 2019 clearly demonstrate a consistent pattern of underachievement in mathematics. In the May/June 2018 S.S.C.E., a total of 1,572,396 students took the test. Among them, only 714,380 of them, accounting for 45% of the total, achieved up to credit level in mathematics, while the other 55% of candidates failed. Out of the 618,119 students who took the June 2019 tests, 43.7% achieved high marks in mathematics, earning them distinction and credit levels. Conversely, 56.3% of the candidates did not meet the passing criteria.

Despite previous study endeavours to identify the elements contributing to subpar academic achievement in mathematics, the issue remains unresolved. Furthermore, several research failed to adequately consider various psychological aspects that may impact the academic achievement of secondary school student. Analysis of many studies indicates that there has been a lack of prior research conducted in Delta and Edo states pertaining to the mathematical ability and academic achievement of secondary school students in mathematics.

The researchers believe that demographic variables, such as sex, may moderate the association between mathematical ability and mathematics achievement in secondary school students. There is a lack of consistency in the link between mathematical ability and mathematics achievement among secondary school students based on their sex. Hence, this research aims to examine the correlation between mathematical ability and academic achievement in mathematics among secondary school students, taking into account their sex in Edo and Delta States.

1.3 Research Questions

The following research questions guided the study:

1. What is the relationship between mathematical ability and academic achievement of secondary school students in Edo and Delta States?
2. What is the relationship among sex, mathematical ability and academic achievement of secondary school students in Edo and Delta States?

1.4 Hypotheses

The following null hypotheses were formulated to direct the study:

1. There is no significant relationship between mathematical ability and academic achievement of secondary school students in Edo and Delta States.
2. There is no significant relationship among sex, mathematical ability and academic achievement of senior secondary school students in Edo and Delta States.

1.5 Purpose of the Study

The purpose of this study is to examine the relationship among mathematical ability, and academic achievement of secondary school students in mathematics in Delta and Edo States. Specifically, the study ascertained the correlation:

1. between mathematical ability and academic achievement of secondary school students in Edo and Delta States;
2. among sex, mathematical ability and academic achievement of secondary school students in Edo and Delta State;

Scope and Delimitation of the Study

The research examined the correlation between mathematical ability and achievement in mathematics among secondary school students in Delta and Edo State. The focus of this research was limited to the mathematical ability and academic achievement of students. The independent variable in this study was mathematical ability, whereas the dependent variable was academic achievement in mathematics. Sex of the students was included as a Moderating variable.

Additionally, the research was restricted to students in their last year of secondary school (senior secondary school II) in the states of Delta and Edo. The participants were picked from certain public secondary schools located in both urban and rural regions throughout all the senatorial districts of Delta and Edo States.

Research Method

Research Design

The study used a correlational research design. In a correlational study, the researcher often lacks control over the variables of interest and is therefore unable to influence them. The design was selected because it allowed the researcher to establish the correlation between students' mathematical ability and their achievements in mathematics.

Population of the study

The population for this research consisted of 51,526 senior secondary school II (SSII) students from all 792 public secondary schools in Edo and Delta states. Among the total of 51,526 pupils in the SSII category, 29,409 were enrolled in the 477 public secondary schools in Delta State, while the remaining 22,117 were attending the 315 public secondary schools in Edo State. **Sample and Sampling Technique**

The study's sample consisted of 800 SS2 students selected from 80 public secondary schools located in Edo and Delta states. Among the 800 SSII students, 480 were from the 48 public secondary schools in Delta State, while the remaining 320 were from the 32 public secondary schools in Edo State. The research used multi-stage sampling approaches to choose the sample.

Research Instruments

The instruments that were used for data collection in this study are the Student Scholastic Ability Test (SAT) and Mathematics Achievement Test (MAT). Section A of both instruments were designed to collect respondents' biodata. Section B of the Scholastic Ability Test (SAT) consists of 25 multiple-choice items with options A–D. The items in the SAT were adopted from Online Test Centre (2005). Section B of the the Mathematic Achievement Test (MAT) consists of 50 multiple-choice items adapted from Macrae et al.'s (2016).

3.5 Validity of Research Instruments

The face validity of the instrument was determined by an expert in Measurement and Evaluation. The instrument was subjected to content and construct validity after the face validity has been certified by the expert, the content and constructs validity was carried out to ensure that all the variables were addressed in the instrument. The content validity of the Mathematics Achievement Test (MAT) was also carried out by the use of table of specification to ensure that all the content of mathematics for SS 2 as specified in the scheme of work were included in the instrument. The content validity was carried out by the use of table of specification (Table 1a). The content of each concept was derived from the Nigerian Educational Research and Development Council (NERDC) Mathematics scheme of work for Senior Secondary school II (SS2

3.6 Reliability of the Research Instruments

The reliability of the Scholastic Ability Test (SAT) and Mathematics Achievement Test (MAT) was carried out using the internal consistency method. Using the method for determining the reliability of the instruments, the instruments were administered to fifty (50) SSS2 students in five different secondary schools in Onitsha, Anambra State, who were not part of the study area. The Kuder-Richardson-21 was used to compute the reliability of the Scholastic Ability Test (SAT), and Mathematics Achievement Test (MAT). This yielded a reliability index of 0.76 for the Scholastic Ability Test (SAT), 0.72 for the Aptitude Test (AT), and 0.73 for the Mathematics Achievement Test (MAT).

