Predictive Validity of Students' Entry Qualifications into Mathematics Programme in Nigeria's Osun and Oyo States' Colleges of Education

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Abstract

This study investigated the relationship between students' performance in entry examination and students' mathematics performance in College of Education (CoE). The population comprised CoE students in South-western Nigeria. A sample of 276 CoE students was purposively selected for the study. Data collected from students' records of two selected Colleges of Education included students' entry qualification, their age, sex and semester results in Mathematics during 2010/2011 to 2012/2013 sessions. Results showed that the Unified Tertiary Matriculation Examination (UTME) was the best predictor of College performance. Results also indicated that there is no significant relationship between students' performance in entry examination and their mathematics performance at the CoE. Finally, it was discovered that there was no significant relationship between students' entry qualifications and their mathematics performance at the CoE. In conclusion, neither entry qualification nor entry examination performance could singly predict mathematics performance at the CoE.

Keywords: Predictive Validity; Predictor Scores; Criterion Scores; College Students' Performance; Future Relatedness

1. Introduction

Predictive validity refers to the extent to which a test could accurately forecast the extent to which a person would perform in a future related activity. It is an important sub-type of criterion-related validity, and it is the extent to which a test performance is related to some other measure of performance in the future. The concept of predictive validity was described by Faleye (2005) as a term used to describe the capacity of a measuring instrument to forecast future performance in a related task. Similarly, Afolabi (2012) described predictive validity as the degree of correlation between the scores on a test and some other measures that the test is designed to predict. A number of factors are found to potentially affect the predictive validity of test items. These include factors that are capable of affecting reliability, since reliability is an essential factor in ensuring validity (Badmus & Omoifo, 1998). These factors also include those relating to the test itself, that is, the nature of the items, their psychometric properties of discrimination and distracter abilities as well as the homogeneity of the items. Most educational and employment tests are used to predict future performance, so, predictive validity is regarded as essential in these fields.

Studies on predictive validity usually take the grades achieved after the first year of studies (criterion scores), and compare them with the secondary school performance (predictor score) in similar subjects. A high correlation indicates that the selection procedure worked perfectly, a low correlation signifies that there is something wrong with the approach. However, most studies usually show that there is a strong correlation between the two, and the predictive validity of the method is high, although not perfect. There is a weakness in the type of data being tested in predictive validity.

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If the example of those selected the into higher institutions are considered, this approach does not test the students who failed to attend university, due to low grades, personal preference or financial concerns. This leaves a hole in the data used for investigating predictive validity, and the procedure now demands that the investigator makes some assumptions. If, for instance, the students with the best result scores highest after their first year at university, and the students who just managed to get admitted get the lowest, researchers assume that someone not admitted at all would still have scored lower. This downwards extrapolation might be incorrect, but predictive validity has to incorporate such assumptions.

Despite this weakness, predictive validity is still regarded as an extremely powerful measure of statistical accuracy. In many fields of research, it is regarded as the most important measure of quality, and researchers constantly seek ways to maintain high predictive validity. Predictive validity comes to mind when mention is being made of the effectiveness with which an examination could forecast students' or candidates' future performance in related tasks. When candidates are selected into the higher institution on the basis of their scores in the Unified Tertiary Matriculation Examination (UTME) results, the underlining assumption in such selection is that meeting the admission criterion by those admitted suggests that they will be successful in the subsequent academic activities attached to their studies.

Predictive validity, within this context, demands that for any test of performance to be used as index of later performance in a school, it must be fully established that the test scores are capable of forecasting the degree of success in their studies. In other words, for the test scores to be used as predictors of future academic performance there must be a significant relationship between such scores and later performance. It should be noted that when an achievement test is set on a particular subject, emphasis is usually placed on content validity. It is therefore important to note that predictive validity is not necessarily a component of content validity, and vice versa, because a test performance may be very effective in sampling current performance, but fail in predicting future performance.

