



PROFICIENCY IN ALGEBRAIC EQUATIONS AS A PREDICTOR OF SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS

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Cite this article:

Imasuen K., Stanley O.E. (2022), Proficiency in Algebraic Equations as a Predictor of Secondary School Students' Academic Achievement in Mathematics. African Journal of Mathematics and Statistics Studies 5(3), 33-42. DOI: 10.52589/AJMSS-3MYQULVV

Manuscript History

Received: 14 July 2022

Accepted: 12 Aug 2022

Published: 11 Sept 2022

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ABSTRACT: *Mathematics is a tool for achieving educational and economic goals and aims in a nation or society. Thus, being good in mathematics will pave the way to excel in other subjects. Algebra has always been one of the main subjects in mathematics all over the world. This is probably due to the fact that algebra is the door to the extension of complex arithmetic calculations. This study therefore examined proficiency in algebraic equation as predictors of secondary school students' performance in mathematics in Benin Metropolis. To achieve this, four research questions were raised. The design of this study was survey. The population of the study consisted of all the public junior secondary schools in Benin Metropolis, Edo State. One thousand one hundred and forty (1,140) students from 38 junior secondary schools serve as the sample for the study. The instrument for the data collection was an achievement test constructed by the researcher, which was drawn from past Basic Education Certificate Examination conducted by the National Examination Council for the 2018, 2019, 2020 and 2021 academic sessions. The validity of the instrument was presumed to have been carried out by the National Examination Council, being an examination body saddled with the responsibility of conducting examinations in Nigeria. The reliability of the instrument was ascertained using the Kuder-Richardson Formula 20 and it gave the reliability indices of 0.90 and 0.93 respectively. The data collected were analyzed using mean and standard deviation, two-way Analysis of Variance, and Pearson Product Moment Correlation Coefficient (r). The finding that emerged from the study revealed that the level of students' proficiency in solving algebraic equations and mathematics was low. A significant relationship existed between proficiency in solving algebraic equations and students' performance in mathematics, and sex was not a determining factor in students' proficiency in algebraic equations and performance. It was recommended among others that teachers should ensure that students are well taught using various methods that will promote their comprehension of mathematical concepts.*

KEYWORDS: Algebra, Mathematics, Proficiency, Secondary School, Performance.



INTRODUCTION

Mathematics is a branch of science that deals with numbers and operations. Hence, Omorogbe (2016) describes it as a science that deals with the study of relationship among objects. This relationship could be in terms of one object heavier, thinner, lighter, darker, smoother, rougher, bigger, smaller, thicker or of the same shape with other objects. Mathematics reveals the hidden patterns that help to understand the world around us. It is a subject that cultivates in the mind of children the habit of reasoning; hence, it is often said that mathematicians reason in the “if and then manner”. Mathematics is indispensable as its applications cut across all subjects and every aspects of life. That is, everyone all over the world is doing the business of mathematics. The knowledge of mathematics is used for analyzing and communicating information and ideas to address a range of practical tasks and real-life problems (Gray & Tall, 1999). The knowledge of mathematics is also employed in the production industry. The production of electricity, musical instruments, drugs, medical equipment, vehicles, aircrafts, agricultural equipment and many more requires mathematical knowledge.

Mathematics also plays a vital role in the shaping of economy. It helps to determine the performance or functionality of every sector—how funds are generated and distributed, and the areas of the sector that need special attention. The Advanced Learners’ Dictionary (2001) defines mathematics as the science of size and numbers of which arithmetic, algebra, trigonometry and geometry are branches.

Algebra is an offspring of mathematics. It came from the Arabic word Al-jabr, meaning reunion of broken parts. It is defined as the study of mathematical symbols and the rules for manipulating these symbols. Algebra is that part of Mathematics that requires extensive abstract thinking. It makes use of logic in manipulating signs and symbols. The knowledge of algebra moves students beyond an emphasis on arithmetic operations. The knowledge of algebra helps students to reason logically using symbols and solving equations which enable them to proffer solutions to life time problems.

The Greeks were the first to introduce algebra in the third century and eventually it was traced to Arab and the early Babylonians. The Babylonians were the ones who created formulae and equations that are still in use in solving problems till date. Diophantus is regarded as the father of algebra. Ilori (1994) stated that societies and governments around the world recognize the importance of mathematics for national development. The knowledge of algebraic equations has helped in so many areas in bringing solutions to problems. Some of the areas include politics, dispute settlement, discovery of business ideas, production of goods, development of skills and many more.

