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Basic Education Certificate Examination in Mathematics as Predictor in Science Subjects at the National Examinations Council in Nasarawa State, Nigeria

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Abstract

The study explored the extent to which students' scores at the Basic Education Certificate Examination in Mathematics can predict their scores in science subjects at the National Examinations Council in Nasarawa State, Nigeria. The study was guided by three research questions and their corresponding hypotheses. The study employed correlational design. The population of the study comprised all the 15, 848 Science students from 83 public senior Secondary Schools who sat for BECE Mathematics in 2018 and also sat for science subjects (Biology, Chemistry and Physics) at NECO in the year 2021. The sample for the study comprised 800 students from 12 science public senior Secondary Schools in Nasarawa State, Nigeria using purposive sampling technique. The researchers designed a Proforma to be used for extracting data from the students' record files for data collection. The logical index of 0.80 and reliability of 0.84 using Cronbach coefficient Alpha method. Data to answer the research questions were analyzed using Ordinary least square (OLS) regression method together with Pearson product-moment correlation coefficient was used to test null hypotheses 1-3 at 0.05 level of significance. The study revealed that that students' score in Mathematics at the BECE significantly predict their grade in Chemistry and Physics except in Biology at the NECO. The study concluded that BECE Mathematics is a predictor of NECO across the selected subjects (except Biology) but, the magnitude of relationship and the percentage of prediction of NECO science subjects from BECE Mathematics performance was very low and weak. The study recommended among others that BECE Mathematics curriculum be reviewed to be in conformity with the SSCE syllabus for science subjects (Biology, Chemistry and Physics) to enhance its predictive validity, National BECE conducted by NECO should be used by all schools compulsorily to ensure uniformity, maintain and improve standard of the Junior secondary school leaver as well as well prepare good product for the senior secondary education and teachers.

Keywords: BECE, Mathematics, NECO, Predictor and Science Subjects.

Introduction

In school setting, emphasis is highly placed on certification at the end of course which only reflects the cognitive aspect of their learning as the evaluation mode. Examination in broad perspective is an instrument for testing, assessment, evaluation and accreditation. It is used for the purpose of selection, placement, certification and promotion. Thus, in schools, factories, industries and in every human endeavour, examination is a potent instrument for the judgment of knowledge or and competence. For any examination to be credible, it must

possess key elements which are validity and reliability. These key elements can only be present if the examination is free and fair, devoid of partiality, cheating and all sorts of malpractice (Liman, 2016). The Federal Republic of Nigeria (FRN, 2014) through the National Policy on Education (NPE) adopted six-year duration for secondary education given in two stages – Junior Secondary School (JSS) and Senior Secondary School (SSS) respectively. Students are expected to spend three years each at the JSS and the SSS. These two levels of secondary school education have different external bodies conducting their examinations. The Junior Secondary Certificate Examination (JSCE) or Basic Education Certificate Examination (BECE) is conducted by each state of the Federation through respective Ministries of Education (MoEs) for the final year students of public and private-owned junior secondary schools. These different MoEs develop, administer, mark and award grades and award certificate to students under their jurisdiction. On the other hand, it is the responsibility of the National Examinations Council (NECO) to conduct the BECE for all the Federal Government Colleges (Unity Schools) in the States and some interested private secondary schools, also the National Examinations Council (NECO) independently conduct the Senior Secondary Certificate Examination (SSCE) in Nigeria. In line with the recommendations of the Nigerian Educational Research and Development Council (NERDC, 2018), what the students learn at the JSS level will lay the foundation for the students SSS education and it should be systematically connected to it. This continuity in the educational process is the essence of the educational system in Nigeria. It is therefore assumed that a student who is admitted into the Senior Secondary School 1 (SSS1) possesses the basic skills to cope with the challenges of schooling at that level.

Although the curriculum of the Junior Secondary differs a little from that of the Senior Secondary, but they have in common some basic core-subjects like, Mathematics, English Language, Integrated Sciences and Agricultural Science (NERDC, 2018). It is speculated that achievement of students in these subjects at JSCE, which stand, as entry qualification for the senior secondary programme could positively predict student's performance in the National Examinations Council (NECO). There are presently two versions of the SSCE: the one conducted by the National Examination Council (NECO). The curriculum of the Junior Secondary differs from the Senior Secondary in terms of integrated subjects (Social Studies and Basic Science). At the Senior Secondary level, Social Studies is split into Geography, Economics, Government and History. Students In the science classes offer Geography and Economics, while Government and History are offered by students in arts classes. At the senior level, Basic Science is likewise split into Chemistry, Biology and Physics, but the popular choice among the science students are Biology and Chemistry. The issue of whether performance of students in Mathematics in BECE will positively predict performance in the related subjects in the NECO remains uncertain and inconclusive. The foregoing call for empirical investigation into the predictive validity of Mathematics scores for students' academic in secondary school.