The challenges associated with measuring academic achievement crop up when future academic achievement is to be predicted from past achievement as represented by present achievement. In predicting academic achievement, the criterion measure and the predictor scores must be identified. According to previous research, one of the most important predictors of post-secondary educational attainment is high school academic performance (Anastasi, 1988; Daugherty & Lane, 1999). Academic performance can be measured through various indicators. The most widely used indicator is standardized test score, deemed an appropriate measure of academic ability because it measures differences in terms of cognitive skills and abilities. Several other components could also be brought into the procedures leading to the determination of the forecast ability of achievement test outcomes.

A number of associations have been discovered to have existed between some achievement tests, especially, public examinations and candidates' performance in the future. Richter (2003) found the Abitur to be a valid measure of overall educational achievement and a good predictor of future academic performance. Some non-cognitive factors are capable of affecting the forecast ability of an achievement test measure (Faleye, 2005). These personality factors (such as age, sex and teaching experience) have been discovered to have impaired the performance of students. Jacobs, Lanza, Osgood, Eccles and Wingfield (2002) found out from their research that young women achieved at comparable or higher levels in mathematics as males, but their interest especially from the high achieving females, are the same or lower than males. They also maintained that for young men in higher-level mathematics, mathematics interest is much more strongly related to mathematics school grades than for young women in the mathematics courses or mathematics-related courses.

They further submitted that in order to encourage more women into mathematics, science and information technology fields, interventions need to be designed, focusing not on the academic achievement of women but on how to make mathematics and science related occupation more interesting for young women. This type of intervention, according to Jacobs et. al., should start early in the academic careers of these adolescents and young women, because of their lack of interest in mathematics being earlier than the junior high school years and never improved. Deberard, Spielmans and Julka, (2004) also submitted that the female students are as endowed as their male counterparts when they conducted a longitudinal study of the prediction of academic achievement and retention among college freshmen. They submitted that female students were found to have sought help and counselling and thus they were able to use the help they receive in removing the gap that could have existed between them and their male colleagues.

A minimum amount of standard is required before a student could be admitted to secondary (or any other) school. This minimum entry requirement varies from one school to the other and also from one level of schooling to the other. The importance of academic qualification could not be exhaustively discussed due to the purpose it serves apart from its selection function. Achor, Aligba and Omananyi (2010) investigated the predictive strength of two selection examinations on the Senior School Certificate Examination (SSCE) results of pre-degree students of the Benue State University in Nigeria. They concluded that though students' SSCE results were successfully predicted by the Pre-degree examination and the University Matriculation Examination (UME) results in Physics, it was not the same for Mathematics. In the same vein at the higher institutions, Olaewe and Abioye (2014) were of the view that the UTME was a good predictor of university students' performance in final degree examinations. Similarly, Tewari (2014) investigated the predictive validity of Matric Math examination for first year degree performance in Math in South Africa. He concluded that the entrance examination was a good predictor of first year degree performance in Mathematics.

Abdullahi (1993) also carried out a research to determine the relationship between performance in Joint Matriculation Examination (JME) and performance during the first year examination in the University. Fifty science and 50 social science students who had been admitted to the University of Ilorin were selected for the study. Their JME and first year examination scores were compared and it was discovered that there was a significant and positive relationship between JME scores and first-year university examination scores in Physics, Chemistry and Economics. This means that students with high scores in JME also obtained high scores in university's undergraduate examinations. It was however found that JME and University examination did not show any significant correlation in Geography and Biology. The former findings were attributed to the quantitative nature of the subjects. Abdullahi (1993) then concluded that JME could only predict first-year university performance, but not in all disciplines in the University. Obioma and Salau (2007) also investigated the predictive validity of public examinations in Nigeria. They concluded that public examinations were not good predictors of students' performance in the higher institutions in the country. They thereafter stated that the conduct of additional entrance examinations in the higher institutions exemplified their finding.