Mathematics is a field of knowledge which is a tool to think, communicate and solve real life problems. Suherman and Erman in Trisnawati et al. (2018) revealed that all mathematical concepts have relationships with one another. It starts with the simple to the complex, thereby making students understand the previous lesson so that they can understand the next lesson. The relationship between algebraic equations and mathematics is like that of a mother and child. Algebraic equations are found or embedded in mathematics. Mathematics gave rise to algebra; as a result, they both have symbols and how they are being manipulated. They both deal with symbols and numbers in their operations; they use similar operations such as addition, subtraction, multiplication and division.



Algebra has always been one of the main subjects in mathematics all over the world. This is probably due to the fact that algebra is the door to the extension of complex arithmetic calculations, and a progression leap from concrete to abstract concepts in learning mathematics (Skouras, 2014). The placement of algebra as a subject of study in mathematics within the school's syllabus might be different as some countries might offer it in an integrated syllabus, while others might employ it as unified body strands within their mathematics curriculum, like algebra, arithmetic and geometry. In some countries, algebra is first introduced to pupils at the primary school level, and the syllabus progresses into more comprehensive and advanced stages at the secondary school level. To ensure proficiency in mathematics, students generally have to sit for mathematics classes for at least four to five periods a week. This became imperative so as to improve the performance of students in the subject, because Mathematics as a subject has always been correlated with greater chances of employment, better wages and higher on-the-job productivity (Geary & Hamson, 2000). For this reason, it is significantly important to recognize the factors that affect students' mathematics achievement, in order to make good progression and prediction for the future, relating to mathematical decisions.

Each student is unique in terms of acquiring knowledge in learning. In terms of results, students' performance may be poor, not necessarily because they do not have the skills, but they have not been able to optimize their skills. It is important to measure students' achievement in high school because it has direct and influential effects on their mathematics performance at the tertiary level (Ismail & Awang, 2007). Ismail and Awang (2007) found out that more than 50% of students in Singapore score higher than the average score of 603 in TIMSS-2003, compared to only 10% of students in Malaysia who managed to do so in the same examination. By comparing the content tested, such as geometry measurement, fractions and algebra, they found out that Singaporean students have always scored significantly higher than Malaysian students, regardless of gender. The result also showed that girls have always outperformed boys in every area tested, with girls averaging a mean of 53.0 while boys generally hover around the mean for 47.0. Ismail and Awang (2011) also found out that girls (mean = 479.88, standard deviation = 75.94) still scored better than boys (mean = 468.27, standard deviation = 80.37).

On his part, Rajoo (2013) found out that girls performed better than boys, using 445 students as sample size. The girls tend to be more involved (more active and joyful) during mathematics lessons, compared to the boys. Abd Razak et al. (2014) found that there was a significant relationship between teachers' gender and eighth grade student achievement in mathematics in their research titled, "Relationship of Students and Classroom Level Variables with TIMSS 2011 Mathematics Achievement in Indonesia, Malaysia and Thailand." Furthermore, when students' scores were correlated with teachers' gender, in the context of Malaysia, the result also showed that female teachers taught better than male teachers. However, unlike the previous studies, Dahlan et al. (2010) found that there was no significant difference between boys' and girls' achievement in four national schools in Kuala Lumpur, in terms of mathematics results in the Lower-Secondary National Examination (PMR).

Che Yusof et al. (2020), in their study on factors influencing mathematics performance among secondary school students in Malaysia, found that there was a significant main effect in terms of students' achievement in algebra between boys and girls, and also, a significant main effect in terms of students' achievement in algebra among national schools, religious schools and boarding schools, and above all, no interaction effect in terms of students' achievement in algebra between gender and types of schools.



Mathematics is a compulsory subject offered in Nigeria schools (primary, secondary and tertiary). It is usually taught daily in all the schools. The importance of mathematics in education made curriculum developers make the subject compulsory in schools and required to be taught daily. The first national curricula for primary and secondary schools used in Nigeria were developed in 1979. They were revised in 1986 to be 6-3-3-4. However, the Universal Basic Education (UBE) programme was launched to replace the 6-3-3-4 system in the country. The UBE programme consists of a 9-3-4 system in the country, unlike the former system of 6-3-3-4 which involves 6 years in primary school, 3 years in junior secondary school, 3 years in senior secondary school and 4 years in tertiary institution. The 9-3-4 system of education comprises 9 years in the basic level, that is from primary one to Junior Secondary School Three (JSS 3), 3 years in senior secondary school and 4 years in tertiary institution.

Therefore, the relevance of mathematics in secondary schools includes enabling familiarity with symbols and shapes, facilitating the application of mathematics knowledge in other subjects, helping in decision making, risk taking, and to be useful in society. Algebra is a subject of mathematics; therefore, a student that is extremely proficient in the study of algebra will without doubt perform well in mathematics. Thus, performing well in algebra is a stepping stone to performing excellently in mathematics.

