# THE PREDICTIVE VALIDITY OF JUNIOR SECONDARY SCHOOL MATHEMATICS SCORES: A COMPARATIVE STUDY OF SENIOR SECONDARY SCHOOL MATHEMATICS SCORES IN DELTA AND EDO STATES

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**Abstract–**This paper presents the results of a comparative study of the extent to which scores obtained by students at the Junior Secondary Certificate Examination (JSCE) in Mathematics predict the scores obtained in the same subject at the Senior Secondary Certificate Examination (SSCE) in the same subject. The study adopted an ex-post facto design, using 400 students who participated in JSCE in 2010 and SSCE in 2013, and randomly selected from twenty (20) secondary schools – 10 from Delta and 10 from Edo State. The JSCE scores and SSCE scores were extracted from school record files. Regression analysis was used to estimate the parameters of the specified equations. The results established that there is a significant relationship between scores obtained by students in Mathematics at the JSCE and the scores they obtain in the same subject at the SSCE. The results also indicated that location of the State has a significant effect on the scores obtained by students in SSCE Mathematics, as established by shift and slope dummy procedures and the Chow test, while the Theil's inequality coefficient showed that the forecasting power of the JSCE Mathematics on performance of SSCE Mathematics is slightly higher for Delta State compared to Edo State. The results suggest that Mathematics at the JSS should be taken seriously by students to enhance better performance in the subject at SSCE.

**Keywords:** predictive validity, JSCE, SSCE, mathematics.

## INTRODUCTION

The Federal Republic of Nigeria (FRN, 2004) 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) is conducted by each state of the Federation, including Federal Capital Territory (FCT) Abuja through their 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 JSCE for all the Federal Government Colleges (Unity Schools) in the States including FCT and some interested private secondary schools, while the West African Examinations Council (WAEC) and 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, 2008), 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 Class 1 (SSS1) possesses the basic skills to cope with the challenges of schooling at that level. The above stated position however may not necessarily reflect what is happening at the secondary school level; for example it has been observed that some students who were promoted to SSSI because they obtained acceptable grades at the JSCE later failed at the SSCE (WAEC, 2008; Adeyemi, 2008), thus questioning the validity of the JSCE as a benchmark for predicting performance at the SSCE level.

According to Ukwuije (2009), the validity of a test is the most important attribute of a test and concerns with what the test measures and how well it does so, while the predictive validity is the extent to which test scores relate to a benchmark or criterion score (Osadebe, 2003). In line with the view of Orubu (2012), studies on predictive validity provide a framework for establishing the degree of credibility that can be placed on any prior examination.

In this study, the subject in focus is Mathematics. Oyedeji (1999) identifies mathematics as a specialized language in which knowledge of the physical world is recorded. Nurudeen (2007) viewed that Mathematics is an instrument to ease or facilitate the thinking capabilities of an individual in the learning of other subjects. A strong background in Mathematics is critical for many career and job opportunities in today increasingly technological society. Hence studies that will improve performance in it at this point are justified. Current government policy in Nigeria also specifies at least a pass in mathematics at the JSCE level (lower level) as a prerequisite for admission into SSSI. In the proposition of NERD (2008), with a pass at the JSCE, one should be able to determine students that would likely do well at the SSCE, but it is a common knowledge (and as already noted) that performance in SSCE Mathematics has always been relatively poor, when compared to other subjects, such as Biology, Government, Commerce, History, Literature in English, to mention but a few.

The results from prior studies on the effect of scores in lower level examinations predicting higher level examinations are mixed. Adeyemi (2008), in predicting students' performance at the SSCE level from their performance at the JSCE in Ondo State Nigeria, revealed that JSCE scores were good predictors of scores obtained by students at the SSCE. Osadebe (2003) investigated the predictive validity of JSCE scores in Mathematics and English for scores obtained at the SSCE in Delta State Nigeria. The results obtained showed positive and significant relationship between JSCE and SSCE students' scores in Mathematics and English. In a similar study by Onuka, Raji and Onabamiro (2010), they established that, there was a significant relationship between the overall performance in both examinations, as measured by scores obtained at the JSCE and SSCE, in Epe Local Government Area of Lagos State Nigeria. The results in a study by Falaye & Afolabi (2005), for Osun State, however indicated generally contrasting evidence, that Osun State JSCE, is a poor predictor of students' performance in the SSCE, except for their finding that JSCE English Language and Mathematics tend to have relatively greater capacity to predict performance in SSCE English language and Mathematics than the other subjects.