College of Education is one of the tertiary institutions existing in Nigeria. College of Education is a teacher training institution where would-be teachers of the junior secondary schools are trained (Federal Republic of Nigeria, 2004). The college of education programme is a three-year programme by design except for situation whereby students have to undergo a year of preliminary study before being admitted to year one. This instance adds to the three year duration of the programme for those involved. Graduates of College of Education are awarded the Nigerian Certificate in Education (NCE) and they, in the employment world, are not at par with their university counterparts after employment. While university graduates are placed on Grade Level Eight on entry into public service, graduates of Colleges of Education (or NCE holders) are placed on Grade Level seven at entry. Those interested in obtaining first degrees are admitted for a three-year 'direct-entry' (i.e. without having to write any entrance/admission examination, such as the UTME) undergraduate programme. There are three Colleges of Education in Osun State, one of them is privately owned while the remaining two are owned by the state government. Similarly, there are three Colleges of Education in Oyo State, the Federal and state governments own one each while the third belongs to private individual..

1.1. *Purpose*

The major purpose of the present study therefore, is to investigate the relationship between the cognitive entry characteristics of college of education students and their performance at the end of their first year of study. The specific objectives were to

i.   determine the entry qualification that best predicts academic achievement in the College of Education;
ii.   investigate the relationship between students' performance in entry examination and mathematics performance of in the NCE programme; and
iii. investigate the relationship between entry qualification and mathematics performance at college of education.

In a bid to achieve the objectives stated above, one research question and two hypotheses were raised.

1.2. *Research Question*

i.   Which set of entry qualification best predicts academic achievement in the College of Education?

1.3. *Hypotheses*

i.   There is no significant relationship between students' performance in entry examination and their first year mathematics performance in the NCE programme.
ii.   There is no significant relationship between students' entry qualification and their mathematics performance at the NCE programme.

2. Methodology

This study adopts an ex-post-facto design. Kerlinger (1986) defines ex-post facto research as a systematic empirical inquiry in which the scientist does not have direct control of the independent variables because their manifestations have already occurred or because they are inherently not manipulatable. Inferences about relations among variables are made without direct intervention from concomitant variation of independent and dependent variables. In this study, the researcher does not have direct control on the dependent and independent variables, since their manifestations have already occurred. The academic performance of the students selected in the college of education examination was the dependent variable (or criterion scores) while the students' performance at the Monotechnic, Polytechnic and Colleges of Education Matriculation Examination, UTME (which has now been merged with the University Matriculation Examination (UME) by the Joint Admissions and Matriculations Board (JAMB) into the Unified Tertiary Matriculation Examination (UTME), and their performances at the Senior School Certificate Examination (SSCE) were the independent variables (or predictor variables).

The population of this study was made up of all Colleges of Education students in Osun and Oyo States of Nigeria. Sample (Mathematics students) was selected by purposive techniques from two Colleges of Education, one from Osun (Osun State College of Education - OSCE, Ilesha) and the other from Oyo state (Emmanuel Alayande College of Education - EACE, Oyo), all in the southwestern part of Nigeria. Students that have completed their course of study and had their final result GPA computed at the end of the programme were sampled for this research. The sample size amounted to 276, made up of 140 students from seven subject combinations for 2010 set of OSCE (Twenty students were purposively selected from the following subject combinations: Primary Education Study/Mathematics, Integrated Science/Mathematics, Physics/Mathematics, Chemistry/Mathematics, Computer/Mathematics, Economics/Mathematics and Geography/Mathematics) and another 136 students (made up of 20 students from each of the afore-mentioned subject combinations) for the 2010 set of EACE, Oyo, except for Chemistry/Mathematics where the candidates were not up to 20 for the year.

Data were collected from the academic record of the students from their respective schools and department. Such records included their entry grades in Senior School Certificate Examination (SSCE) in Mathematics – conducted by NECO or WAEC, their grades in the Teachers' Grade II certificate in mathematics. Teachers Grade Two Certificate (TCII) or their grades in the National Business and Technical Certificate (NBTC) grade in mathematics. Furthermore, their Mathematics Scores in the UTME were also obtained from their academic records in their respective departments. Other data collected for the study included the students' semesters examination grades in mathematics for 2010/2011, 2011/2012 and 2012/2013 academic sessions, their age and sex. These were used to determine their Cumulative Grade Point Average (CGPA) also obtained from their College Academic Offices. The criterion variables were scores in the mathematics courses offered by students in each of the six semesters of the college of education programme. The SSCE, TC II examination, NBTC examination and the UTME are all public examinations in Nigeria. The items of these examinations are written by experts and therefore, the scores obtained by students are assumed to be valid and reliable. Whereas the college semester examinations are teacher-made tests that are not universally accepted to be valid and reliable if the principles of testing is to be invoked (Afolabi, 2012), the assumption of reliability and validity will only be limited to the college.

