Cognitive Entry Characteristics and Semester Examination Scores as Correlates of College Students’ Achievement in Mathematics

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ABSTRACT

Aims: This study was designed (i) to investigate the relationship between cognitive entry characteristics (CEC), semester examination scores and student’s achievement in mathematics and (ii) to find out the predictive strength of CEC and semester examination scores on college students’ achievement in mathematics.

Study Design: The study employed ex-post facto design.

Place and Duration of Study: College of Education, Ikere-Ekiti, Ekiti State, Nigeria between October 2012 and January 2013.

Methodology: The sample, 415 full-time students admitted into a three-year National Certificate in Education (NCE) programme in 2007/2008 and 2008/2009 academic sessions were selected using purposive sampling technique. An inventory, “entry characteristics and academic achievement proforma” was used in collecting all the relevant data for the study. The data collected were subjected to statistical analysis using correlation and multiple regression analysis.

Results: The results of the study revealed that there is a positive and significant correlation between the criterion variable (Cumulative Grade Point Average CGPA), CEC (Senior

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School Certificate Examination SSCE, Unified Tertiary Matriculation Examination UTME) and semester examination scores. There is a low correlation coefficient of 0.095 and 0.158 between CGPA and UTME as well as CGPA and SSCE respectively. Results also revealed that SSCE, UTME and semester examination results jointly contributed 64.3% to the prediction of college students CGPA. However, semester examination scores show a higher predictive strength than cognitive entry characteristics.

**Conclusion:** Based on the findings of the study, there is the need to encourage teachers to regularly test their students’ ability since the use of formative tests (or semester examinations) for diagnostic purposes seems to result in better cognitive achievement than when given as summative test or examination.

**Keywords:** Cognitive entry characteristics; semester examination scores; college students; achievement; mathematics.

**1. INTRODUCTION**

Achievement is central to our existence. [1] opined that the ultimate goal of any human being is to achieve the objective of any project he sets for himself. [2] sees academic achievement as a scholastic standing of a student at a given moment. That is, the ability of an individual to demonstrate his or her intellectual abilities. According to [3] there is an alterable variable called Cognitive Entry Characteristics (CEC) which he believes accounts for 50% of the variations in learning outcome while [4] also asserted that most of the variations in school learning is directly determined by CEC. [3] also went further to define CEC as the specific knowledge, abilities, or skills which are essential pre-requisites for the learning of a particular school subject or a particular learning task. These prerequisites according to [3] correlate significantly (+0.70) or higher with measures of achievement in a subject and when these prerequisites are identified and measured, they replaced intelligence or aptitude in the prediction of future achievement.

A successful completion of Senior School Certificate Examination (SSCE) with good grades in five subjects including English Language and Mathematics coupled with good pass mark Unified Tertiary Matriculation Examination (UTME) normally qualify a candidate for admission into any Nigerian tertiary institutions (Colleges of Education or Technology, Polytechnics and Universities). The grades and scores obtained by the candidates that are given admission into the tertiary institutions are expected to be a measure of their cognitive or academic achievement that each candidate will exhibit in their chosen discipline in the tertiary institutions. In other words, a high performance in SSCE and UTME as a measure of the candidates' previous background knowledge in the subject matter ought to serve as a pre-requisite to the intended course of study by a candidate at the tertiary level.

[5] opined that general background knowledge in the same subject matter will facilitate learning of new materials in a similar future learning task, but examination may not always consistently measure present achievement or predict future achievement since achievement is not static but changes as attitude and interest change with time and new abilities or ideas. While, [6] submitted that the acquisition of high entry point does not necessarily imply high academic performance except that past experiences may likely influence one’s level of performance in future learning task. However, research studies have shown that CEC have a causal effect on further cognitive achievement [3] while the enhancement of CEC leads to high levels of cognitive achievement [4]. The import of these findings is that, if all learners come into a learning situation with adequate levels of CEC, a good number of them if not all
would attain a high degree of learning. This can be demonstrated in a learning situation by teaching and facilitating topics which provide learners with basic skills, knowledge and find out how well they have mastered the learning task before proceeding to a new learning task in comparison with those who did not possess similar CEC [3].

The academic achievement of students in our Colleges of Education, Polytechnics, Colleges of Technology or higher institutions in general is influenced by a number of factors. [7] classified these factors into two namely: (i) Extrinsic factors, which includes those factors that affect the students learning, but are not within his environment such as home background, school environment, birth order, cultural, political and economic environment as well as teacher’s influence and (ii) Intrinsic factors which includes total student input into study and the students’ characteristics such as intelligence. [8] had earlier reported that the academic performance of students in school depends on factors such as the quality of environment. This quality is characterized as goods and time input. Goods input refer to nutritious food, healthcare and materials that stimulate intellectual interests while time input include parental time, reading and talking to children.