A few works have considered the factor of location, by investigating the proposition that variation in schools located could exhibit different performance ratings, which may be explained by heterogeneity effects such as the quality of the test, managerial skills, environmental factors and others. On school location, Adepoju & Akinwumi (2002) revealed by their study on location of secondary school students as a factor in determining academic performance of students in SSCE in Oyo State Nigeria, that there was a significant relationship between location of secondary schools and academic performance of students. However, in a related study by Onah &Ugwu (2002), they established that there was no significant relationship between school location and students' performance at Ebonyi State Nigeria.

This study is a contribution to the empirical literature on the role of scores obtained at a lower level examination in predicting scores obtained at higher level examination. Specifically, the research problem investigated hinges on the extent to which scores obtained in Mathematics at the JSCE can predict scores obtained in Mathematics at the SSCE, using data for Dlelta and Edo States. This comparative study for both States is justified, based on the historical relationship between the two States. Both Delta and Edo States in Nigeria, made up the old Midwest Region, created in 1963. In 1976, the Midwest Region was renamed Bendel State – subsisting until 1991 – when Delta and Edo States were created out of the defunct Bendel State.

Arising from the fore-going, the following three (3) hypotheses were raised to sharpen the focus of the study:

1. There is no significant relationship between scores obtained by students in mathematics at the JSCE and the scores they obtain in the same subject at the SSCE.
2. The location of the State has no significant effect on the scores obtained by students in SSCE Mathematics.
3. There is no significant difference in the forecasting power of scores obtained in Mathematics at the JSCE in respect to scores obtained in Mathematics at the SSCE, across Delta and Edo States.

The theoretical framework under-pinning this study is the one provided by Ausubel's (1970) theory of learning, which stresses the value of prior (lower) knowledge and the sequence of instruction in students' learning. This implies that meaningful learning takes place when there is appropriate link between prior knowledge and new knowledge. In other words, the learning of a new concept or skill depends upon the mastery of prerequisite concepts. This implies that previous knowledge determines higher knowledge. Therefore, one would expect the students' performance in the SSCE (higher level examination) to be determined by the performance in JSCE (lower level examination).

**METHOD**

The ex-post facto design is used in this study. This design is most appropriate because the event under investigation has already taken place. All the secondary schools in Delta State and Edo State who presented students for JSCE in 2010 and SSCE in 2013 were the population for the study. Twenty secondary schools were randomly selected for the study; ten from Delta State and ten from Edo State. Two hundred students were sampled from Delta State schools and two hundred were sampled from Edo State schools. The total number of four hundred students with intact record was used for the study. The instrument that was used to collect data from documented results from the principal is and Inventory. Since student's results for JSCE and SSCE are normally presented in qualitative format using A (Distinction), C (Credit), P (Pass) and F (Fail) for the JSCE and A1, B2, B3 corresponding to (Distinction, very Good and Good) C4, C5, C6 (corresponding to Credit), P7, P8 (corresponding to pass) and F9 (corresponding to Fail) for the SSCE, these format do not allow for a numerical range that will enable comparison of performance, hence for the purpose of scoring, JSCE grades of A, C, P and F were awarded 4,3,2 and 1 and the SSCE grade s of A1, B2, B3, C4, C5, C6, P7, P8 and F9 were awarded scores of 9,8,7,6,5,4,3,2,1 respectively. Thus an aggregate score that was amenable for data analysis were obtained for each student.

Data analysis involved the use of multiple Regression Analysis (MRA), using both F and T-Statistics to test for the statistical significance of the established parameters at 0.05 level of significance, the method of dummy variable was used to accommodate state location (Delta and Edo state). The basic regression equations that was estimated are

$MATHSSCE = b_0 + b_1 MATHJSCE + u_1$ ---------- $EQP_1$, $EQD_1$ and $EQE_1$

$MATHSSCE = b_0 + b_2 STATE + u_1$ ---------- $EQP_2$ and $EQP_3$

The Chow F-statistic was computed to establish the differences in $b_0$ and $b_1$ between the two states. Theil's inequality coefficient was also calculated to verify the forecasting power of JSCE in Delta and Edo states. The dependent variable is the SSCE scores in mathematics while the independent variables are the JSCE scores in mathematics and JSCE scores in mathematics conducted by two states MoEs (Delta and Edo State). On different JSCE conducted by different MoEs, one may argue that since JSCE is meant to serve as a benchmark for admission into the SSS in any state, it is expected that the standards set with JSCE score in mathematics for any state with uniform scheme of work should be an adequate predictor of performance of students in SSCE mathematics across the country. With variation in human and material resources in the evaluation department of the state's MoEs, one should also expect the predictive validity of these JSCE scores in relation to SSCE scores to vary. How this variation is applicable to Delta State and Edo State can only be answered by an analysis of the data relating to JSCE and SSCE scores in Mathematics in Delta State and Edo State.