This study sampled scores on mathematics in Senior School Certificate (SSC), National Business and Technical Certificate (NBTC) and TCII examination, all of which were obtained from the students' records. Students' scores in the examinations from the very first semester of their first year to the sixth semester (of their third year) in the school were also obtained. The true identities of the selected sample were not disclosed, instead, each candidate was given a serial number. Thus, all criterion variables for this study were obtained from the comprehensive academic records of the selected sample.

For the purpose of analysis, the entry qualifications SSC, NBTC, UTME Scores and the college semester results of the students were coded and the semester grades and the GPA of selected students were also coded as presented in Table 2.2. The College GPA rating scale was used to rate the UTME scores of the students. The grades collected for each of the examinations were subjected to appropriate statistical analysis to test the acceptance or rejection of the stated hypotheses. For the period under investigation, the number of Mathematics courses students offered varied. The mean score of students in the courses was computed and used as measures of academic performance, The main hypothesis for this study "There is no significant relationship between the cognitive entry characteristics (qualifying entry certificates, certificate worth, entrance examination, age and sex) and academic performance of mathematics students of OSCE and EACE students". Multiple regression analysis was used to test this hypothesis. Each criterion variable was considered separately as dependent variable and predictor variables were considered as independent variables. The overall accuracy of the prediction equation as reflected by the square of the multiple correlations (R^2) was examined. The correlation between the semesters scores of students in mathematics, MUTME scores and the college G.P.A. were calculated by using Pearson's product-moment correlation analysis.

3. Results

3.1. *Research Question 1:* Which set of entry qualification best predicts academic achievement in the Colleges of Education?

To answer this research question, two major approaches were adopted. Firstly an inter-correlation matrix of all the variables in the study (school, sex, age, marital status, students' mathematics score during the UTME examination, their total score in the UTME examination, the type of their entry qualification, their Mathematics credit scores in their entry qualification and their Cumulative Grade Point Average - CGPA) was conducted to find out the inter-relationships among the variables. The second approach involved the use of multiple regression to determine the extent to which each of the variables will predict the academic performance of the students in Mathematics measured by their CGPA in their respective Colleges of Education. From the result of the inter-correlation, only the students age bore a significant positive correlation with the CGPA obtained by the students at their Colleges of Education (r = 0.123, p = 0.034). Consequently, age was treated as the first variable in the second approach using multiple regression analysis to determine how best to combine the variable to predict student academic performance as measured by their CGPA. A stepwise multiple regression analysis was conducted by firstly combining age with different variables and by gradually introducing other variables into the regression models and evaluating each model as soon as a new variable is introduced. The results were as presented in Table 3.1.

From Table 3.1, the value of R was largest for a combination of students' age with their total scores in the UTME. The R-square (0.016) value was also highest for this model as well as the adjusted R-square value. Results also indicated from the same Table that only a combination of age with the students' total scores during the UTME examinations seem to produce a significant model that can be used to best predict the academic achievement of the students using their CGPA (t-value = 1.690 at p =0.043). It can then be concluded that although the UTME total alone could not significantly predict the students' academic achievement measured by their CGPA, when combined with age it became a significant contributor to prediction of students' academic achievement in the colleges. Furthermore, the possibility of introducing more variables such that more than two variables can predict the academic achievement of learners was also explored. Students' age and their total scores during UTME were entered into the regression model in the first step while others were gradually introduced using a stepwise Multiple Regression procedure. The results were as presented in Table 4. From Table 3.2, the R and R-square values were highest for model number 7 that incorporated all the variables but the Adjusted R-square value for this model was a negative value. Consequently this model cannot be adopted, in fact, any model that has a negative adjusted R-square value cannot be adopted as one that could best predict academic achievement measured by the students' CGPA.

