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Research Paper

Scaling and regression models of statistical moderation

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Abstract. This study investigated scaling and regression models of statistical moderation of internal assessment scores. This is an ex-post-facto research design in which there was no treatment and manipulation of subject, instead it involves the collection of data from records, cluster sampling technique was adopted to select five hundred (500) students that were made up of fifty students each from ten schools. The two questions and two hypotheses were analyzed using Pearson-product-moment correlation statistical technique. The results revealed that both scaling and regression model do not utter the strength of relationships among the internal assessment scores in Mathematics, English language and Integrated Science and at the same time there were significant relationships among the internal assessment scores in Mathematics, English Language and Integrated Science before and after the applications of statistical moderation by scaling and regression models. Based on these findings, this study does not recommend scaling and regression models as means of moderating internal assessment scores because they do not utter the strength of relationship as expected in order to ascertain the quality control of teachers' assessment scores in Nigeria Secondary Schools.

Keywords: Scaling, regression, statistical moderation, moderated scores and internal assessment scores.

INTRODUCTION

Moderation in Educational perspective is a process of ensuring that the same assessment standards are applied to students from every school doing a particular study. Statistical moderation is a process for adjusting schools' Internal Assessment scores to the same standard while maintaining the students rank order given by the school. The examination board use statistical moderation to ensure that the internal assessment scores given by different schools are comparable throughout the state or country (Bandele, 1989, 1997; MacCann, 1995; Abe, 1995, 2002, 2004, 2006, 2007, 2008, 2009; Abe and Gbore, 2006; Alonge and Abe, 2007). However, in Nigeria the major problem that besets the internal assessment is comparability of standard which come with differences in entry behavior of pupils, quality of teacher, methodologies, ability of the teachers to motivate students to learn, quality of test and other assessment used in different school (Agwubike and Momoh, 1995).

In anticipation to alleviate these differences, some local governments in Nigeria Secondary school devised uniform test and marking schemes at the end of the term in other to maintain equal standard among the student internal assessment scores, but this is still far from achieving the uniform comparable standard state wide. Since the internal assessments differ from schools, how could this mode of assessment be normalized or standardized among schools? (Garguilo, 1986; Bandele, 1989). Also, Ojerinde (1985), Abe (1995, 2002, 2006, 2007a, b), Abe and Gbore (2006) and Alonge and Abe (2007) raised a number of questions, one of such question is that could the raw score sent by each school be relied upon? How much can we rely on those scores sent by the school? This corroborates with Ziderman (1984) and MacCann (1995) who argue that in school internal assessment, teachers may tend to under-evaluate or over-evaluate pupils for reasons that are non-academic. Garguilo (1986), Bandele (1989), MacCann (1995), Abe (1995, 2002, 2004, 2006, 2007a, b), Abe and Gbore (2006) and Alonge and Abe (2007), argue that, it would defy psychometric consideration if individual

schools internal assessment scores are used by states, WAEC or NECO to issue certificate to all candidates on assumed equivalent standard. In view of this, the possibility of transforming the internal assessment scores into more reliable form had therefore been one of the greatest concerns of stakeholder on education mostly test, measurement and evaluation experts and educational practitioner. This necessitated the researcher to verify the applicability of Scaling and regression in moderating the internal assessment scores in mathematics, English Language and Integrated Science among the junior secondary Schools in Ekiti State, Nigeria. According to Smith (1978), Awuwoloye (1986), Bandele (1989) and Abe (2006), the regression statistical model employs the regression equation to predict internal assessment scores from external assessment scores, that is, y = a + b(x - x) where a = intercept of y axis, (x, y) is the centroid and b is the gradient given by:

$$b = \frac{\sum (x - \bar{x})\,\bar{y}}{\sum (x - \bar{x})^2}$$

$$= \frac{\sum xy - Nxy}{\sum x_i^2 - Nx^2}$$

$$b = \frac{COVxy}{S_x^2}$$

Simply put as y = a+ bx + E, where y = external assessment (dependent or criterion variable), x = internal assessment (independent or explanatory variable), E = error whose expectation is zero from Abe and Gbore (2004). The moderated scores is given by y = y + b(x - x) where y = straight line value of y as against the observed value of y = the intercept of (x-x), (x, y) = centroid, b = the gradient of line of best fit which is given by the relation:

$$b = \frac{(x - \bar{x})\,y}{(x - x)^2}$$

and for computational

$$\text{Simplify } b = \frac{\bar{X}Y - XY}{\bar{X}^2 - nX^2}$$

Scaling model according to Bandele (1989, 1997) and Abe (1995, 2002, 2006, 2007) indicates scaling the internal assessment scores to external score by the equation:

$$\frac{X_A - M_E}{SD_E} = \frac{\bar{X} - M_1}{SD_1}$$

Where X_A = moderated score,
X_I = Internal assessment score,
M_I; M_E = Means of both internal and external assessment scores,
SD_I, SDE = Standard deviations of both Internal and External Assessment Scores.

In view of this, the major problem of the study therefore is to empirically verify the applicability of the two proposed models in moderating internal assessment scores in Mathematics, English Language and Biology among the Senior Secondary Schools in Ekiti State, Nigeria.

Significance of the study

The significance of the study is for the control of teachers assessments from secondary schools to the Ministry of Education and examination body like NECO and WAEC in Nigeria mostly where adequate reliance are on the score sent from schools for the awards of certificates for the students, hence diversity in the award of scores need to be controlled in order to guide against the arbitrariness of marks being awarded by these categories of teachers whom their knowledge of evaluation is not detailed; hence implications of the actions on the award of marks to students is not known to them or they are totally ignorant of their actions on the future career of the students under them. Therefore, the need for appropriate statistical moderation model is required.

Research Questions

Two research questions guided this study

1. Is there any significant relationship among the internal assessment scores in the three selected subjects before and after the statistical Moderation by Scaling and Regression Models?
2. Is there any significant relationship between the moderated scores by Scaling and Regression Models?

Research hypotheses

To guide this study the following two null hypotheses were formulated:

1. There is no significant relationship among the internal assessment scores (Internal assessment in senior

Table 1. Correlation coefficients internal assessment scores in three selected subjects before moderation.

Subject	IAS1 and IAS2	IAS1 and IAS2	IAS2 and IAS3
Mathematics	0.61	0.58	0.65
English language	0.52	0.53	0.51
Integrated science	0.48	0.48	0.45

P < 0.05, Critical value 0.345 (2 tailed tests) * is significant; Magnitude 0.0 - 0.2 = very low, 0.2 - 0.4 = low; 0.4 - 0.6 = moderate, 0.2 - 0.8 = high, and 0.8 - 1.0 very high.

Table 2. Correlation coefficients of moderated internal assessment score (IAS1, IAS2 and IAS3) after statistical moderation by regression model.

Subject	IAS1 and IAS2	IAS1 and IAS3	IAS2 and IAS3
Mathematics	0.61	0.58	0.65
English language	0.51	0.53	0.51
Integrated Science	0.48	0.48	0.45

secondary school one (IAS1), Internal assessment in senior secondary school two (IAS2) and Internal assessment in senior secondary school three(IAS3) in the three selected subjects before and after the Statistical Moderation by Scaling and Regression Models.

