(RESEARCH ARTICLE)

Predictive validity of mathematics basic education certificate examination as correlate of mathematics geometry achievement among SS 2 students in Delta state

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Abstract

This study examined predictive validity of mathematics basic education certificate examination as correlate of mathematics geometry achievement among SS 2 students in Delta State. Two research questions and null hypotheses guided the study and Correlational research design was employed. The population of the study consisted of 105, 848 students who sat for BECE Mathematics in 2022 and SS 11 students in year 2024 in Delta State. The sample size of the study was 480 while the instruments used for this study was mathematics BECE scores and Geometry Achievement test (GAT). The internal consistency of the GAT yielded an index of 0.62. The Cronbach alpha method of estimating reliability was employed to obtain the reliability index of 0.84 for the mathematics BECE Proforma. The Pearson's Product Moment Correlation Coefficient of Determination was used to answer the research questions while regression and fisher-z statistics were used to test the hypotheses at 0.05 level of significance. Based on this finding it was concluded that BECE Mathematics is a predictor of mathematics geometry achievement. However, the magnitude of relationship and the percentage of prediction of mathematics geometry achievement from BECE Mathematics performance were very low and weak. Based on the findings it was recommended among others that BECE Mathematics scheme, contents and curriculum should be reviewed in conformity with mathematics geometry to enhance its predictive validity, BECE that are conducted by NECO should be compulsorily used by all schools to ensure uniformity.

1. Introduction

In the school environment, a significant value is put on cognitive learning, as evidenced by diplomas granted at the end of each course. These diplomas granted are obtained through examination. Aminu, Kassim, and Anifowoshe (2023) define examination as a tool for testing, assessment, evaluation, and accreditation. It is used for diagnosis, selection, placement, certification, and advancement. Thus, in all human endeavors, examination is a powerful tool for evaluating knowledge. For any examination tool to be convincing, it must possess the qualities of the test (validity and reliability). These traits (validity and reliability) can only exist if the examination is free and fair, free of bias, cheating, and other forms of malpractice (Liman, 2016). The Federal Republic of Nigeria (FRN, 2014), in accordance with the National Policy on Education (NPE), agreed to a six-year secondary education period. Secondary education is separated into Junior Secondary School (JSS) and Senior Secondary School (SSS). Students are expected to devote three years to each of these educational levels. Examinations for these two levels of secondary school education are conducted by separate external authorities. The Basic Education Certificate Examination (BECE) is administered independently in each state of Nigeria by the local Ministry of Basic and Secondary Education (MOBSE) to final-year students in all government and recognized private schools. Except for unification schools and federal government institutions, which are run by NECO, each MOBSE develops, administers, marks, and awards certificates to students under their control. The West Africa Examination

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Council (WAEC) and other examination-accredited bodies, such as NABTEB and NECO, are responsible for conducting the Senior Secondary Certificate Examination (SSCE) in Nigeria independently. The Nigerian Educational Research and Development Council (NERDC, 2018) stated that what students learn at the upper basic level will lay the foundation for their SSS education because the curriculum of the upper basic or Junior Secondary differs slightly from that of the Senior Secondary, but they have in common some basic core-subjects such as Mathematics, English Language, Basic Science, and Agricultural Science (NERDC, 2018).

It is claimed that pupils' achievement in these topics at the basic education certificate examination (BECE), which serves as an entry qualification for SS education, could be predicted by their WAEC results. Geography, Economics, Government and History are the four areas of Social Studies taught at Senior Secondary School. Students in science classes offer geography and economics, whilst students in arts classes offer government and history. At the senior level, Basic Science is divided into Chemistry, Biology, and Physics, with Biology and Chemistry being the most popular choices among science students. The question of whether students' achievement in Mathematics at BECE will positively predict performance in related subjects in the WAEC remains open and unanswered.