Also, the adjusted R-square value was highest for the first model which has only age as the predicting variable, the R-square value which actually gives the percentage of the observed variance that can be explained by the model is the lowest, therefore model 3 or 4 would have been most appropriate but the Adjusted R-square value was higher in model 3 than that of model 4. Hence we adopt model 4 and we can conclude that age and students' total score during the UTME examinations are the best predictors of academic performance of the students' measure by their CGPA.

3.2. Hypothesis 1: There is no significant relationship between students' performance in entry examination and their first year mathematics performance in the NCE programme.

To test this hypothesis, the students CGPA scores were categorized into five groups: GPA of 0-1, GPA of 1.01 to 2.00, GPA of 2.01 to 3, GPA of 3.01 to 4 and GPA of 4.01 to 5. Also, their UTME scores were categorized into four groups of scores of 0 to 130, 131 to 150, 151 to 170 and 171 to 190. A cross tabulation and chi-square test was conducted between the two variables – GPA scores and total scores in UTME. The results were as presented in Table 5. From Table 3.3, it can be seen that the chi-square value obtained in the relationship between academic performance of the students as denoted by the CGPA and their UTME scores was 15.593 at p = 0.211. Since the p-value surpasses the 0.05 threshold, the null hypothesis cannot be rejected. The hypothesis is therefore accepted and it can be concluded that there is no significant relationship between students' total scores at the UTME and their academic achievement measured by their CGPA.

3.3. Hypothesis 2: There is no significant relationship between students' entry qualification and their mathematics performance at the NCE programme

To test this hypothesis, the students CGPA scores were categorized into five groups: GPA of 0-1, GPA of 1.01 to 2.00, GPA of 2.01 to 3.00, GPA of 3.01 to 4.00 and GPA of 4.01 to 5. A cross tabulation was conducted between the students CGPA groupings and the three variants of their entry qualifications (WAEC's SSCE, NECO's SSCE and a combination of both). The results are as presented in Table 6

From Table 3.4, the chi-square value obtained from the investigation of the relationship between Academic achievement of the students measured by the CGPA and their qualifying entry certificate is 5.965 (p = 0.651). Since the p- value surpasses the 0.05 threshold, the null hypothesis cannot be rejected. The hypothesis is therefore accepted and it can be concluded that there is no significant relationship between students' entry qualifications and their academic performance measured by their CGPA.

4. Discussion

The findings of this study revealed that students' UTME score and level of maturity in terms of age are best predictor of college students' performance in Mathematics. It was also found out that the UTME did not significantly predict College of Education students' performance in Mathematics, ditto for entry qualifications alone. These results were in agreement with the submission of Faleye (2005) when he investigated the influence of cognitive test anxiety on students' performance; he stated that there are other non-cognitive factors (like age, sex and teaching experience of teachers) that are capable of affecting students' performance. In the same vein, Jacobs, Lanza, Osgood, Eccles and Wingfield (2002) investigated changes in the self-competence and value of grade one to twelve students. They submitted that young women achieved at comparable or higher levels in mathematics as males, but their interest (especially from the high achieving females) are lower than that of males. Obioma and Salau (2007) also stated that the public examinations were not good predictors of students' performance in the higher institutions. However, the nature of the findings in this study does not foreclose the fact that there are a number of studies whose results were at variance to the foregoing. For example, Olaewe and Abioye (2014) while investigating the predictive validity of the UTME submitted that the examination was a good predictor of students' performance in final degree examinations. Also, Tewari (2014) investigated the predictive validity of matric Math examination in South Africa and concluded that the examination was a good predictor of Mathematics performance at first year level of degree examinations.