2. There is no significant relationship between the moderated scores by Scaling and Regression Models.

METHODOLOGY

This study was an ex-post-facto research design in which there was no treatment and manipulation of subjects, instead it involved the collection of data from schools. This type of design was formulated by Chappin (1955) and expanded by Campbell and Stanley (1966) as an attempt to solve the problems of organization and control of variables in educational research. Since there was no treatment, nothing is being manipulated but the variables of interest were nearly observed as found and used for the purpose in which the study was designed. The target population consisted of all junior secondary schools in Ekiti State Nigeria, while cluster sampling technique was adopted to select 10 schools from the 3 senatorial districts and simple random technique was used to select five hundred students which were made up of 50 students per school. The research assistant went to all the selected school and collected the school copies of school-based assessment scores (JSS1, JSS2, and JSS3) for the three consecutive years (2008 to 2011). The data were analyzed using EXCEL and SPSS by applying the Pearson Product Moment Correlation Statistical techniques. It should be noted that IAS1, IAS2, and IAS3 denote internal assessment score for JSS1, JSS2 and JSS3 respectively, while scal (IAS1)Scal, (IAS2)Scal, (IAS3), represents moderated scores by scaling model and Reg Mod indicate moderated scores by regression model.

RESULTS AND DISCUSSION

To what extent is there a relationship among the internal assessment score in the three selected subjects before and after the statistical moderation by regression and scaling models? In response to this problem the question was transformed into the following hypothesis.

Ho: There is no significant relationship among the internal assessment scores one junior secondary one (IAS1) junior secondary Two (IAS2) and junior secondary 3 selected subjects before and after the statistical moderation by scaling and regression models:

The analysis of hypothesis was carryout using product moment correlation statistical technique as illustrated in Tables 1 to 3.

Table 1 shows high and positive strength of relationship between (IAS1 and IAS2 and IAS3) in mathematics moderate and positive strength of relationship existed between (IAS1 andIAS3) in mathematics likewise between (IAS1 and IAS2), (IAS1 and IAS3) and (IAS2 and IAS3) in English Language and Integrated Science, respectively, before moderation.

As $p < 0.05$, value of 0.345, there was significant relationship between the internal assessment scores (IAS1 and IAS2), (IAS1 and IAS3) and (IAS2 and IAS3) in Mathematics, English Language and Integrated Science, hence the null hypothesis was not upheld before the application of either regression or scaling models of statistical moderation.

At $P < 0.05$, critical value of r is 0.345 (2tailed tests),* significant, Table 2 reveals the same strength of relationship among the moderated internal assessment

Table 3. Correlation coefficients of moderated internal assessment scores in the three subjects after the application of statistical moderation by scaling model.

Subject	Scal (IAS1 and IAS2)	Scal (IAS1 and IAS3)	Scal (IAS2 and IAS3)
Mathematics	0.61*	0.58*	0.65*
English language	0.52*	0.53*	0.50*
Integrated Science	0.48*	0.48*	0.45*

At P < 0.05 critical value of r = 0.345 (2 tailed tests) *is significant.

Table 4. Correlation coefficients of moderated internal assessment scores in the three subjects after the applications of scaling and regression models.

Subject	SCAL IAS1	SCAL IAS2	SCAL IAS3
Reg Mod Maths	-0.86*	-0.90*	-0.59*
Reg Mod English	-0.95*	0.67*	-0.55*
Reg Mod ISC	-0.14	0.34	0.56*

scores in the three subjects which corroborates the same finding in Table 1. However, at p < 0.05 significant relationship existed between moderated internal assessment score after the application of statistical moderation by regression model on the raw scores, hence the hypothesis was not upheld.

Table 3 shows high and positive strength of relationship between Scal IAS1 and IAS2, and IAS2 and IAS3 in mathematics, while moderate and positive relationship existed between three subjects (Scal IAS1 and IAS2, IAS1 and IAS3, and IAS2 and IAS3) while at P < 0.05 significant relationship existed between the moderated assessment scores in mathematics, English and Integrated Science after the application scaling model of statistical moderation, hence the null hypothesis was not upheld.

Question two: To what extent is there a relationship between the moderated scores by scaling and regression models?

Addressing this problem, the question was transformed into the following hypothesis:

Ho: there is no significant relationship between the moderated scores by scaling and regression models.

