

Process Error and Students' Academic Achievement in Senior Secondary Certificate Examination in Mathematics in Nigeria

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Abstract

The purpose of this study is to examine the effect of the four identified process errors (arbitrary, structural, executive and clerical errors) in mathematics on students' academic achievement in Senior Secondary Certificate Examination (SSCE). The instrument used for this study was the students' scripts and redesigned marking scheme for those scripts in mathematics. Four hundred SS3 students were used as the sample. The data generated were analyzed using simple proportion, frequency count, chi-square test and Analysis of variance (ANOVA). The result of the analyses showed that students committed more of structural error which is the most serious error that has to do with the conceptual knowledge of the basic concepts in mathematics. Also girls were found committing more of the identified process errors than their male counterparts. The mean achievement score of students classified as committing more of structural and arbitrary errors differed significantly from the other two errors. Structural and arbitrary errors had more negative effects on students academic achievement than executive and clerical errors. On the basis of this finding it was recommended that students should be made to play down on the quest for right answer and highlight the importance of the steps involved in arriving at the right answers.

Keywords: process errors, academic achievement, senior certificate examination

INTRODUCTION

Mathematics is very important bedrock for the successful functioning of all aspects of human endeavour. No nation can achieve any measure of scientific and technological advancement without proper foundation in mathematics (Ukeje, 1997). Its importance is shown in the position it occupies in admission into Nigerian higher institutions. Joint Admission Matriculation Board (JAMB) brochure states that a credit pass in mathematics is required for admission into the sciences. A pass in mathematics is a necessary requirement for admission into any discipline in many higher institutions all over the world. Despite the important position mathematics occupies, it still remains one of the subjects that students persistently perform very poorly in. Mathematics remains the most dreaded subject for many students in the primary and secondary schools. The alarming rate of poor performance in mathematics has caused a lot of concern to every one as to what could be the contributing factors to this situation. Amazigo (2000) attributes this poor performance to lack of interest and poor attitude to students toward this subject. Ekwueme (1998, 2001) attributes poor performance to students' quest for right answer syndrome irrespective of the procedure taken to arrive at the answer. From personal experience and exposure to the teaching of these students and marking of their scripts, it has been

observed that the way these students respond to mathematics questions especially in SSCE goes a long way to affect their academic performance. Most of them feel that getting the correct answer to a mathematics problem is all that matters irrespective of the procedure/steps taken.

Donaldson (1963) identified and classified errors that students commit into arbitrary, structural, and executive errors. Usman and Harbor-Peters (1998) also categorized the process errors committed by students into conceptual, translational, logical and applied errors.

Therefore, from the classification made by these researchers, it is obvious that students make similar errors. It is therefore the intention of this study to identify the process errors committed by students in mathematical problem solving in SSCE. Specifically, the purpose of this study could be stated thus:

- (i) To identify the type of process errors committed by students,
- (ii) To investigate the frequency of committance of each type of errors by male and female students and
- (iii) To find out the effect these identified errors have on student's academic achievement.

METHODOLOGY, SAMPLING AND INSTRUMENTATION

The following research questions were investigated:

- (1) What is the proportion of different types of errors committed by SS3 students while solving mathematical problems?
- (2) What is the frequency of each type of process errors committed by male and female students in solving mathematics problems?

The following Hypotheses were also tested:-

- 1. There is no significant difference in mean achievement scores of students whose major type of error is arbitrary, or structural or executive or clerical error while solving mathematics problems in SSCE.
- 2. There is no significant difference in the frequency of each type of error committed by male and female students while solving SSCE mathematics problems.

Population and Sampling

The population of this study consisted of 18,000 students that sat for mathematics in 2002 May/June SSCE in Enugu and Cross River States of Nigeria (Ekwueme, 2005). From the 218 schools in the two states, 47 schools were randomly selected using a proportionate stratified random sampling. 400 students were randomly selected from the 47 schools and their scripts were selected out of the heap of scripts of all the students that took the examination. The source of data for this study was the students' scripts from where their scores were gotten and the errors committed at each step of their solution. Also the redesigned marking scheme where the possible errors were fixed at important steps was used.