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. The foregoing call for empirical investigation into the predictive validity of BECE scores and NECO for students' academic achievement in senior secondary schools. According to Webster (2013), predictive means to declare, indicate in advance, foretell, or make a prediction based on observation, experience, or scientific reasoning 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. Emaikwu (2013) 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. In addition, research reports on the influence of gender and location of school are also not conclusive. Establishing the predictive validity of BECE on performance in NECO would go a long way in fulfilling some of the important uses of evaluation, for placement and for certification.

The old education structure of 6-3-3-4 and the new education structure of 9-3-4 systems, specify BECE as a yardstick for admission into SSS level. 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 Junior Secondary 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 NECO. The present policy which does not consider a student's grade in Mathematics before he or she is admitted into the science class in SSS1 is questionable. In the present arrangement, a student could move on to the SSS1 class in science, 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 SSCE level. Mathematics as described by Iji (2017) is a subject which deals with numbers and numerations, measurements, basic numeric operations, practical and descriptive geometry and everyday statistics and it is recognized that these are the basis for solving human, artistic, scientific, and technological problems. It is also a common knowledge that Mathematics helps in logical thinking and the mental development of an individual. Speaking on the weak Mathematics base among students as a threat to the production of engineers and scientists in Nigeria, 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. 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 Mathematics. Mathematics is also used as a basic entry requirement into any of the prestigious courses such as medicine, architecture, and engineering among other degree programs (Ale & Adetula, 2020; Mbugua, Kibet, Muthaa & Nkonke, 2012). By implication, the fundamentals of all scientific and technological skills are intricately interwoven with a sound knowledge of the principles of Mathematics. A pass in Mathematics at the BECE has been a requirement for admission into SSS I in Nigeria (FRN, 2014).

However, since the BECE is meant to serve as a benchmark for admission into the SSS1 in all states in 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 Chemistry, Physics and Biology at the NECO. Some studies by Ajegena (2022) revealed that Students' knowledge of Basic Science at BECE is significant predictor of their performance in Chemistry at SSCE (WAEC), Obijuru (2022) indicated that Students' SBA 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 on the students' scores at the Basic Education Certificate Examination in Mathematics as predictor in science subjects at the National Examination Council in Nasarawa State, Nigeria using correlation design. This is therefore, the gap this study intends to fill.

Research Questions

The following research questions were raised to guide the study:

a. To what extent do students' score in Mathematics at the BECE predict the grade obtained in Biology at the NECO in Nasarawa State, Nigeria?
b. To what extent do students' score in Mathematics at the BECE predict the grade obtained in Chemistry at the NECO in Nasarawa State, Nigeria?
c. To what extent do students' score in Mathematics at the BECE predict the grade obtained in Physics at the NECO in Nasarawa State, Nigeria?

Statement of the Hypotheses

To facilitate the investigation, the following hypotheses postulated were tested at 0.05 level of significance:

Ho_1: students' score in Mathematics at the BECE do not significantly predict their grade in Biology at the NECO in Nasarawa State, Nigeria.

Ho_2: students' score in Mathematics at the BECE do not significantly predict their grade in Chemistry at the NECO in Nasarawa State, Nigeria.

Ho_3: students' score in Mathematics at the BECE do not significantly predict their grade in Physics at the NECO in Nasarawa State, Nigeria.

Methodology

Correlational research design was employed to determine students' grades at the Basic Education Certificate Examination in Mathematics can predict their scores in science subjects at the National Examination Council in Nasarawa State, Nigeria. The population of the study consisted of 15, 848 Science students who sat for BECE Mathematics in 2018 and sat for science subjects (Biology, Chemistry and Physics) at NECO in the year 2021 from 83 Senior Secondary Schools in Nasarawa State, Nigeria during 2020/2021 academic session. The sample for the study comprised 800 students from 12 senior secondary schools in Nasarawa State, Nigeria was selected using the purposive sampling technique. Format designed for data collection considered General School information, such as serial number, information of students' Academic Records, BECE scores and NECO grades. The grades collected were appropriately coded. The version of the NECO was used in this study for the purpose of comparison with the BECE being conducted by the state Ministry of Education. The logical validity index of 0.80 was obtained for the Proforma. Cronbach coefficient alpha method of estimating reliability was employed to obtained the reliability index of 0.84. Descriptive statistics used to answer the research questions while Ordinary least square (OLS) regression method together with Pearson product-moment correlation coefficient was used to test null hypotheses at 0.05 level of significance.

Results

Research Question 1: To what extent do students' score in Mathematics at the BECE predict the grade obtained in Biology at the NECO in Nasarawa State, Nigeria?

