

DIAGNOSTIC ANALYSIS OF ERRORS COMMITTED IN PHYSICS EXAMINATION BY SECONDARY SCHOOL STUDENTS IN SOKOTO METROPOLIS, SOKOTO STATE, NIGERIA

Dr. Y. M. Kamar¹ and Nuradeen Malami²

¹Department of Science and Vocational Education, Usmanu Danfodiyo University, Sokoto

²Department of Physics Shehu Shagari College of Education, Sokoto

ABSTRACT

This study analyzed the errors committed by senior secondary school students in physics examination in Sokoto Metropolis. The problem that necessitated the analysis includes the poor performance of students in physics examination despite the importance of the subject to science and technology. Three research questions guided the study and one null hypothesis was tested. Four hundred (400) students comprising of 200 boys and 200 girls were selected from 4 schools offering physics in Sokoto Metropolis. Error Diagnostic Test was the instrument used in collecting data. Simple percentages and chi-square were used for analyzing the data. The result showed that six types of errors were committed by students namely; factual/wrong explanation of concepts, grammatical, spelling, algorithm, wrong result/conclusion and wrong/absence of unit errors and that there was significant difference in the frequency of errors committed by male and female students in physics examination. It was recommended among others that ways of reducing or preventing the re-occurrence of errors such as remediation, corrections should be developed by teachers to improve performance of students.

KEYWORDS: Errors, Physics, Diagnostic, secondary school, Sokoto State

INTRODUCTION

The importance of science education cannot be over emphasized as it is regarded as an essential part of education for all people growing up in a fast changing and increasingly complex technological world. According to the National Policy on Education, one of the broad aims of education in Nigeria is to equip students to live effectively in the age of modern science and technology (Federal Republic of Nigeria, 2013). To concretize the policy aim, science subjects among which is physics are made core subjects to be taught in Nigerian secondary schools. According to Atodoga (2000), the teaching of physics is expected to achieve certain aims which include training to specialize in a science based career, broadening the horizon of non-technical students by familiarizing them with the content and discipline of the subject and training of technical manpower such as research scientists and engineers. Yakubu (2003) asserted that in the modern world of science, the technological potential of any nation could be more accurately gauged by the quality of its science education programme. Since science education prepares individuals to function in technologically driven societies, science educators and members of the society cannot afford to retain substandard performance of science students, or method of science instruction. There is therefore the need to assess the quality of

teaching and learning strategies in order to identify and possibly reduce the general problems leading to substandard performance among science students generally.

Falalu (2014) relates the poor performance of students in physics to errors they committed in examinations. Error according to Inekwe as cited by Falalu (2014) is defined as a wrong process carried out by students in problem solving, which leads to a wrong solution after one has been taught the right process. Regarding the conception of errors in science, Piaget (1977) believes that individuals construct their own knowledge as a result of their interaction with specific phenomenon and that conceptions formed during this process constitute personal explanatory knowledge of the phenomenon in question. According to Piaget also concept formed by the learner usually form the foundation on which new knowledge is anchored. Where the conception of the learner does not agree with the scientific ideas, error or misconception is said to occur. Error analysis therefore, is the study of the kinds and quantities of errors committed by students in a subject of study. According to Muhammed (2000) error analysis could indicate the level of the learner and show areas where remediation is needed. To the learners, it is psychologically important to indicate to them their errors, not as a sign of failure but as a positive source of improvement.

As students' errors are in different forms and classes, approaches of treating them may differ. The approaches or stages of analyzing errors are known as models of error analysis. Mohammed (2000) employed a synthetic model containing identification, classification and explanation stages. At the identification stage, the analyst tries to interpret the learners' intended meaning of the concept with the aim of arriving at authoritative interpretation. During the second stage, the original student's response is compared with expected correct responses. This gives a description of the error committed. The last stage is the explanation of error, at this stage, the why and how of committed errors are given.

On classification of errors, West African Examinations Council Chief examiners report (WAEC Chief Examiners' Report, 2013) classified errors as grammatical error, spelling errors, factual errors (involves using wrong law or principle, wrong explanation of concepts, wrong unit), algorithm error (using wrong formula or equation in solving mathematics related exercises), and wrong results/conclusions, etc. This classification approach was used in this study to classify the identified errors committed in physics examination by secondary school students in Sokoto metropolis.

STATEMENT OF THE PROBLEM

A general evaluation of students' performance in science at senior secondary school examination in Nigeria showed that the percentage of students with credit in physics were 39.9, 44.3, 37.9, 38.8, 35.6, 51.9 and 46.3 for 2006, 2007, 2008, 2009, 2010, 2011 and 2012 respectively (WAEC Chief Examiners' Report, 2013). The shows that students' performance in physics is not encouraging with about half of students passing their examination below credit level. As for Sokoto State, the area of present study, the percentage of credit passes were 39.0, 42.3, 35.5, 36.9, 34.6, 49.1 and 46.0 for

2006, 2007, 2008, 2009, 2010, 2011 and 2012 respectively which also indicated more than half of the students passed below credit level (WAEC, 2013). Moreover, Mustapha (2008) reported physics as facing inadequate popularity due to lack of interest and perception of difficulty by some students which affect their performance. He also reported low participation of Sokoto State indigenes in engineering and technical studies, which he attributed to their low performance in physics at senior secondary examination, which in turn disqualified them from admission into such courses. This suggests that students committed errors while writing external exams which prevented them from making good grades.