**RESULTS**

The results of data analysis are presented in table 1, according to the research hypotheses. The basic reference equations for testing hypothesis 1 are $EQP_1$, $EQD_1$ and $EQE_1$. For the pooled data, the sign of the coefficient attached to MATHSJSCE measured at 1.437 is positive and statistically significant at 1 percent level of significance. In terms of overall fit, the F statistic ($R^2$) estimated at 0.149 and the adjusted value ($\bar{R}^2$) measured at 0.147, indicating that about 15 percent of the systematic variation in the scores obtained in Mathematics at the SSCE is explained by the scores obtained in Mathematics at the JSCE. The overall F-statistics measured at 69.68 is statistically significant and showed that the regression equation has no specific error and has an acceptable fit. When the data were treated separately, the coefficient attached the MATHS JSCE in Delta and Edo States were 0.598 and 1.724. They were also statistically significant at 1 percent level of significance. With these results, the null hypothesis was rejected in favour of the alternative that there is a significant relationship between scores obtained by students in mathematics at the JSCE and the scores they obtain in the same subject at the SSCE.

**Table 1. Summary of Regression Results; Dependent Variables =SSCE scores in Mathematics.**

| Independent Variables/Statistics | Results for Pooled Data | | | Results for Delta State | Results for Edo State |
|---|---|---|---|---|---|
| | EQP1 | EQP2 | EQP3 | EQD1 | EQE1 |
| Constant | -0.245<br>(-0.62) | 0.378<br>(0.92) | 0.125<br>(0.32) | 1.195<br>(2.30)** | -0.511<br>(-0.90) |
| MATHSJSCE | 1.437<br>(8.35)* | 1.340<br>(7.92)* | 1.466<br>(8.79)* | 0.598<br>(2.57)* | 1.724<br>(7.24)* |
| STATE | | -0.808<br>(-4.69)* | | | |
| MATHSTATE | | | -0.396<br>(-5.29)* | | |
| $R^2$ | 0.149 | 0.194 | 0.205 | 0.032 | 0.209 |
| Adj. $R^2$ | 0.147 | 0.190 | 0.201 | 0.027 | 0.205 |
| F statistic | 69.68* | 47.70* | 51.21* | 6.60* | 52.37* |
| RSS | 1221.17 | 1156.94 | 1140.69 | 373.544 | 754.376 |
| DW statistic | 0.662 | 0.685 | 0.686 | 0.787 | 0.658 |
| N | 400 | 400 | 400 | 200 | 200 |

Source: Regression computations, using STATISTIX Version 8. Notes: The figures in parentheses under the coefficients are the corresponding t-values. The maintained null hypothesis is that the coefficient attached to each estimated coefficient is not significantly different from zero. A two-tailed test was performed. The critical t-values are: For $\alpha = 0.01$, the 9bounds are $t_1 = -t_{0.005} = -2.576$, $t_2 = +t_{0.005} = +2.576$. For $\alpha = 0.05$; the bounds are $t_1 = -t_{0.025} = -1.960$, $t_2 = +t_{0.025} = +1.960$. In all cases, one asterisk indicates statistical significance at $\alpha = 0.01$ (1 percent), while two asterisks (**) indicate statistical significance at $\alpha = 0.05$ (5 percent).

The second null hypothesis was that the location of the schools by the state of origin has no significant effect on the scores obtained by students in SSCE Mathematics. The reference equations for testing this hypothesis are $EQP_2$ and $EQP_3$ in table 1. The $EQP_2$ test for shift effects, while $EQP_3$ tests for slope or differential effect. The coefficient attached to STATE (Delta 1, Edo 0) is – 0.808, it is negative and statistically significant at 1 percent level, indicating that students in Edo State do better in Mathematics at the SSCE compared to students in Delta State. The intercept of the equation $EQP_2$ is 0.378. The differential effect of Delta State therefore lowered the intercept of the equation to – 1.570. The coefficient of the slope dummy variable MATHSTATE was used to establish if the performance of students in Mathematics at the JSCE exerted more effect on their performance in Mathematics at the SSCE in Delta State than in Edo State. The coefficient of MATHSJSCE as shown in figure 1 was estimated at – 0.396 and found to be statistically significant at 1 percent level of significance. Given these results, the null hypothesis that there is no significant relationship is rejected in favour of the alternative. To further confirm this result, the Chow test which is a measure of equality between coefficients obtained from different samples was estimated. The equations EQD1 and EQE1 are estimated separately for Delta and Edo States; under the null hypothesis that the coefficients estimated (that is,$b_0$ and $b_1$) do not differ significantly from each other across the two States, the Chow F-statistic (F*) is given by the formula,

$$F^* = \frac{[RSSp - (RSSd + RSSe)]/K}{(RSSd + RSSe)/(Nd + Ne - 2K)}$$

Where,

$RSS_P$ = residual sum of squares for the regression pooled for both Delta and Edo States;