Mathematics, according to Maliki et al. in Kakraba (2020), was described as a subject that affects all aspects of human endeavor at different degrees. National Mathematical Advisory Panel cited in Parcutilo and Luna (2016) described mathematics as a phenomenon that is used throughout our daily lives. In spite of the importance of mathematics, students' performance in it has not improved significantly. In developing countries, modalities are put in place to ensure adequate teaching and learning of this subject. The availability of computers and other teaching instructional materials makes the teaching and learning of mathematics easy and understandable.

In Nigeria, most mathematics teachers do not have computers let alone the students. Majority of the secondary schools in Nigeria, Edo State in particular, do not have mathematics laboratories. How do we expect the students to perform academically? Despite the significance of the subject, it is observed, over the years, that the performance of students in Senior Secondary School Mathematics in Nigeria has consistently been poor and unimpressive. Available data from the two public examination bodies—the West African Examination Council (WAEC) and National Examination Council (NECO)—Secondary School Certificate Examination (SSCE) indicate that students' achievement in mathematics has been low. The West African Examination Council's results in 2018 reflected that a total of 1.57m candidates sat for WAEC as public students. The results showed that 48.15% had 5 credits and above, including English and Mathematics, while 51.85% failed to do so. In the same year, a total of 109,798 candidates sat for WAEC as private students but only 33.81% of them had 5 credits and above including English and Mathematics while 66.19% did not (National Bureau of Statistics, 2019).

Mathematics is a tool for achieving educational and economic goals and aims in a nation or society. Thus, being good in mathematics will pave the way to excel in other subjects. The importance of mathematics is seen when planning budget and distribution of resources to every sector of the economy. It is also of great significance to school authorities and even parents. The teaching of mathematics is meant to play a vital role in encouraging students to be proactive and develop interest in mathematics, and above all, help the students to develop



problem solving skills or techniques in solving real life problems. These skills and techniques come as a result of proficiency in solving algebraic equations. However, over the years, there has been a decline in the performance of students in mathematics. This has given educators, parents and other stakeholders in education a serious concern. This study, therefore, is to ascertain if students' proficiency in algebraic equations could predict their achievement in mathematics.

Research Questions

1. What is the level of proficiency of public junior secondary school students in Benin Metropolis in solving algebraic equations?
2. What is the level of performance of public junior secondary school students in Benin Metropolis in mathematics?
3. Is there an interaction effect of sex on students' proficiency in solving algebraic equations and performance in mathematics?
4. Is there a relationship between proficiency in solving algebraic equations and performance in mathematics?

METHODS

The design of this study was survey. The population of the study consisted of all the public junior secondary schools in Benin Metropolis, Edo State. One thousand one hundred and forty (1,140) students from 38 junior secondary schools were selected to serve as the samples for the study. Thirty (30) students were purposively selected from the 38 schools chosen. The instrument for data collection was an achievement test constructed by the researcher, which was drawn from past Basic Education Certificate Examination conducted by the National Examination Council for the 2018, 2019, 2020 and 2021 academic sessions. It had two categories—category one was based on algebraic equations while category two was based on general mathematics. The validity of the instrument was presumed to have been carried out by the National Examination Council, being an examination body saddled with the responsibility of conducting examinations in Nigeria. The reliability of the instrument was ascertained using the Kuder-Richardson formula 20 and it gave the reliability indices of 0.90 and 0.93 respectively. The tests were administered by the researcher with the help of the mathematics teachers in the schools visited. The data collected were analyzed using mean and standard deviation, Two-way Analysis of Variance, and Pearson Product Moment Correlation Coefficient (r).



RESULTS

Table 1: Level of performance of public junior secondary school students in solving algebraic equations

Students' performance	Mean	Standard deviation
Algebraic equations	42.79	4.24

Table 1 shows the level of performance of public junior secondary school students in solving algebraic equations. It further shows a mean of 42.79 and a standard deviation of 4.24. This indicated that the level of the performance of public junior secondary school students in solving algebraic equations was low.

Table 2: Level of performance of public junior secondary school students in mathematics

Students' performance	Mean	Standard deviation
Mathematics	42.98	4.97

Table 2 shows the level of performance of public junior secondary school students in mathematics. It further shows a mean of 42.98 and standard deviation of 4.97. This indicated that the level of the performance of public junior secondary school students in solving mathematics was low.

Table 3: Mean and standard deviation of male and female students of public junior secondary schools in solving algebraic equations and mathematics

Sex	Variables	Mean	Standard deviation	N
Male	Mathematics	42.03	4.68	350
	Algebraic equations	41.62	3.92	350
	Total	41.83	4.31	700
Female	Mathematics	44.51	5.09	220
	Algebraic equations	44.69	4.09	220
	Total	44.60	4.59	440
Total	Mathematics	42.98	4.97	699
	Algebraic equations	42.79	4.24	441
	Total	42.89	4.61	1140

Table 3 shows the mean and standard deviation of public junior secondary school in solving algebraic equations and Mathematics as 42.03 and 4.68, 41.62 and 3.92, 44.51 and 5.09, and 44.69 and 4.59 for male and female students respectively.