Hence, the need for this study to identify such errors committed in physics examination by senior secondary school students in Sokoto metropolis, comprising of Sokoto South, Sokoto North, Dange Shuni and Wamakko Local Government areas.

OBJECTIVES OF THE STUDY

The objectives of this study are to find out:

- (i) Types of errors committed by senior secondary school students in physics examinations in Sokoto metropolis.
- (ii) Frequency of occurrence of each type of error committed by senior secondary students in physics examination in Sokoto metropolis.
- (iii) Whether a difference exist between the frequency of type of errors committed by male and female students in senior secondary school physics examination in Sokoto Metropolis.

RESEARCH QUESTIONS

Based on the research objectives highlighted above, the following research questions were raised to guide this study.

- (i) What types of error do senior secondary students of Sokoto Metropolis commit in physics examination?
- (ii) What is the frequency of occurrence of different types of errors committed by senior secondary school students of Sokoto Metropolis in physics examination?
- (iii) Is there any difference in the frequency of error types committed by Senior Secondary school male and female students of Sokoto Metropolis in physics examinations?

NULL HYPOTHESIS

Based on the stated research questions, the following null hypothesis was formulated and tested at 0.05 level of significance

Ho1 There is no significant difference in the frequency of error types committed by senior secondary male and female students of Sokoto Metropolis in physics examination.

RESEARCH DESIGN

This study was aimed at analyzing and classifying errors committed by senior secondary school students in physics examination. The design of the study was therefore descriptive survey research design. Because it involves diagnosing errors through test, classifying and comparing frequency of errors based on groups.

POPULATION OF THE STUDY

Population of a study according to Ogunleye (2000) is the limit within which the research findings are applicable. The population of this study was Senior Secondary (SS) III students offering physics in public secondary schools in Sokoto metropolis. The population of students offering physics in public schools in the study area was 3,723 comprising of 2,083 males and 1,640 females distributed within the 25 secondary schools. Sokoto metropolis comprises of secondary schools located in Sokoto North, Sokoto South and some parts of Kware, Wamakko and Dange Shuni Local Government areas of Sokoto State. There are 25 public senior secondary schools offering physics in the metropolis under state Ministry of Basic and Secondary Education and Ministry of Science and Technical Education. Twelve of the schools are male schools; five are female schools, while eight are mixed schools. The SS III students were chosen because they have learnt more than two third of secondary school physics syllabus and were soon to write their Senior School Certificate Examinations (SSCE). The study subjects have an average age of 18 years. The distribution of the population according to schools was presented in Table 1.

Table 1 List of Public Senior Secondary Schools Offering Physics in Sokoto Metropolis

S/N	Name of school	Types of school	M	F	Total
1	Abdulrasheed Raji Spec. Sch.	Coeducational	57	34	85
2	Army Day Sec School Sokoto	Coeducational	100	90	190
3	Giginya Memorial Sec. Sch. Sokoto	Boys	100	-	100
4	Government Day Sec. Sch. Arkilla	Coeducational	120	100	220
5	Government Day Sec sch. K/Marke	Coeducational	62	16	108
6	Nana Girls Sec Sch Sokoto	Girls	-	326	326
7	Sani Dingyadi Unity Sec School	Boys	200	-	200
8	Sokoto Science College	Boys	180	-	180
9	Sultan Atiku Sec Sch. Sokoto	Boys	113	-	113
10	Sultan Attahiru Sec Sch Sokoto	Boys	111	-	111
11	Sultan Bello Sec Sch Sokoto	Boys	125	-	125
12	Women Centre for Continuing Education	Girls	-	170	170
13	Ahmadu Bello Academy Sokoto	Boys	120	-	120
14	Govt. Technical College Farfaru	Boys	140	-	140
15	Govt Technical College R/Sambo	Boys	130	-	130
16	Govt Girls College Sokoto	Girls	-	196	196

17	Hafsatu Ahmadu Bello Arabic Sec. Sch	Girls	-	184	184
18	Nagarta College Sokoto	Boys	240	-	240
19	Sultan Abubakar College	Boys	72	-	72
20	Shekh Abubakar Gummi Memorial Collg	Boys	60	-	60
21	Sultan Mohamed Maccido Sch for Q.G.S	Coeducational	90	50	140
22	Government Day Sec School Old Airport	Coeducational	48	40	88
23	Government Girls Day Sec School Rujin Sambo	Coeducational	-	210	210
24	Government Girls Day Sec School T/Wada	Girls	-	144	144
25	Government Day Sec. School Mabera	Coeducational	85	80	165
	Total		2083	1640	3723