Method of Data Collection

All the instruments: The Scholastic Ability Test and Mathematics Achievement Test were administered to all the SS II students sampled from all the selected secondary schools for the study. The cooperation of the school authorities in each school was solicited and obtained through a letter (see Appendix K). All teachers of mathematics in the sampled schools who were the research assistance, were requested to assist in the administration of the instruments. 800 copies of the instrument were sent to be administered to 800 students (10 in each school). While some schools returned the complete 10 for each instrument, others returned less than 10 copies of each instrument. The total copies that was retrieved back from all the sampled schools were 760, which represent approximately 95% of the total number of administered instruments. Hence, it was 760 copies of the returned instrument that were used for data analysis.

Method of Data Analysis

The data were analysed using the Pearson product moment correlation coefficient (r) and regression. In the analysis, the Pearson Product Moment Correlation (r) coefficient was used to answer research questions one; research questions two was answered using multiple correlation. Hypotheses one was tested using linear regression, and hypotheses two tested using multiple regression. All hypotheses were tested at the 0.05 level of significance.

Result and Discussions

Research Questions 1: What is the correlation between mathematical ability and mathematics achievement of secondary school students in Edo and Delta State?

Table 1: Correlation (r) Analysis of Mathematical Ability and Academic Achievement

Variables	**N**	**Mean**	**SD**	**R**	**r^2**	r^{2adj}	r^2 %	Remark
Mathematical ability	760	81.47	25.55	.232	.054	.052	5.40	Positive correlation
Academic achievement	760	55.49	26.82					

Table 1 depicts a correlation (r) value of 0.232, indicating the degree of correlation between the mathematical ability and mathematics achievement of students in secondary schools in Edo and Delta States. The positive correlation suggests that an improvement in mathematical ability would result in a corresponding rise in the academic achievement of secondary school students in Edo and Delta States. The coefficient of determination (r^2) value of 0.054 suggests that students' mathematical ability accounts for 5.40% of the variability in the mathematics achievement of secondary school students in the Edo and Delta States. Therefore, it was concluded that there is a positive correlation between mathematical ability and the academic achievement of secondary school students in the Edo and Delta States.

Hypothesis 1: There is no significant relationship between mathematical ability and academic achievement of senior secondary school students in Edo and Delta State.

Table 2: linear Regression Analysis of mathematical ability and academic achievement of secondary school students

ANOVA [a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7319.696	1	7319.696	42.942	.000[b]
	Residual	129203.798	758	170.454		
	Total	136523.495	759			

Table 2 shows a linear regression output of the correlation between mathematical ability and academic achievement of secondary school students in Edo and Delta States. The computed F-value of 42.942 has a p-value of 0.000. Testing the null hypothesis at an alpha level of 0.05, the p-value of 0.000 was less than the alpha level of 0.05. Therefore, the null hypothesis was rejected. This means that there is a significant relationship between mathematical ability and academic achievement of senior secondary school students in Edo and Delta States.

Research Questions 2: What is the moderating impact of sex on the correlation between mathematical ability and academic achievement of secondary school students in Edo and Delta States?

Table 3: Moderation Analysis of Sex, Mathematical Ability and Academic Achievement of Secondary School Students in Edo and Delta States

Variables	N	R	R-sq	R^2-chng	Remark
Int_1: Mathematical Ability x sex	760	.264	.069	.0020	Positive moderation impact

Dependent Variable: academic achievement

Table 3 shows the moderation analysis of sex on the correlation between mathematical ability and academic achievement of secondary school students in Edo and Delta States, the results reveal that the interaction term (Int_1: Mathematical Ability x Sex) has a coefficient of 0.264. This coefficient suggests a positive moderating impact of sex on the correlation between mathematical ability and academic achievement. The R-squared value of 0.069 indicates that approximately 6.9% of the variance in academic achievement is explained by the model. Additionally, the R^2-change of 0.0020 suggests that the inclusion of the interaction term contributes a small amount to the explained variance, indicating that sex plays a little role in moderating the association between mathematical ability and mathematics achievement of secondary school students in Edo and Delta States.

Hypothesis 2: There is no significant moderating impact of sex on the correlation between mathematical ability and academic achievement of secondary school students in Edo and Delta States.

Table 4: moderation Analysis of Sex on Mathematical Ability and Academic Achievement of Secondary School Students in Edo and Delta States.