To determine the degree of relationship that exists between the students' score in Mathematics at the BECE and their Biology grade at the NECO, the Pearson product-moment correlation coefficient was to provide answers to research question, while the regression analysis was used to establish the predictive strength from the test of the hypothesis. This result is presented in Table 1.

Table 1: Coefficients of Correlation for score in Mathematics at the BECE and Biology grade at the NECO

Model	N	r	R^2	Adjusted R Square	Remark
BECE NECO	800	0.113	0.013	0.011	Weak

In Table 1, the correlation coefficients (r) for students' score in Mathematics at the BECE and Biology grade at the NECO 0.113 indicate that there exists positive relationship between students' score in Mathematics at the BECE and Biology grade at the NECO. From the analysis, the coefficient of determination (R^2) 0.013 and adjusted R square of 0.011 indicates that 1.3 percent of the total variations in the criterion variable (Biology grade at the NECO) 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.

Hypothesis 1: students' score in Mathematics at the BECE do not significantly predict their grade in Biology at the NECO in Nasarawa State, Nigeria.
To test this null hypothesis, the students' grade in Biology at the NECO (criterion variable) score in Mathematics at the BECE (predictor variable) were collected and related to obtain correlation coefficient (r) that was subjected to t-test transformation to establish the significance level. The results obtained are shown in table 2.

Table 2: Summary Regression Analysis for score in Mathematics at the BECE and grade in Biology at the NECO

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

Table 2 shows that correlation index 0.113 indicates that there exists a positively low relationship between students' score in Mathematics at the BECE and grade in Biology at the NECO. The regression equations for predicting students grade in Biology at the NECO 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 (grade in Biology at the NECO) will increase by 0.113. Furthermore, at 0.05 level of significance and degree of freedom of 798, the t-test 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 grade in Biology at the NECO.

Research Question 2: To what extent do students' score in Mathematics at the BECE predict the grade obtained in Chemistry at the NECO in Nasarawa State, Nigeria?

Table 3: Coefficients of Correlation for score in Mathematics at the BECE and Chemistry grade at the NECO

Model	N	r	R^2	Adjusted R Square	Remark
BECE NECO	800	0.045	0.00203	0.021	Weak

In Table 3, the correlation coefficients (r) for students' score in Mathematics at the BECE and Chemistry grade at the NECO 0.045 indicate that there exists positive relationship between students' score in Mathematics at the BECE and Chemistry grade at the NECO. From the analysis, the coefficient of determination (R^2) 0.00203 and adjusted R square of 0.021 indicates that 20.3 percent of the total variations in the criterion variable (Chemistry grade at the NECO) 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.

Hypothesis 2: students' score in Mathematics at the BECE do not significantly predict their grade in Chemistry at the NECO in Nasarawa State, Nigeria.

Table 4: Summary Regression Analysis for score in Mathematics at the BECE and grade in Chemistry at the NECO

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	17.924	1.047		19.554	0.000
BECE* NECO	1.064	0.069	0.45	2.143	0.019

Table 4 shows that correlation index 0.45 indicates that there exists a positively low relationship between students' score in Mathematics at the BECE and grade in Chemistry at the NECO. The regression equations for predicting students grade in Chemistry at the NECO from score in Mathematics at the BECE is Y = 17.924 + 0.45X. It therefore means that for a unit increase in X (score in Mathematics at the BECE), Y (grade in Chemistry at the NECO) will increase by 0.45. Furthermore, at 0.05 level of significance and degree of freedom of 798, the t-test value is 2.193 which is greater than the critical value of 1.96. Therefore, since the calculated value of t is greater than its critical value, the null hypothesis is therefore rejected. The finding is that students' score in Mathematics at the BECE significantly predict their grade in Chemistry at the NECO.

Research Question 3: To what extent do students' score in Mathematics at the BECE predict the grade obtained in Physics at the NECO in Nasarawa State, Nigeria?

Table 5: Coefficients of Correlation for score in Mathematics at the BECE and grade in Physics at the NECO

Model	N	r	R^2	Adjusted R Square	Remark
BECE NECO	800	0.42	0.176	0.016	Weak

In Table 5, the correlation coefficients (r) for students' score in Mathematics at the BECE and grade in Physics at the NECO 0.42 indicate that there exists positive relationship between students' score in Mathematics at the BECE and Physics grade at the NECO. From the analysis, the coefficient of determination (R^2) =0.176 and adjusted R square of 0.016 indicates that 17.6 percent of the total variations in the criterion variable (Physics grade at the NECO) 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.

Hypothesis 3: students' score in Mathematics at the BECE do not significantly predict their grade in Physics at the NECO in Nasarawa State, Nigeria.