5. Conclusion

It is obvious so far that entry qualification alone or entrance examination alone could not significantly predict students' performance in the college of education. Thus, a third variable, age, needed to be introduced before students' performance could be accurately predicted at the college of education. The implication of this is that maturity level of students will no doubt influence their ability to do well or otherwise at the college of education. This is not surprising at all because the freedom which students in the college of education (or better still higher institutions) enjoy was not available in the secondary school. Thus, a student who is not mature may misuse the freedom and then lose track of the need to study seriously. Not only that, many activities abound (in the college of education) and they arise from student associations and social activities. These may constitute distraction to fresh students who are just experiencing them. Therefore, students need to manage all of them well so that they don't impact negatively on their academic performance. Thus, it is recommended that the criteria for admitting students into Mathematics programme of Colleges of Education should consider candidates' age as a criterion.

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List of Tables

Table 2.1: SSC and NBTC Stanine Scores and their Weights

Stanine Grade	AI	A2/B2	A3/B3	C4	C5	C6	P7/D7	P8/D8	F9
Weights	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00

Table 2.2: The College Grade Point Average (GPA) rating Scale.

Raw scores	75-100	70-74	65-69	60-64	55-59	50-54	45-49	40-44	0-39
Grade	A	AB	B	BC	C	CD	D	E	F
Weights	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00

Table 3.1: Evaluation of Successive Stepwise Multiple Regression Model in Predicting Students' Academic Performance

Model	R	R^2	Adjusted R^2	Std. Error of Estimate	Unstandar-dized Coeffici-ents,	Standar-dized Coeffici-ents, Beta	t	Sig
Age Sex	0.118	0.014	0.005	0.80180	0.054 -0.041	0.119 -0.025	1.81	0.072
Age Marital	0.116	0.013	0.005	0.80198	0.055 -0.038	0.121 -0.015	1.703	0.090
Age UTMEE	0.116	0.013	0.005	0.80201	0.053 -0.001	0.117 -0.011	1.778	0.077
Age UTME	0.126	0.016	0.007	0.80099	0.050 0.004	0.110 0.051	1.690	0.043
Age Entry Qual	0.123	0.015	0.007	0.80130	0.058 -0.047	0.129 -0.045	1.892	0.060
Age Entry Math	0.117	0.014	0.005	0.80189	0.054 -0.013	0.118 -0.021	1.800	0.073

Table 3.3: Test of relationship between students' UTME scores and Mathematics   Performance of students in the NCE programme

UTME Scores	GPA					Total	χ^2	p
	0 - 1	1.01 – 2.00	2.01 – 3.00	3.01 – 4.00	4.01 – 5			
130 or less	0	4	3	7	0	14	15.593	0.211
131 to 150	3	19	44	41	2	109		
151 to 170	5	10	47	46	2	110		
171 and above	1	0	1	1	0	3		
Total	9	33	95	95	4	236		

* $p>0.05$: Result not significant

Table 3.4: Test of relationship between qualifying entry certificate and academic performance of mathematics students of College of Education.

SSCE	GPA					Total	χ^2	P
	0 - 1	1.01 – 2.00	2.01 – 3.00	3.01 – 4.00	4.01 - 5			
WAEC	1	9	16	20	0	46	5.965	0.651
NECO	1	10	29	28	1	69		
WAEC and NECO Combined	7	14	50	47	3	121		
Total	9	33	95	95	4	236		

* p>0.05: Result not significant

Table 3.2: Stepwise Multiple regression predicting students' academic achievement from more than one variable

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.115(3)	0.013	0.009	0.80034
2	0.126(b)	0.016	0.007	0.80099
3	0.133(0)	0.018	0.005	0.80196
4	0.135(d)	0.018	0.001	0.80346
5	0.136(e)	0.019	-0.003	0.80514
6	0.136(0	0.019	-0.007	0.80685
7	0.145(g)	0.021	-0.009	0.80768

1 Predictors: (Constant), Age
2 Predictors: (Constant), Age, UTME
3 Predictors: (Constant), Age, UTME, EntQualTyp
4 Predictors: (Constant), Age, UTME EntQualTyp, sex
5 Predictors: (Constant), Age, UTME, EntQualTyp, sex, EntryMath
6 Predictors; (Constant), Age, UTME, EntQualTyp, sex, EntryMath, Marstat
7 Predictors: (Constant), Age, UTME, EntQualTyp, sex, EntryMath, Marstat, UTMEmath.