Model	b	Se	T	P	LLCI	ULCI
Constant	37.1726	9.7888	3.7975	.0002	17.9562	56.3891
mathematical ability	.1087	.1141	.9526	.3411	-.1153	.3326
Sex	-1.3085	6.3053	-.2075	.8357	-13.6864	11.0694
Int_1:mathematical ability x Sex	.0942	.0739	1.2745	.2029	-.0509	.2393

Dependent variable: mathematics achievement

Table 4 shows that the coefficient(b) of the interaction term (Int_1: mathematical ability x Sex) is 0.0942. The standard error(se) of the interaction term is 0.0739 with a t-value of 1.2745. The p-value associated with this t-value is 0.2029. Testing the null hypothesis at an alpha level of 0.05, the p-value (0.2029) is greater than the alpha level of 0.05. Therefore, the null hypothesis was not rejected. This indicated that there is no significant moderating impact of sex on the correlation between mathematical ability and academic achievement of secondary school students in Edo and Delta States. The results suggest that the correlation between mathematical ability and academic achievement is not significantly different for males and females in this context.

Discussion of Results

The outcome of the data analysis was discussed under the following headings:

The Correlation Between Mathematical Ability and Mathematics Achievement of Secondary School Students

Findings from research question one and its corresponding hypothesis show that there is a relationship between mathematical ability and mathematics achievement among secondary school students in the Edo and Delta States. This study has indicated that mathematical ability influences the academic achievement of senior secondary school students in the Edo and Delta States. This may be due to the fact that students in the study area have developed

the capacity to focus on mathematics for extended periods of time without showing obvious signs of fatigue, and at the same time, they have shown the tendency to learn and master new mathematical concepts as well as the ability to solve new and unusual problems. This finding is in line with that of Nizoloman (2013), who found that there was a significant positive relationship between mathematical ability and achievement in mathematics. The finding also aligns with Komarraju et al. (2013), who found that a student's mathematical ability is crucial to academic achievement. This finding also aligned with Barreiro (2014), who showed that mathematical ability is a major predictor of academic achievement in students. According to Rajalaxmi et al. (2019), students' mathematical ability predicts traits that impact their academic achievement.

Moderating Impact of Sex on the Correlation Between Mathematical Ability and Mathematics Achievement of Secondary School Students

Findings from research question two and its corresponding hypothesis show that there is no moderating impact of sex on the correlation between mathematical ability and mathematics achievement among secondary school students in the Edo and Delta States. One of the possible explanations for this finding could be that sex does not play a significant role in determining mathematical ability or mathematical achievement in this population. There may be other factors or variables that overshadow the influence of sex. For instance, individual differences in cognitive or non-cognitive abilities, such as working memory or problem-solving strategies, may contribute more significantly to academic achievement in mathematics. This absence of a statistically significant moderating impact suggests that it may also be due to the fact that both male and female students are being given equal access to educational resources and support, minimising the potential moderating impact of sex on academic achievement. This implies that in settings with gender equality in education, differences in mathematical achievement may be less pronounced. This finding agrees with Oliweh and Oyem (2021) who found no significant difference in the achievement of male and female students in mathematics. This finding does not agree with Zhuzheng (2017), who found that males and females solve mathematics problems differently due to the differential level of mathematical ability. This finding is also at variance with that of Egorova and Chertkova (2016), who found differences in mathematical ability and achievement on the basis of sex.

Conclusion

This research investigated the influence of mathematical ability and academic achievement in mathematics among secondary school students in the Edo and Delta States. The study suggests a strong correlation between mathematical ability and achievement in mathematics. The study contends that sex has no bearing on the relationship between mathematical aptitude and mathematics achievement among secondary school students in the Edo and Delta States. Therefore, the conclusion is that there is a considerable correlation between mathematical ability and mathematical achievement. The correlation between mathematical ability and academic achievement in mathematics among secondary school students in Edo and Delta States is evident and substantial. Therefore, students with more mathematical ability are likely to get better scores in mathematics examinations. Additionally, since there is no discernible effect of sex on the relationship between mathematical ability and mathematics achievement among secondary school students in Edo and Delta States, it is possible to draw the conclusion that the students' sex does not have a significant impact on the influence of mathematical ability on mathematics achievement.

Recommendations

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

1. Mathematics teachers should strive to recognise and cater to the varying mathematical abilities of students and endeavour to implement teaching strategies that accommodate diverse learning needs.
2. Mathematics teachers should also endeavour to design classroom activities that provide opportunities for students to engage with mathematical concepts at different levels, allowing those with strong mathematical abilities to be challenged appropriately.
3. Mathematics teachers should strive to implement regular assessments to gauge students' mathematical abilities and provide constructive feedback. This can help guide students in areas where improvement is needed.
4. Students should endeavour to recognise and understand their own mathematical abilities by reflecting on their strengths and areas for improvement to set realistic academic goals.
5. Policymakers should consider enhancing the mathematics curriculum to ensure that it caters to the varying abilities of students. This may involve incorporating more challenging content for those with higher aptitude.
6. The government should invest in professional development programmes for mathematics teachers to equip them with effective strategies for addressing diverse learning needs in the classroom.

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