There is also the problem of how and what parameters to be use in measuring the scholastic ability of students. The award of marks by teachers and grade patterns are often been used to represent students’ academic achievement standing, but the reliability of such marks is questionable. Letter grades are based on opinion and hence unreliable. [9] argued that marks and grades only measure on approximation that is a far cry from the true academic performance. [10] stated that one of the major problems associated with the use of grades for assessment of academic performance is the possibility of bias on the part of the teacher since a grade is a function of interactions between a student and his teacher. Inadequate education in valid assessment and grading principles and practices is a reason many teachers continue to perpetuate invalid grading practices with students.

Grading systems used by teachers vary widely and unpredictably and often have low levels of validity due to the inclusion of non-academic criteria used in the computation of grades [11,12,13]. [14] reported that teachers have been found to make decisions about grades related to student effort in attempts to be fair in their grading practices. Research studies have equally shown that two out of every three teachers believe that effort, student conduct and attitude should be taken into consideration in students’ final grades [15]. [16] reported that grades are used as desirable classroom management behaviors while [17] also reported that grades are used as a motivational tool as well as a means of developing good study habits.

In the use of grade point average [GPA], errors and variations sometimes occur when grades from different departments or sources are being combined to obtain the aggregate scores. However, these errors or variations can be reduced according to [18] when uniform tests are used in measuring academic performance. He further contended that uniform tests would remove the initial knowledge of the social interaction between students and teachers, which is indicated to some extent by marks assigned by the teachers. Although grades and marks are loaded with various problems, they are the most acceptable and widely used measure of scholastic ability. [1] stated that the problems associated with measuring academic performance also crop up when future academic performance is to be predicted from past achievement as represented by the present performance.

Important decisions are often made based on students’ grade; hence invalid grades may result in dire consequences for the student. Grades can open up or close down important
learning opportunities for students [19]. Students with high grades get admitted to colleges and universities of their choice and possibly receive scholarships or bursary awards, since grades are one of the major selection criterions in colleges and universities admission process. Similarly, students with low grades may find it very difficult to get admitted to some colleges and universities. Invalid grades that understate the student’s knowledge may prevent a student with ability to pursue certain educational or career opportunities.

Several research studies have examined the relationship between attainment of academic success and cognitive/non-cognitive variables respectively. [20] reported that a high positive correlation existed between the performance of students in Mock and West African School Certificate (WASC) examinations while [21] reported a significant relationship between students’ achievement in mock Mathematics and Junior School Certificate Mathematics. [5] reported that University Matriculation Examination (UME) is not a potent predictor of university academic performance in terms of grade point average. Similarly, [22] also reported that there is no association between UME and academic performance of university undergraduates. He went further to report a high relationship between UME and SSCE. [22,23,24] all reported that Senior School Certificate Examination (SSCE) is a potent predictor of undergraduate academic achievement since it exerted a direct and significant positive influence on undergraduate GPA which seems to reveal its stability in establishing predictive validity over time than the UTME.

WAEC further reported that SSCE in its present state has fair predictive power. [25] had earlier claimed in their study that Joint Matriculation Examination (JME) scores correlated significantly and positively with first year undergraduate performance. [26,27,28] all reported positive correlations between Business Studies and Engineering Technology students’ scores in WASC, Semester scores, CGPA and GPA. He also reported a significant contribution of first year GPA to CEC and formative evaluation. [29] also reported a positive and significant relationship between the criterion variable (CGPA) and CEC (SSCE, ND and NCE). He also reported a low correlation coefficient between CGPA and UME while a moderate correlation coefficient was also reported between CGPA and NCE as well as between CGPA and ND results.

The regular semester examination or testing of students’ ability as demanded by the Nigerian system of educational goes a long way in discovering the performance of students and could be used to improve learning. The tests given periodically, as formative tests or semester examinations, are supposed to remove the threatening effects of a single test (summative test) generally given at the end of a course of study. [30,31] opined that feedback from tests motivates students intrinsically in the sense that a student who is adequately informed of his successful performance on test would begin to develop interest in that course and explore means by which he will continue to do well in subsequent tasks. He further reported that students exposed to formative testing with remediation achieved higher than students exposed to formative testing with feedback or instruction without formative testing in mathematics. Similarly, [1] also reported that certificate worth and entrance examination results were not related to academic performance but formative test scores were the most effective measure of academic performance.