Webster (2013) opined that predictive means to declare, indicate in advance, foretell, or make a prediction based on observation, experience, or scientific reasoning. This declaration based on observations is valid when it predict accurately. Emaikwu (2013) stated that predictive validity refers to how accurately a person's current test score can be used to estimate what the criterion score would be at the later time. The academic achievement of students admitted into senior secondary school education has been an issue of great concern to many people who are interested in education industry in Nigeria. Emaikwu (2013) further stated that prediction studies deal with measuring a variable that can be used to predict some future events. From this, it can be understood that predictive validity is concerned with the usefulness of test scores in forecasting or estimating how the individual will perform on some subsequent criterion tasks. This is to say, how accurately students' Mathematics scores can be used to estimate (predict) what their academic performance in schools would be at the later time. Establishing the predictive validity of BECE on performance in WAEC would go a long way in fulfilling some of the important uses of evaluation, for placement and for certification.

The new education structure of 9-3-4 systems, specify BECE as a measure for admission into senior secondary education. It is therefore assumed that a student who is admitted into the SSS1 possesses the basic skills to cope with the challenges of schooling at that level (Faleye & Afolabi, 2018). Accordingly, systematic connection with the content of basic education is one of the basic features of the Senior Secondary Education curriculum (NERDC, 2018). This is in support of an earlier argument by Daniel and Schouten as cited in Alonge, Mordi, Nworgu and Busari (2017) that a prediction of future examination result could be made with reasonable success based on the result of an earlier examination and that grades could serve as prediction and criterion measures. Faleye and Afolabi (2018) had highlighted the growing concern among stakeholders about the predictive validity of these examinations thus, questioning the validity of the BECE as adequate criterion for predicting performance of students at the WAEC. The present policy of the upper basic education which does not consider students grade in Mathematics before admitting them into sciences or social sciences in SSS education. This act is highly questionable among public schools. Presently, a student could move on to the SS education even if he or she failed Mathematics at BECE, provided the student passed Mathematics and English Language among other subjects at the BECE.

Another issue of debate is that scores in Mathematics at the BECE should predict scores of students in the science at the SS level. Mathematics as a subject affects all aspects of human life at different degrees. Geometry is one of the branches in mathematics that deals with shapes, degrees among others. The understanding of how well a student will effectively performed in test measuring geometry depends on the achievement at the junior level. Betiku (2015) views geometry as the science of space which describes and relates with shapes. Betiku (2015), continued by stating that basic geometry allows students to determine properties such as the areas and perimeters of two dimensional shapes, and surface areas and volumes of three-dimensional shapes. It is also a common knowledge that Mathematics helps in logical thinking and the mental development of an individual. Ale (2014) pointed out that a country will find it extremely difficult to produce graduates in the fields of engineering, science and technology, unless it lays a solid foundation in the mathematical science for students in all categories (geometry). Salau (2020) opined that, there exists an impregnable link between Mathematics and other science subjects, and that the practical aspect of Chemistry, Biology and Physics can hardly be achieved without the knowledge of geometry. By implication, the fundamentals of all scientific and technological skills are intricately interwoven with a sound knowledge of the principles of geometrical mathematics.

Location in this study could be seen as the environment of the learner, on the issue of location, Witkin and Goodenough (2017) opined that urban students learn mathematics better when compared to rural students. The urban students with little guidance from their teacher were found to learn better in mathematics and science subjects (Biology, Chemistry, Physics) than their rural counterparts. However, since the BECE is meant to serve as a benchmark for admission into

the SSS in all states of Nigeria, the standards set in BECE in Mathematics for any state with the use of uniform curriculum should be an adequate predictor of performance of students in geometrical mathematics at the WAEC. This was revealed in review by scholars that include Aminu, Kassim and Anifowoshe (2023) that students' scores in BECE mathematics predict science subjects at the National Examinations Council in Nasarawa State, Nigeria. Obijuru (2022) also indicated that Students' scores in Basic science significantly predict their BECE. Also, Allwell and Ibiene (2019) observed that JSCE Basic Science is not a potent predictor of SSCE Biology performance ($\beta = 0.030$, $P > .05$). Similarly, Adeyemi (2018) revealed there was no significant relationship between students' performances in JSCE Integrated Science and performance in Chemistry, Physics and Biology at the SSCE. Moreso, Aminu (2018) showed that students' Basic science scores do not significantly predict their scores in Physics, Chemistry and Biology at SSCE. Likewise, Orubu (2016) revealed that the scores obtained by students in Integrated Science and Mathematics do predict performance of students in science at the SSCE level. Dike and Garba (2017) revealed that achievement of students in Integrated Science significantly predict their later achievement in Biology at SSCE. However, the reviewed studies were at variance with the present study in terms of geographical scope and period of study, there was no emphasis or literature on the students' scores at the Basic Education Certificate Examination in Mathematics as predictor in mathematics geometry achievement in Delta State, Nigeria using correlation design. This is therefore, the gap this study filled.