Table 4: Analysis of variance of the effect of sex on solving algebraic equations and mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	377.562	3	125.854	9.472	0.000
Intercept	359868.235	1	359868.235	27084.24	0.000
Sex	371.569	1	371.569	27.965	0.000
Students	0.655	1	0.655	0.049	0.825
Sex*Students	4.224	1	4.224	0.318	0.573
Error	3932.845	1136	13.287		
Total					
Corrected Total					

R Squared = 0.088 (Adjusted R Squared = 0.074)

Table 4 shows an F-value of 0.049 and a p-value of 0.825. Testing at alpha level of 0.05, the p-value was greater than the alpha level. Therefore, the null hypothesis which states that “there was no significant difference between male and female students of public junior secondary school students in solving algebraic equations and mathematics” was retained. Table 4 also shows that the interaction effect of the sex of students and ability to solve algebraic equation and mathematics was not significant ($F_{0.05,1,1136} = 0.318$; $p = 0.573$). This implied that sex was not a determining factor in the solving of algebraic equation and mathematics. Furthermore, the adjusted R-squared value of 0.074 implied that sex interaction only contributed about 7.4% to students solving algebraic equations and mathematics.

Table 5: Pearson r of the relationship between proficiency in solving algebraic equations and performance in mathematics of public junior secondary school students

Variables	N	Pearson r	p-value	Remark
Mathematics	1140	0.374	0.000	Significant
Algebraic equations	1140			

Table 5 shows a Pearson r-value of 0.374 and a p-value of 0.000. Testing at alpha level of 0.05, the p-value was less than the alpha level. Therefore, there was a relationship between proficiency in solving algebraic equations and performance in mathematics. Proficiency in solving algebraic equations accounted for about 14.0% of students’ performance in mathematics.



DISCUSSION OF FINDINGS

The study revealed that the level of students' proficiency in solving algebraic equations and mathematics was low. This indicated that performance in mathematics depended to a large extent on the proficiency of students in solving algebraic equations, that is, a relationship existed between proficiency in solving algebraic equations and performance in mathematics. This corroborates with Suherman and Erman in Trisnawati et al. (2018) which showed that all mathematical concepts had relationships with one another starting from simple to complex. The knowledge of algebra enables one to reason logically, proffer solutions to problems and to learn how to manipulate symbols and figures. In the same vein, Skouras (2014) stated that algebra was the door to the extension of complex arithmetic articulation, and a progression leap from concrete to abstract concepts in learning mathematics. It fostered the relationship between algebra and mathematics as can be seen in this study. Proficiency in solving algebraic equations accounted for about 14.0% of students' performance in mathematics.

Another revelation from the study was the fact that sex was not a determining factor in students' proficiency in algebraic equation and performance in mathematics. This implied that students' ability to solve algebraic equation and perform well in mathematics was not sex dependent—sex had no interaction effect on students' proficiency in solving algebraic equations and performance in mathematics. This was in tandem with Dahlan et al. (2010) who found that there was no significant difference between boys' and girls' achievement in four national schools in Kuala Lumpur, in terms of mathematics results in the Lower-Secondary National Examination (PMR).

However, the findings contradicted the views of Ismail and Awang in Che Yusof (2020) who averred that a significant difference existed between boys and girls in their performance in mathematics. Also, Rajoo (2013) found out that girls performed better than boys. The girls tend to be more involved (more active and joyful) during mathematics lessons, compared to the boys. This was also corroborated by Che Yusof (2020) who showed that there was a significant main effect in terms of students' achievement in algebra between boys and girls, and also, a significant main effect in terms of students' achievement in algebra among national schools, religious schools and boarding schools, and above all, no interaction effect in terms of students' achievement in algebra between gender and types of schools.

Conclusion and Recommendations

For the development of economy and human capacity, algebra and mathematics play an important role. The knowledge of both when properly executed would bring about development and independence in every area of our lives. More so, performance in mathematics depends to a large extent on the students' proficiency in solving algebraic equations. This implies that when students are well grounded in algebra, there is a likelihood that it will facilitate their learning of mathematics.

Based on this, it was recommended that teachers should ensure that students are well taught using various methods that will promote students' comprehension of mathematical concepts. The government should also provide conducive environments for the teaching and learning of mathematics. Above all, qualified teachers should be employed to teach mathematics at the junior secondary school level so that the students will have a solid foundation in mathematics.



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