Mathematics holds a valued place in the academic curriculum; it is prominent on high-stakes measures of achievement generally used for level placement, for entrance into special programmes, and for college and universities admissions; and it has been called a “critical filter” for students in pursuit of scientific and technical careers at the college, polytechnic and university levels [23]. Hence, this study is designed (i) to investigate the relationship between
cognitive entry characteristics, semester examination scores and college students’ achievement in mathematics and (ii) to find out the predictive strength of cognitive entry characteristics and semester examination scores on college students’ achievement in mathematics.

1.1 Research Hypotheses

The following research hypotheses were formulated and tested for validity or otherwise at 0.05 level of significance:

1. There is no significant relationship between previous knowledge (WASC, UTME scores), semester examination scores and college students final CGPA in mathematics.

2. There is no significant contribution from previous knowledge (WASC, UTME scores), semester examination scores to the college students final CGPA in mathematics.

2. MATERIALS AND METHODS

The study employed ex-post facto research design. The sample for the study consisted of 415 full-time students admitted into a three-year National Certificate in Education (NCE) programme in the School of Sciences and School of Arts and Social Sciences, College of Education, Ikere-Ekiti with mathematics as one of their teaching subjects (either as major or minor teaching subject) in 2007/2008 and 2008/2009 academic sessions. Purposive sampling technique was used in selecting participants from the following subject combinations: Mathematics/Social Studies; Mathematics/Political Science; Physics/Mathematics; Computer Science/Mathematics; Economics/Mathematics; Geography/Mathematics; Integrated Science/Mathematics and Chemistry/Mathematics who participated in the study. The data for the study were scores obtained by students from the following examinations using Cognitive Entry Characteristics and Academic Achievement Proforma:

1. SSCE, National Examination Council (NECO) and National Business and Technical Examination Board (NABTEB) grades in Mathematics.
2. UTME scores in Mathematics,
3. Semester Examination grades in MAT 111, MAT 112, MAT 114, MAT 121, MAT 221 and MAT 313 for students offering mathematics as major or minor teaching subjects.
4. The third year NCE cumulative grade point average for 2009/2010 and 2010/2011 academic sessions.

The SSCE/NECO/NABTEB and UTME achievement tests were assumed to be valid and reliable since they are standardized achievement tests and the semester teacher-made achievement tests were equally moderated internally and externally by specialists in that field. Pearson product-moment correlation analysis and multiple regression analysis were used to test the validity of the hypotheses generated at 0.05 level of significance. For the purpose of statistical analysis the school certificate (SSCE/NECO/NABTEB), UTME scores and the college results of the students were coded as shown in Tables 1 and 2.
Table 1. The WASC stanine scores and their weights

| Stanine scores | A1 | B2 | B3 | C4 | C5 | C6 | D7 | D8 | F9 |
|----------------|----|----|----|----|----|----|----|----|----|
| Weights        | 4.00 | 3.50 | 3.00 | 2.50 | 2.00 | 1.50 | 1.00 | 0.50 | 0.00 |

Table 2. The college grade point average [GPA] rating

| Raw scores | 70 – 100 | 60 – 69 | 50 – 59 | 45 – 49 | 40 – 44 | 0 – 39 |
|------------|----------|----------|----------|----------|----------|--------|
| Stanine score | A | B | C | D | E | F |
| Weights        | 5.00 | 4.00 | 3.00 | 2.00 | 1.00 | 0.00 |

3. RESULTS AND DISCUSSION

In determining the relationship between cognitive entry characteristics (SSCE, UTME scores), semester examination scores and college students’ achievement score (CGPA) in mathematics, the Pearson’s correlation analysis was computed.

A cursory look at Table 3 reveals the correlation coefficient matrix for the nine variables. It indicated that there is a positive and significant relationship between the criterion variable (CGPA) and CEC (SSCE, UTME) as well as semester examination results at 0.05 level of significance. It is also observed from the correlation coefficient matrix that semester examination results (MAT 313 (.565); MAT 114 (.472); MAT 112 (.458); MAT 221 (.411); MAT 111 (.382); MAT 121 (.342)) correlated more with the criterion variable (CGPA) than the other independent variables (SSCE (.158) and UTME (.095)) in this study.

However, the correlation coefficients UTME and CGPA (.0952) as well as SSCE and CGPA (.158) are positive but very low. The correlation coefficients observed in Table 3 ranged between 0.095 and 0.565. The least correlation coefficient was between CGPA and UTME while the highest correlation coefficient was between CGPA and semester examination results (MAT 313).