Table 6: Summary Regression Analysis for score in Mathematics at the BECE and grade in Physics at the NECO

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	11.284	1.077		19.194	0.000
BECE* NECO	0.154	0.119	0.42	2.113	0.011

Table 6 shows that correlation index 0.42 indicates that there exists a positively low relationship between students' score in Mathematics at the BECE and grade in Physics at the NECO. The regression equations for predicting students grade in Physics at the NECO from score in Mathematics at the BECE is Y = 11.284 + 0.42X. It therefore means that for a unit increase in X (score in Mathematics at the BECE), Y (grade in Physics at the NECO) will increase by 0.42. Furthermore, at 0.05 level of significance and degree of freedom of 798, the t-test value is 2.113 which is greater than the critical value of 1.96. Therefore, since the calculated value of t is greater than its critical value, the null hypothesis is therefore rejected. The finding is that students' score in Mathematics at the BECE significantly predict their grade in Physics at the NECO.

Discussion of Findings

Findings based on Hypothesis 1 indicated that students' score in Mathematics at the BECE do not significantly predict their grade in Biology at the NECO. This finding is in agreement with the findings of Allwell and Ibiene (2019) which reported that that JSCE Basic Science is not a potent predictor of SSCE Biology performance. Other findings in support include: Aminu (2018) who determined 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 in Biology at SSCE. In addition, the findings are similar to that reported by Orubu (2016) which reported that showed that the scores obtained by students in Integrated Science and Mathematics do predict performance of students in science at the SSCE level. More so, Faleye and Afolabi (2015) which reported that Osun State JSCE is a poor predictor of students' performance in the SSCE; overall performance in JSCE across the six subjects investigated is a poor predictor of SSCE performance (except English Language and Mathematics). This result however contradicts the findings of Dike and Garba (2017) which reported that achievement of students in Integrated science significantly predict their later achievement in Biology at SSCE. In addition, the findings are similar to that reported by Ajegena (2022) who reported that students' knowledge of Basic Science at BECE is significant predictor of their performance in Chemistry at SSCE (WAEC).
Findings based on hypothesis 2 indicated that students' score in Mathematics at the BECE significantly predict their grade in Chemistry at the NECO. This finding agrees with the findings of Ajegena (2022) who reported that students' knowledge of Basic Science at BECE is significant predictor of their performance in Chemistry at SSCE (WAEC). Other findings in support include: Adeyemi (2018) who reported that the JSC examinations were a good predictor of performance at SSC examination. In addition, the findings are similar to that reported by Awal and Allwell (2016) which reported that that JSCE Integrated science is a significant predictor of SSCE chemistry performance. This result however contradicts the findings of Aminu (2018) who reported that students' Basic science scores do not significantly predict their scores in Chemistry at SSCE. In addition, the findings are similar to that reported by Orubu (2016) who reported that showed that the scores obtained by students in Integrated science and Mathematics do predict performance of students in science at the SSCE level.
Findings based on hypothesis 3 indicated that students' score in Mathematics at the BECE significantly predict their grade in Physics at the NECO. This finding is in agreement with the findings of Ajegena (2022) who reported that students' knowledge of Basic Science at BECE is significant predictor of their performance in Chemistry at SSCE (WAEC). Other findings in support include: Adeyemi (2018) who reported that the JSC examinations were a good predictor of performance at SSC examination. In addition, the findings are similar to that reported by Dike and Garba (2017) which reported that achievement of students in Integrated science significantly predict their later achievement in Biology at SSCE. This result however contradicts the findings of Aminu (2018) who reported that students' Basic science scores do not significantly predict their scores in Chemistry at SSCE. Other findings in support include: Obijuru (2022) who reported that students' SBA scores in Basic science significantly predict their BECE. In addition, the findings are similar to that reported by Orubu (2016) which reported that showed that the scores obtained by students in Integrated science and Mathematics do predict performance of students in science at the SSCE level.

Conclusion

In view of the findings of this study, the following conclusions were drawn: From the above results, it is clearly seen that BECE Mathematics is a predictor of NECO across the selected subjects (except Biology) but, the magnitude of relationship and the percentage of prediction of NECO science subjects from BECE Mathematics performance was very low and weak. This could be because of the high failure rate in NECO science subjects in recent years as against the robust performance witnessed in BECE examinations. It was concluded that some positive relationship exists between BECE and NECO which is the predictive value in question.

Recommendations

The above findings imply that BECE scores are good predictor of students' NECO. Consequently, the following recommendations are made:

1. BECE Mathematics curriculum be reviewed to be in conformity with the NECO syllabus for science subjects (Biology, Chemistry and Physics) to enhance its predictive validity.
2. National BECE conducted by NECO should be used by all schools compulsorily to ensure uniformity, maintain and improve standard of the Junior secondary school leaver as well as well prepare good product for the senior secondary education.
3. State MOE should improve on the quality of the items that are used for the testing of the candidates for the BECE by using test experts for the development and standardization of the test instrument.
4. Serious attention should be paid to the students' preparation at the BECE to have greater positive effects on their performance at the NECO.

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