1.1. Statement of the Problem

Research findings, publications of government and examinations bodies over the years have demonstrated that students in Nigeria perform poorly in mathematics geometry at all levels of education, but Senior Secondary School is the worst. A review of Delta State students' performance in mathematics for the Senior Secondary Certificate Examinations (SSCE) from 2018 to 2020, conducted by the West African Examinations Council (WAEC), reveals an overall unsatisfactory state of affairs, which is reflected in the students' poor performance in mathematics. In order to lower the level of poor performance in mathematics, especially in geometry at the SS education, attention must be paid to students' performance in mathematics in the Senior Secondary Certificate Examination. It appears that students believe that geometry topics are boring, difficult and terrifying to them, as a result they show unfavourable attitude toward the learning of geometry as the upper basic mathematics curriculum could not have grinded them on SS mathematics geometry. The foregoing calls for empirical investigation into the predictive validity of mathematics BECE scores and mathematics geometry achievement in Delta State.

1.2. Purpose of the Study

The specific purpose of the study is to:

- Determine the extent to which students' score in Mathematics BECE predict the mathematics geometry achievement test in Delta State?
- Explore the extent to which students' score in Mathematics BECE predict the mathematics geometry achievement test in urban and rural students in Delta State?

1.3. Research Questions

The following research questions were raised to guide the study:

- To what extent do students' score in Mathematics BECE predict the mathematics geometry achievement test in Delta State?
- To what extent do students' score in Mathematics BECE predict the mathematics geometry achievement test in urban and rural students in Delta State?

1.4. Hypotheses

The following null hypotheses were formulated to guide this study:

- Students' score in Mathematics at the BECE do not significantly predict mathematics geometry achievement test in Delta State
- Mathematics scores at the BECE do not significantly predict mathematics geometry achievement test in urban and rural students in Delta State

2. Methodology

Correlational research design was employed to determine students' scores at the Basic Education Certificate Examination in Mathematics to predict their scores in mathematics geometry achievement test.

2.1. Population of the Study

The population of the study consisted of 105, 848 students who sat for BECE Mathematics in 2022 and SS 11 students in year 2024 from 477 Senior Secondary Schools in Delta State during 2023/2024 academic session.

2.2. Sample and Sampling Technique

The sample size of the study is 480. This size was used to make sure a controllable sample size from the population of the study. Stratified random sampling techniques was used to draw the sample. The stratification was based on Delta North, Delta Central and Delta South. In other word, 34 public schools from Delta North, 38 public schools from Delta Central and 24 schools from Delta South, making a total of 96 public senior schools across the 25 local government areas of Delta state. Secondly, 5 students were drawn from each sampled school through simple random sampling techniques (SRST) by a balloting method.

2.3. Research Instrument

The instruments used for this study was mathematics BECE scores and Geometry Achievement test (GAT). The GAT was prepared by the researcher from a pool of past standardized tests of examining bodies (WAEC, NECO, GCE, and NABTEB) mathematics multiple choice tests items. The GAT contains 50 items that are dichotomously scored. The GAT was constructed from four topics on plane shape Geometry such as square, rectangle, trapezium and parallelogram. The version of the GAT was used in this study for the purpose of comparison with the BECE that are conducted by the Delta state Ministry of Basic Education.

2.4. Validity of the Instruments

A table of specifications and mathematics scheme of work for Senior Secondary Schools in Nigeria were used to construct the GAT items. The main procedure used in determining the face and content validity of the GAT is by giving a copy of it to three experts in Mathematics Education, Measurement and Evaluation who established that the instrument was suitable to measure what it was designed to measure.