Hypothesis two was aimed at determining the total contribution of SSCE, UTME and semester examination results taken together on students final CGPA. Table 4 shows that SSCE, UTME and semester examination results jointly contributed 0.643 (64.3%) to the prediction of college students CGPA. They jointly accounted for 41.3% of the total variance \((R^2 = 0.413)\) in college students CGPA. That is, the fitted model explains only 41.3% of the total variation in college students final CGPA living 58.7% unexplained. This implies that there other variables or major factors, which also contributed to the variations in college students’ achievement in mathematics than these predictor variables.
Table 3. Intercorrelational matrix of the cognitive entry characteristics (CEC) and CGPA

| Variable | SSCE  | UTME  | MAT111 | MAT112 | MAT114 | MAT121 | MAT221 | MAT313 | CGPA |
|----------|-------|-------|--------|--------|--------|--------|--------|--------|------|
| SSCE     | 1.000 |       |        |        |        |        |        |        |      |
| UTME     | 0.071 | 1.000 |        |        |        |        |        |        |      |
| MAT 111  | 0.134 | 0.426*| 1.000  |        |        |        |        |        |      |
| MAT 112  | 0.183 | 0.325*| 0.368* | 1.000  |        |        |        |        |      |
| MAT 114  | 0.107 | -0.075| 0.239* | 0.332* | 1.000  |        |        |        |      |
| MAT 121  | 0.453*| 0.061 | 0.236* | 0.294* | 0.304* | 1.000  |        |        |      |
| MAT 221  | -0.200| 0.091 | 0.210* | 0.415* | 0.302* | 0.512* | 1.000  |        |      |
| MAT 313  | -0.111| -0.024| 0.301* | 0.310* | 0.298* | 0.419* | 0.399* | 1.000  |      |
| CGPA     | 0.158 | 0.095 | 0.382* | 0.458* | 0.472* | 0.342* | 0.411* | 0.565* | 1.000|

*p ≤ 0.05
Table 4. Regression of cognitive entry characteristics, semester results on CGPA

Summary of regression analysis

| Multiple R | R Square | Adjusted R Square | Standard Error of Estimate |
|------------|----------|-------------------|---------------------------|
| 0.643      | 0.413    | 0.379             | 0.234                     |

Analysis of variance (ANOVA)

| Source       | Sum of Squares | Df | Mean Square | F cal. | F tab. |
|--------------|----------------|----|-------------|--------|--------|
| Regression   | 1.362          | 8  | 0.1703      | 14.428 | 3.71   |
| Residual     | 4.771          | 406| 0.0118      |        |        |

Table 4 also reveals that the F (8, 406) = 14.428, is significant since F cal. > F tab. Consequently, the null hypothesis was rejected and we conclude that SSCE, UTME and semester examination results actually contributed to college students’ achievement in mathematics. Table 5 shows the relative contribution of individual variables to the prediction of college students final CGPA.

Table 5. Relative contribution of cognitive entry characteristics, semester results on CGPA

| Variables | B      | Standard error | Beta | T    | Significant |
|-----------|--------|----------------|------|------|-------------|
| SSCE      | -0.072 | 0.036          | -0.031 | -0.165 | -.680       |
| UTME      | -0.083 | 0.041          | -0.024 | -0.102 | -.712       |
| MAT111    | 0.201  | 0.061          | 0.514 | 5.427 | .000        |
| MAT112    | 0.174  | 0.043          | 0.392 | 3.441 | .001        |
| MAT114    | 0.054  | 0.052          | -0.153 | 4.762 | .000        |
| MAT121    | 0.092  | 0.042          | 0.122 | -0.071 | .914        |
| MAT221    | 0.085  | 0.044          | 0.193 | -2.772 | .088        |
| MAT313    | 0.078  | 0.038          | -0.141 | -2.640 | .068        |
| CGPA      | 2.821  | 0.162          | 12.707 | .000     |

The regression equation of the variables is: CGPA = 2.821 + .201(MAT 111) + .174(MAT 112) + .092(MAT 121) + .085(MAT 221) + .078(MAT 313) + .054(MAT 114) – .072(SSCE) – .083(UTME).