$RSS_d$ = residual sum of squares for the regression using only data for Delta State

$RSS_e$ = residual sum of squares for the regression using only data for Edo State

$K$ = number of parameters estimated

$N_d$ = sample size for Delta State's data

$N_e$ = sample size for Edo State's data

The degrees of freedom are: $v_1 = K$, $v_2 = n_e + n_e - 2K$.

$RSS_P = 1221.17$

$RSS_d = 373.544$

$RSS_e = 754.376$

$n_d = 200$

$n_e = 200$

$v_1 = 2$

$v_2 = 396$

$F_{CHOW} = 16.37 > F_{0.05} = 3.63$

Since the calculated Chow break point statistic (16.37) is greater than the critical value (3.63), it can be concluded that the coefficient attached to MATHJSCE is different between Delta and Edo States. In other words, it can be accepted that the data are drawn from two different samples. With these results the null hypothesis was rejected in favour of the alternative. The result indicates that location of the State has a significant effect on the scores obtained by students in SSCE Mathematics.

In order to establish if the estimated model has a better forecasting power for either Delta or Edo State, Theil's inequality coefficient (U) is computed for equations EQD1 (for Delta State) and EQE1 (for Edo State) respectively. The formula for calculating U is given by,

$$U = \sqrt{[\sum (P_i - A_i)^2 / n]/[\sum A_i^2 / n]}, \quad 0 \le U \le \infty$$

Where;

$P_i$ = forecast or predicted value for the $i^{th}$ observation of the dependent variable

$A_i$ = actual or realized value for the $i^{th}$ observation of the dependent variable

n= number of observations

As shown above, $0 \le U \le \infty$. Generally, the smaller the value of U, the better is the forecasting power of the estimated model. Perfect forecasts are obtained when U= 0. When U = 1, then the equation does not forecast better than a 'naïve' zero change prediction. On the other hand, when U > 1 it is preferable to accept the zero change extrapolation. In the case of Delta State, the following results were obtained:-

$$U = \sqrt{[\sum (P_i - A_i)^2 / n]/[\sum A_i^2 / n]} = \sqrt{0.2276} = 0.477$$

In the case of Edo State,

$$U = \sqrt{[\sum (P_i - A_i)^2 / n]/[\sum A_i^2 / n]} = \sqrt{0.2966} = 0.545$$

From the results above, it can be concluded that the forecasting power of the regression equation is slightly better for Delta State, compared to Edo State. In other words, scores obtained by students in Mathematics at the JSCE tend to predict their ultimate performance in the same subject at the SSCE marginally better in Delta State, relative to the case of students in Edo State.

**FINDINGS AND DISCUSSION OF RESULTS**

The finding established that scores in Mathematics at the JSCE do predict their scores in Mathematics at the SSCE level. This is in consonant with the position of NERDC (2008) and the Government policy which specified at least a pass in Mathematics at the JSCE as a compulsory requirement before a student can be promoted to SSS one. This finding is in agreement with the findings of Adeyemi (2008), Osadebe (2003), Onuka Raji and Onabamiro (2010) but negates the result of Falaye and Afolabi (2005) that Osun State JSCE is a poor predictor of students performance in SSCE.

Another finding of this study is that the location of the student's state has a significant effect on scores obtained at the SSCE Mathematics. This corroborated the finding of Akinwumi (2004) that location of secondary school students determine academic performance but contrary to the finding of Onah and Ugwu who found that there was no significant relationship between school location and student's performance.

The third finding of the Study is that the forecasting power of the JSCE Mathematics on performance of SSCE Mathematics is slightly better for Delta State compared to Edo State in Nigeria. This is in agreement with an earlier statement that since the JSCE is conducted by different MoEs in the thirty six States including FCT, with variation in human and material resources in the evaluation department, one should expect the prediction to differ across states to differ.

Based on the findings, it is recommended that:

1. Everything possible effort should be made by government, parents, teachers, students and the larger society to promote meaningful learning of Mathematics at the JSS as this would help the students perform better in Mathematics at the SSCE.
2. Since the JSCE in Mathematics in Delta has higher forecasting power, it could be better if all the State's MoEs could come together to conduct a national JSCE as the case of SSCE conducted by NECO in Nigeria. If this is done it would harness the diversified human and material resources and increase general performance at SSCE level in Nigeria.

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