2.5. Reliability of the Research Instrument

To ascertain how reliable the mathematics geometry achievement is, the test was given to 40 students in Anambra State. The internal consistency of the GAT yielded an index of 0.62 using

Kuder – Richardson formula 21 (KR-21) while the Cronbach alpha method of estimating reliability was employed to obtained the reliability index of 0.84 for the mathematics BECE Proforma.

2.6. Data Analysis

The Pearson's Product Moment Correlation Coefficient of Determination was used to answer the research questions while regression and fisher-z statistics were used to test the hypotheses at 0.05 level of significance.

3. Results

3.1. Research Question 1: To what extent do students' score in Mathematics BECE predict the mathematics geometry achievement test in Delta State?

To determine the degree of relationship that exists between the students' score in Mathematics and mathematics geometry achievement test, the Pearson product-moment correlation coefficient was used to provide answers to the research question

Table 1 Pearson Product-Moment Correlation Coefficient on the extent to which students' score in Mathematics BECE predict the mathematics geometry achievement test in Delta State

Model	N	r	R^2	Adjusted R Square	Remark
Math BECE	480				Weak extent
GAT	480	0.113	0.013	0.011	

Table 1 showed the correlation coefficients (r) for students' score in Mathematics at the BECE and mathematics geometry achievement test 0.113 which indicate that there exists a weak extent between students' score in Mathematics at the BECE and mathematics geometry achievement test. From the analysis, the coefficient of determination (R^2) 0.013 and adjusted R square of 0.011 implies that 0.13 percent of the total variations in the criterion variable (mathematics geometry achievement test) was explained by the variation in the predictor variable (score in Mathematics at the BECE). This indicates a weak predictive validity for score in Mathematics at the BECE.

3.2. Research Question 2: To what extent do students' score in Mathematics BECE predict the mathematics geometry achievement in urban and rural secondary school students in Delta State?

To determine the degree of relationship that exists between the students' score in Mathematics and mathematics geometry achievement test in urban and rural students, the Pearson product-moment correlation coefficient was used to provide answers for the research question

Table 2 Multiple Correlation analysis of the extent to which students' score in Mathematics BECE predict the mathematics geometry achievement in urban and rural students in Delta State

Location	Variables	N	Mean	SD	R	R^2	$R^2\%$	Remark
Urban	Math BECE		34.10	1.61				Moderate prediction
	GAT	220	26.97	5.70	0.737	0.546	54.4	
Rural	Math BECE		34.35	3.34	0.727	0.528	52.8	Moderate prediction
	GAT	260	29.03	5.65				

Table 2 shows the result of a multiple correlation analysis which was used to examine the extent to which students' score in Mathematics BECE predict the mathematics geometry achievement between urban and rural students in Delta State. The result revealed that $R = 0.737$, $R^2 = 0.546$, and $R^2\% = 54.4$ for urban students and $R = 0.727$, $R^2 = 0.528$, and $R^2\% = 52.8$ for rural students. The result showed a moderate prediction of students' score in Mathematics BECE on the mathematics geometry achievement for both urban and rural students. It implied that BECE mathematics contributed 54.4% and 52.8% to the variability in mathematics geometry achievement in Delta State for rural and urban students respectively.

3.3. Hypothesis 1: Students' score in Mathematics at the BECE do not significantly predict mathematics geometry achievement among secondary schools in Delta State

Table 3 Summary of Regression analysis on student's scores in mathematics at the BECE and mathematics geometry achievement

Model	Unstandardized Coefficients	Standardized Coefficients		T	Sig.
	B	Std. Error	Beta		
(Constant)	1.984	0.067		29.594	0.000
BECE GAT	0.064	0.029	0.113	1.193	0.029

Table 3 shows the correlation index of 0.113 which indicates that there exist a positively low relationship between students' score in Mathematics at the BECE and mathematics geometry achievement. The regression equations for predicting students mathematics geometry achievement from score in Mathematics at the BECE is Y = 1.984 + 0.113X. It therefore means that for a unit increase in X (score in Mathematics at the BECE), Y (mathematics geometry achievement) will increase by 0.113. Also, at 0.05 level of significance and 478 degree of freedom, the t-test regression value is 1.193 which is less than the critical value of 1.96. Therefore, since the calculated value of t is less than its critical value, the null hypothesis is therefore accepted. The finding is that students' score in Mathematics at the BECE do not significantly predict their mathematics geometry achievement.