The regression equation indicates that semester examination results (MAT 111, MAT 112, MAT 121, MAT 221, MAT 313 and MAT 114) have the highest predictive strength of all the predictor variables followed by SSCE and UTME. Table 5 also shows that the value of Beta (0.514) associated with MAT 111 was larger than any other value of Beta in that column. Similarly, its t-statistic of 5.427 was the largest. This further shows that the contribution of MAT 111 (20.1%) was the largest, followed by MAT 112 (17.4%). UMTE was the worst predictor with the predictive strength of (-8.3%) and it had a negative contribution to college students’ academic achievement in mathematics. Similarly, MAT 114, MAT 121, MAT 221, MAT 313 and SSCE had predictive strength of 5.4%, 9.2%, 8.5%, 7.8% and -7.2% respectively on college students’ final CGPA. Table 5 also revealed that the predictive weights or indices of MAT 111, MAT 112, MAT 114, MAT 121, MAT 221, MAT 313, UTME and SSCE are 51.4%, 39.2%, -15.3%, 12.2%, 19.3%, -14.1%, -2.4% and -3.1% respectively. Therefore, the null hypothesis which stated that there is no significant contribution from cognitive entry characteristics (SSCE, UTME scores), semester examination scores to the
final cumulative grade point average (CGPA) of college students in mathematics was not accepted.

3.1 Discussion of Results

The findings of this study revealed that positive and significant relationships existed between the cognitive entry characteristics (SSCE, UTME), semester examination results and the final CGPA of college students in mathematics. However, a very low and positive correlation coefficient existed between CGPA and UTME as well as CGPA and SSCE respectively. The moderate correlation coefficients that existed between CGPA and semester examination results is expected since according to [30,31] the regular testing of students’ ability helps in discovering the performance of students and could also be used to improve learning. He opined further that tests given periodically, as continuous assessment tests, the frequency of the period of reporting on teacher-learner achievements, effecting immediate feedback of results into the teaching-learning situation and the emphasis that the results of these in-course assessments be combined with those of terminal assessments in deciding the final output of the individual learner tend to remove the threatening effects of a single test (summative test) generally given at the end of a course of study. This result also corroborates the findings of [26,27,28,32] that formative evaluation (continuous assessment) and semester grades made significant contributions to the prediction of academic achievement among Environmental studies, Business studies and Engineering technology students. The result is also in line with [1] that certificate worth and entrance examination results were not related to academic performance but formative test scores were the most effective measure of academic performance. The findings of [5,29] also supported this result. The findings of this study also revealed that 41.3% of the variability in college students’ academic achievement in mathematics is accounted for by a linear combination of the eight variables at National Certificate in Education (NCE) level thereby leaving 58.7% unaccounted for. This means that there other variables or factors which also contributed to the variations in college students’ achievement in mathematics than the predictor variables considered in this study. A number of factors had been identified by various researchers and educators as being responsible for poor achievement in Mathematics such as students’ characteristics, instructional/classroom characteristics, teachers’ characteristics, societal factors and school factors. Other factors, often cited, include lack of motivation and poor self-image (self-concept) of primary school teachers, lack of innovative teaching methods, lack of teaching facilities, poor school climate, lack of incentives and motivation, poor remuneration, poor condition of service and students’ poor problem-solving abilities [33], sex-stereotyping, transfer of poor attitudes of older students to the younger ones, poor self-concept towards Mathematics and the failure of Mathematics teachers to digest properly and utilize research findings [34]. The negative contribution of UTME and SSCE to the prediction of college students’ academic achievement in mathematics is at variance with the findings of [22,24,35]. However, the result is in line with the findings of [5,29,36] who reported that the validity of JME or UME scores in some subject using university achievement as criterion was very small where significant correlation were obtained. Similarly, [25] also reported that out of 14 correlation analyses carried out, only 2 were statistically significant in favour of students in Business Administration. He concluded that the predictive validity of JME was rather low.
4. CONCLUSION

Based on one of the findings of this study that cognitive entry characteristics (SSCE and UTME) has a very low but positive correlation with CGPA of college students in mathematics, it could be concluded that the blind method of guessing in objective achievement tests or examination by UTME and SSCE candidates and their inordinate ambition or desire to obtain good grades and secure admission at all cost have made them to result to various examination malpractices thereby making JAMB or SSCE results unreliable and deceptive in selecting the best candidates for admission into college programmes. Most of the students with good grades in SSCE coupled with high score in UTME often performed poorly after securing admissions to higher institutions. The results of this study are not conclusive, since UTME, SSCE and semester examination results only succeeded in explaining 41.3% of the variability in college students’ CGPA. This result suggests that there other variables not considered in this study that also affect mathematics achievement in institutions of higher learning other than cognitive entry characteristics and semester examination scores. These variables or factors could be investigated to determine their relationships with CGPA. Finally, regular testing of students’ ability should be encouraged since the use of formative tests (or semester examination) for diagnostic purposes seem to result in better cognitive achievement than when given as summative tests.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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