Data Collection and Analysis

The range of possible errors were classified into four:- Arbitrary (lack of loyalty to what was given in the question or ignoring part of the question while acting on the other(s), structural/conceptual error (lack of understanding of the basic concept in mathematics), Executive error (failure to carry out even reasonable strategy or inability to write an answer in an acceptable form), clerical error (careless mistakes due to lack of concentration or cuewords). These errors were located at the appropriate stages of each of the steps in the redesigned marking scheme and the students' answer scripts were now analyzed recording each of the possible error committed by each question. These were analyzed using simple proportion, frequency counts, chi-square test and ANOVA.

RESULTS AND INTERPRETATION

Research Question 1:

What is the proportion of different types of process errors committed by senior secondary school three

students while performing basic concepts in mathematics?

To answer this research question, the proportion of the different types of errors that the senior secondary three students committed while solving SSCE questions were computed. The result of this analysis is presented in Table 1.

Table 1: Proportion of different types of errors committed by students

S/No	Types of Error	Percentage %	Proportion
1	Arbitrary	10.30	.103
2	Structural	65.80	.657
3	Executive	11.50	.115
4	Clerical	12.50	.125
	Total	100.10	

From Table 1, the proportion of arbitrary error, structural, executive and clerical errors were presented and their corresponding percentages. From this distribution, structural error has the highest proportion of .657 representing 65.80 percent of the total errors committed. This shows that the highest number errors committed is structural error (65.80 percent).

Research Question 2:

What is the frequency of each type of process errors committed by male and female students in solving mathematics problems?

The computation is shown in Table 2.

Table 2: Frequency of the process errors committed by SS 3 students by sex

Type of Error	Sex of Students	Frequency of errors committed
Arbitrary	Male	1413
	Female	1608
Structural	Male	1609
	Female	1761
Executive	Male	1602
	Female	1768
Clerical	Male	1365
	Female	1695
Total	Male	5989
	Female	6832

The frequency of the committance of different types of errors by male and female students were as shown above (Table 2). The evidence obtained here suggests that female students commit more of the identified (arbitrary, structural, executive and clerical) errors than their male counterparts and the variation in committance is wider in clerical error.

Hypothesis I

There is no significant difference in mean achievement scores of students whose major type of error is arbitrary, structural, executive or clerical errors while solving mathematics problems in SSCE. The analysis is as shown in Table 3.

Table 3: One-way Analysis of variance (ANOVA) of mathematics mean achievement scores by students' major type of error

Source of variation	Sum of square	df	Mean square	F-cal	Sign. of F	Significant	Decision
Between Group	2078.7681	3	692.9227	5.1187*	0.0017	S	Reject
Within Group (error)	53607.3094	396	135.3720				
Total	55686.0775	399					

Critical F = 2.60; sign. level .05; df = 3,396.

In Table 3, the calculated F-ratio in respect of the mean achievement in mathematics scores of the students whose major type of error is arbitrary, structural, executive and clerical errors while solving mathematics is 5.1187 and the critical F-value is 2.60. Since the calculated F-ratio of 5.1187 is greater than the critical F-ratio of 2.60 required for significance with 3 and 396 degrees of freedom, it then means that there is a significant difference in mean achievement in

mathematics scores of students classified as committing more of arbitrary or structural or executive or clerical errors.

Hypothesis 2

There is no significant difference in the frequency of each type of error committed by male and female students while solving SSCE mathematics problems.

The result is shown in Table 4.

Table 4: A chi-square Table showing the frequency of each type of error committed by male and female students

Type of error	Sex of students	Cases observed	Cases expected	df	Obs X ²	Critical X ² at .05	Interference
Arbitrary	Male	1413	1510.50	1	12.59*	3.84	S
	Female	1608	1510.50				
Structural	Male	2039	2225.50	1	31.26*	3.84	S
	Female	2412	2225.50				
Executive	Male	1609	1685.00	1	6.86*	3.84	S
	Female	1761	1685.00				
Clerical	Male	1445	1530.00	1	9.44*	3.84	S
	Female	1615	1530.00				
Total	Male	6506	6951.00	1	56.98*	3.84	S
	Female	7396	6951.00				

Critical value = 3.84; at .05 sign. level; df = 1

From the above table, calculated chi-square values of 12.59, 31.26, 6.86, and 9.44 for arbitrary, structural, executive and clerical errors respectively were computed. The critical chi-square value at .05 level of significance with 1 degree of freedom is 3.84 which is less than the calculated values of the four types of errors for both male and female students. This means that the null hypothesis of no significant difference is rejected and so, the sex of the students significantly influence the degree/frequency of the four errors.

