

**PREDICTIVE VALIDITY OF STUDENTS' COGNITIVE ENTRY
CHARACTERISTICS FOR MATHEMATICS PERFORMANCE IN SELECTED
COLLEGES OF EDUCATION IN ONDO AND EKITI STATES OF NIGERIA**

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Abstract

This study determined the entry qualification that best predicts academic achievement in the College of Education; it also investigated the relationship between students' performance in entry examination and students' mathematics performance in college of education. The study also investigated the relationship between entry qualification, entry examination performance and mathematics performance at college of education. This was with a view to determining the predictive validity of the entry characteristics of college of education students for mathematics performance at the college of education in Southwestern Nigeria.

The study population comprised College of Education students in South-western Nigeria. A sample of 276 College of Education students was purposively selected for the study. Data were collected from students' records of the two selected Colleges of Education. Collected data included students' entry qualification, their age, sex and semester results in Mathematics for 2005/2006 session to 2007/2008 session. Data were analysed using multiple regression and Chi-square.

Result showed that the Monotechnics, Polytechnics and Colleges of Education Matriculation was the best predictor (though not significantly) of College performance out of all the entry qualifications. Result also indicated that there is no significant relationship between students' performance in entry examination and their mathematics performance at the College of Education. Finally, it was also discovered that there was no significant relationship between students' entry qualifications and their mathematics performance at the College of Education.

It was concluded that neither entry qualification nor entry examination performance could singly predict mathematics performance significantly at the college of education.

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 tool used to describe the capacity of a measuring instrument to forecast future performance in a related task. 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, and compare them with the secondary school performance 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. If the example of those selected 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 score highest after their first year at university, and the students who just managed to get admitted get the lowest, researchers assume that 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 a 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 Winfield (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, is 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 improve. 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. Achor¹, 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.

Abdullahi (1993) also carried out a research to determine the relationship between performance in 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.

The college of education is one of the tertiary institutions existing in Nigeria. The college of education is a teacher training institution where teachers of the junior secondary schools are trained. 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 the 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 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.

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 students in the NCE programme; and
- iii. find out the relationship between entry qualification and mathematics performance at college of education.
- iv.

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

The *research question* states that:

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

The *hypotheses* raised were:

- 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.

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 while the students' performance at the Monotechnic, Polytechnic and Colleges of Education Matriculation Examination, MPCEME (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.

The population of this study was made up of all Colleges of Education students in Nigeria. Sample (mathematics students) was selected by purposive techniques from two Colleges of Education: one from Ondo (Adeyemi College of Education, ACE) and the other from Ekiti State (Ekiti State College of Education, Ikere-Ekiti), all in the southwestern part of Nigeria. Students that have completed their course of study and 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 the 2005 set

of ACE (Twenty students were purposively selected from the following subject combinations: Primary Education Study (PES)/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 2005 set of COE Ikere-Ekiti, except for Chemistry/Mathematics where only 16 candidates were admitted for the year). However, to give meaning to the statistical deductions from the study, only subject combinations offered by at least five students in the mathematics department were sampled.

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 MPCEME 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 2005/2006, 2006/2007 and 2007/2008 academic sessions, their age and sex. These were used to predict 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 MPCEME 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 are to be invoked, the assumption of reliability and validity will only be limited to the college.

The scores and other information about the study sample were obtained from the Academic Affairs Division, Mathematics and Computer Science Department of ACE Ondo and COE, Ikere Ekiti. The research sample scores on mathematics in Senior School Certificate (SSC), National Business and Technical Certificate (NBTC) and TCII examination 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 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, MPCEME Scores and the college semester results of the students were coded as follows:

Table 1: SSC and NBTC Stanine Scores and their Weights

Stanine									
Grade	A1	A2/B2	A3/B3	C4	C5	C6	P7/D	P8/D8	F9
Weights	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50	0.00

In the same vein, the semester grades and the GPA of selected students were also coded as presented in Table 2.

Table 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

The college GPA rating scale was used to rate the MPCEME 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 was "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 Adeyemi College of Education". 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, MMPCEME scores and the college G.P.A. were calculated by using Pearson's product-moment correlation analysis.

Results

The results are presented in the order of the research question.

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 MPCEME examination, their total score in the MPCEME 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 students' 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 4.2.

Table 3: Evaluation of Successive Stepwise Multiple Regression Model in Predicting Students' Academic Performance

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

From Table 3 above, the value of R was largest for a combination of students' age with their total scores in the MPCEME. 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 MPCEME examinations seems 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 MPCEME 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 MPCEME 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 below.

Table 4: Stepwise Multiple Regression Predicting Students' Academic Achievement from more than One Variable

Model	R	R Square	Adjusted R	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, MPCEME
- 3 Predictors: (Constant), Age, MPCEME, EntQualTyp
- 4 Predictors: (Constant), Age, MPCEME EntQualTyp, sex
- 5 Predictors: (Constant), Age, MPCEME, EntQualTyp, sex, EntryMath
- 6 Predictors; (Constant), Age, MPCEME, EntQualTyp, sex, EntryMath, Marstat
- 7 Predictors: (Constant), Age, MPCEME, EntQualTyp, sex, EntryMath, Marstat, MPCEMEmath.

From Table 4.3, 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 MPCEME examinations are the best predictors of academic performance of the students' measure by their CGPA.

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 200, GPA of 2.01 to 3, GPA of 3.01 to 4 and GPA of 4.01 to 5. Also their MPCEME scores were also 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 MPCEME. The results were as presented in Table 5.

Table 5: Test of Relationship between Students' MPCEME scores and Mathematics Performance of Students in the NCE Programme

MPCEME 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

From Table 5, 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 MPCEMEE scores is 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 MPCEMEE and their academic achievement measured by their CGPA.

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

Table 6: 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

From Table 6, 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 at $p = 0.651$. 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 (certificates) and their academic achievement measured by their CGPA.

Conclusion

It is obvious so far that entry qualification alone or entrance examination alone could not predict students' performance in the college of education. Thus, a third variable, age, needs 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 distractions because new students are just experiencing them. Therefore, students need to manage all of them well so that they don't impact negatively on their academic performance.

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