3.4. Hypothesis 2: Mathematics scores at the BECE do not significantly predict mathematics geometry achievement in urban and rural students in Delta State

Table 4 Pearson's correlation and Fisher's Z statistics of the mathematics scores at the BECE as predictor of mathematics geometry achievement in urban and rural secondary school students of Delta State

Location	Variables	*N*	Mean	*SD*	*R*	Fisher-z	Remark
Urban	Math BECE		34.10	1.61			
	GAT	220	26.97	5.70	0.737	0.286	Not Significant
Rural	Math BECE		34.35	3.34	0.727		
	GAT	260	29.03	5.65			

Table 4 shows the result of a Pearson's correlation and Fisher's Z statistics of the mathematics scores at the BECE as predictor of mathematics geometry achievement among urban and rural secondary school students of Delta State, The result shows that urban students had a coefficient (*R*) of 0.737 while rural students had a coefficient (*R*) of 0.727. The fisher-z (z_{obs}) is 0.286, which is less than 1.96, the correlation coefficients are therefore not statistically significantly different. Hence, the null hypothesis is accepted, which means that mathematics scores at the BECE do not significantly predict mathematics geometry achievement in urban and rural students of Delta State.

4. Discussion

4.1. To what Extent do students' score in Mathematics BECE predict the mathematics geometry achievement test in Delta State

The first finding showed a weak predictive validity for geometry achievement in Mathematics at the BECE and the first hypothesis indicated that students' score in Mathematics at the BECE do not significantly predict their mathematics geometry achievement test. The plausible reason for this is that geometry is just an aspect of Mathematics and so much emphasis may not have been made by teachers to teach the students extensively in this aspect of Mathematics. The result of the findings agreed with the findings of Allwell and Ibiene (2019) who reported that that BECE is not a powerful predictor of SSCE performance. Other findings in support include: Aminu (2018) who carried out a study on students' achievement in Basic science as a predictor of achievement in science subjects and reported that students' Basic science scores do not significantly predict their scores at SSCE. Furthermore, the findings are in line with that of Ajegena (2022) who reported that students' knowledge of Basic Science at BECE is significant predictor of their performance in Chemistry at SSCE (WAEC, NECO among others).

4.2. To what Extent do students' score in Mathematics BECE predict the mathematics geometry achievement in urban and rural students in Delta State

The second finding showed a moderate prediction of students' score in Mathematics BECE on the mathematics geometry achievement for both urban and rural students. It implied that BECE mathematics contributed 54.3% and 52.8% to the variability in mathematics geometry achievement in Delta State for rural and urban students respectively while mathematics scores at the BECE do not significantly predict mathematics geometry achievement in urban and rural students in Delta State. Findings align with Orubu (2016) which reported that the scores obtained by students in Integrated science and Mathematics do predict performance of students in science at the SSCE level. The findings however contradicted the support of Obijuru (2022) who reported that students' scores in Basic science significantly predict their BECE.

5. Conclusion

In view of the findings of this study, the following conclusions were drawn; that BECE Mathematics is a predictor of mathematics geometry achievement. However, the magnitude of relationship and the percentage of prediction of mathematics geometry achievement from BECE Mathematics performance were very low and weak. It was concluded that some positive relationship exists between BECE and mathematics geometry achievement.

Recommendations

- BECE Mathematics scheme, contents and curriculum should be reviewed in conformity with mathematics geometry to enhance its predictive validity.
- BECE that are conducted by NECO should be compulsorily used by all schools to ensure uniformity, maintain and improve standard of the upper basic school and
- Delta State MOBSE should improve on the quality of the test items used in testing by using test experts for the development and standardization of the test instrument.

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