In analysis, this hypothesis, after the applications of the two models to the raw data using the two formulae in the introduction, the moderated scores were subjected to product normally correlation statistical technique. The findings are shown in Table 4.

At P < 0.05, critical value of r=0.345 (2 tailed tests), from table 4, the strength of relationship between Reg Mod Mathematics and SCAL (IAS1, IAS2 and IAS3) are negatives and very high and moderate, also in between Reg Mod English and SCAL (IAS1, IAS2 and IAS3) Negatives, very high, high and moderate. While very low, low and moderate strength of relationship existed in Reg Mod Integrated Science (ISC) and SCAL (IAS1, IAS2 and IAS3). At p < 0.05, there was significant relationship between the moderated scores by Scaling and Regression models in Mathematics, English and Reg Mod and SCAL1 in ISC. Hence, the null hypothesis was not upheld, while there was no significant relationship between Reg Mod ISC and SCAL (IAS2 and IAS3).

Findings

The finding of this study showed that the strength of relationship among the internal assessment scores in Mathematics between (IAS1 and IAS2) as well as (IAS2 and IAS3) was high and positive before the moderation, this corroborate the findings of Abe (2004), Abe (2006, 2007a, b) and Abe and Gbore (2006) while moderate and positive relationship existed between (IAS1 and IAS3) in Mathematics (IAS1 and IAS2), (IAS1 and IAS3) and (IAS2 and AS3) in English Language and Integrated Science.

This is also in line with the findings of Abe (2004, 2006, 2007a, b). The same finding was also upheld after the moderation of the internal assessment scores by both scaling and regression models. The strength of relationships among the moderated scores by scaling model was at variance to that of regression model in the sense that, scaling model improves the strength of relationship to very high and positive in Mathematics, English Language and Integrated Science.

This is in line with the studies of Bandele (1989), MacCann (1995), Abe and Gbore (2006) and Abe (2006 and 2007a). The finding also revealed that, at P < 0.05, significant relationships existed among the internal assessment scores before and after the moderation by

scaling and regression models. This upheld the principle of statistical moderation as asserted by Smith (1978), Hornby (1980), Ward (1981), Bandele (1989), MacCann (1995) and Abe (1995, 2002, 2006, 2007a, b). Finally, there was no significant relationship among the moderated scores between the Scaling and Regression models of statistical moderation in Mathematics, English Language and Integrated Science in Junior Secondary School in Ekiti State, Nigeria.

Conclusion

The overall findings showed that the strength of relationship among the internal assessment scores before and after the applicability of Scaling and Regression Models was high and positive in English and Integrated Sciences but moderate and positive relationship existed in Mathematics which implies that Scaling and Regression models did not utter the strength of relationship as expected of the models. However, the findings also revealed that negative and significant relationship among the moderated scores of regression and scaling model in Mathematics in the three years assessment scores also in English in the first and third year assessment scores, and also in second year assessment score in Integrated Science, while positive and significant relationship existed between moderated scores of regression and scaling models in second year English and in first and third year moderated scores in Integrated Science which led to the upholding of the null hypothesis between regression and scaling models.

Implication

The two models did not comply adequately to the principle of statistical moderation which state that, all the three years assessment scores must be in moderate strength of relationship as an indication that teachers' biasness on internal assessment scores has been removed. The motive behind the moderation of internal assessment score was as stated in the National Policy of Education in Nigeria schools.

RECOMMENDATIONS

1. Based on the premise of these findings, this paper could not recommend the use of scaling and regression models as a means of moderating internal assessment scores in Nigeria secondary schools since the models could not uphold strictly to the principles of statistical moderation.
2. The two models did not meet the requirement of National Policy of Education that allows the involvement of teachers assessments of students in Junior Secondary Schools and allows the use of appropriate statistical moderation models that will minimize the teachers biasness of students at that level, that is to say at Junior Secondary Schools.
3. Other researchers can apply the models in other states or countries to confirm the appropriateness of the models in their schools whether it will conform to their systems of education.

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