DISCUSSION

From the result of research question one, it was obvious that students' overall performance will be greatly affected since structural error which was the most frequent error committed has to do with the student' lack of understanding of the basic concepts (Ekwueme 2005). The result also showed girls committing more of the identified errors than boys. The wide range observed in clerical error suggests that boys are more stable in solving mathematics problems than girls since clerical error had to do with carelessness, boredom, distraction. This agrees with Ekwueme and Nenty (2001) who stated in their study that girls commit more of clerical errors than their male counterparts. In a similar manner, Awodeji

(1997) and Okoro (1998) also discovered gender difference in committance of systematic errors.

The major type of error a student is classified into is closely linked with the mean achievement score. It was discovered that the source of significant difference was on the comparison, between the structural and arbitrary errors with arbitrary showing the major source of difference. This goes to support the concept of arbitrary error that deals with ignoring part of the instruction given in a question while acting on others while solving mathematics problems. Students who have the basic knowledge of the mathematics concepts (Structural) may tend to ignore some aspect of instructions given while solving mathematics problems (arbitrary errors). It is possible that students who commit arbitrary errors may have the basic knowledge of the concept but they do not carry out the actual operation posed to them, hence ignoring such aspect and that will adversely affect their achievement, for instance, premature approximation before the end of a solution especially when such value will be used to solve further problem will affect the result.

CONCLUSION

This study has revealed that

- (i) students commit more of structural errors in solving SSCE mathematics questions
- (ii) Girls commit more of the identified errors than their male counterparts and boys are more stable in solving mathematics problems.
- (iii) the mean achievement score of students is significantly affected by the category of error that student is classified as committing most.

Some students feel satisfied and confident due to mastery of rote learning through memorizing formulae and waiting for the time to release them. It hampers their performance because most of the time, one might not be able to reproduce the formulae of solution memorized without proper understanding of the fundamentals of such problem. The implication was shown in the negative effect that such errors especially structural error had on academic achievement. This study had therefore, exposed to us that the process errors committed within the step-by-step solution irrespective of the correctness of the final answer has great negative effect on their final score. Also, another contribution that this study had made to knowledge is that the study had made us to understand that different types of errors affect academic achievement differently. It is therefore very important that teachers should educate the students to play down on the quest for right answer and highlight the importance of the steps involved in arriving at the right answers.

REFERENCES

Amazigo, J. C. (2000). Mathematics phobia: Diagnosis and prescription. National Mathematic Centre 1st Annual Lecture, July, Abuja.

Awodeji, A. F. (1997). Gender and achievement in further mathematics as factors of success in mathematics courses for Engineers. An unpublished Ph. D Thesis University of Nigeria, Nsukka.

Donaldson, M. A. (1963). A study of children's thinking. London Taristock.

Ekwueme, C. O. (1998). Error Pattern and students' performance in junior secondary three certificate examination in mathematics in Calabar municipality of Cross River State. Unpublished M. Ed Thesis dissertation. University of Calabar, Calabar, 110pp.

Ekwueme, C. O. and Nenty, J. H. (2001). Common errors and performance of students in junior sec three mathematics certificate examinations in Cross River State, Nigeria. Global Journal of Pure & Applied Science, 7(3):591 – 596.

Ekwueme, C. O. (2005). Process Errors and Teacher characteristic as Determinants of secondary school students' Academic achievement in Senior Secondary School Certificate Examination in Mathematics in Nigeria. Unpublished Ph.D. Thesis, University of Nigeria, Nsukka, 138pp.

Okoro, C. C. (1998). The efficacy of some psychological principles on primary school children is performance units systematic computational errors. Unpublished Ph. D. Desertation, Nsukka.

Ukeje, B.O.(1997). The challenges of mathematics in Nigeria's economic goals of vision 2010: Implication for secondary school mathematics. A lead paper presented at the 34th Annual National conference of the Mathematical Association of Nigeria.

Usman, K. O. & Habor-Peters, V. F. A(1998). Process errors committed by Senior Secondary Students in Mathematics. Journal of Science, Technology and Mathematics Education (JOSTMED), 1(1), 34 – 39.