Source: Inspectorate Departments M.O.B.S.E & M.S.T.E. (2015)

SAMPLE AND SAMPLING TECHNIQUE

The schools used for the study were four senior secondary schools selected using stratified sampling method. The schools are Sokoto Science College, Government Day Secondary School Arkilla, Army Day Secondary School and Government Girls Day Secondary school Runjin Sambo. The schools were selected based on their different status that is one male, two coeducational and one female school, different ministries as well as different location of the schools in the metropolis that is Sokoto North, Sokoto South Wamakko and Dange Shuni Local government areas. The four schools were also more than 10% minimum sample size recommended by Frankel and Widen (2000). In the sampled schools four classes were selected, one from each school using random sampling to form the study team. A total of 400 SS III students were selected for the study. Details of the schools selected were shown in Table 2.

Table 2 Selected Sample for the Study

S/N	School	Male in class	Female in class	Total students in class	Selected male	Selected female	Total sample students
1.	S.S.C. Sokoto	180	-	180	90	-	90
2.	GDSS Arkilla	120	100	220	60	50	110
3.	Army Day Sec. Sch.	100	90	190	50	45	95
4.	GDSS R/Sambo	-	210	210	-	105	105
	Total	400	400	800	200	200	400

INSTRUMENTATION

Instruments according to Sambo (2005) are means of collecting data in a research. The instrument used for collecting data for this study was Error Diagnostic Test (EDT):

ERROR DIAGNOSTIC TEST (EDT)

Error Diagnostic Test (EDT) is a test designed to diagnose errors that senior secondary school students commit in the process of answering physics questions. The test comprised 35 free response theory questions on the concepts of electricity, work, energy, power, wave, thermal expansion, machine and heat. The test was adapted by the researchers using the guidelines given by Falalu (2014), the areas modified are the topics used in the previous study to make present study different.

VALIDITY OF EDT

The instrument was validated by two senior lecturers from the Department of Science and Vocational Education, a professor from physics Department of Usmanu Danfodiyo University and an experienced physics teacher from a secondary school in Sokoto metropolis. Their suggestions were used to produce final form of the test.

RELIABILITY OF EDT

The reliability of EDT was found to be 0.71 using test-retest, calculated using Pearson Product Moment Correlation Statistical procedure during pilot test at Shehu Shagari College of Education (S.S.C.O.E) staff secondary school, Sokoto.

METHOD OF DATA COLLECTION

Error diagnostic test was administered to the sampled students. After answering the questions, the answer scripts were assessed using the following procedures:

- a. Going through the answer scripts
- b. Selecting the items where students commit errors
- c. Classifying the errors based on classifications of W. A. E. C. chief examiners' report, (2013) comprising factual/wrong explanation of concepts, grammatical, spelling, algorithm, wrong result, conclusion and wrong/absence of unit.
- d. The frequencies and percentages of identified classified errors were computed.

METHOD OF DATA ANALYSIS

The data collected were analyzed using descriptive statistics, simple percentage to answer the research question while chi-square was used to test the null hypothesis generated for this study.

DATA PRESENTATION AND ANALYSIS

Research Question 1

What type of errors do senior secondary school students of Sokoto Metropolis commit in physics examination? Students' answers in the Error Diagnostic Test were analyzed and errors committed were identified, classified and presented in table 3.

Table 3: Type of Errors Committed in Physics Examination by Secondary School Students in Sokoto Metropolis.

S/N	Types of Error
1.	Factual and wrong explanation of concepts
2.	Grammatical Error
3.	Spelling Error
4.	Algorithm error
5.	Wrong result/conclusion
6.	Wrong/absence of unit

Source: Fieldwork, 2017

The result in Table 3 showed that all six types of error were committed by senior secondary school students in Sokoto metropolis of Sokoto State. The identified errors were classified based on the classification of WAEC Chief Examiners Report (2013) as factual and wrong explanation of concepts, grammatical, spelling, algorithm error, wrong result/conclusion and wrong/absence of unit errors.

Research Question 2

What is the frequency and percentage of occurrence of different types of errors committed by students in physics examination in Sokoto Metropolis? In addition to classifying the identified errors, the frequencies of occurrences of each type were calculated and presented in Table 4

Table 4: Frequency of different Types of Error Committed in Physics Examination by Secondary Schools Students in Sokoto Metropolis

S/N	Types of Error	Frequency	Percentage
1.	Factual and wrong explanation of concepts	46	7.46
2.	Grammatical Error	158	25.61
3.	Spelling Error	146	23.66
4.	Algorithm error	92	14.91
5.	Wrong result/conclusion	129	20.91
6.	Wrong/absence of unit	46	7.46
	Total	617	100

Source: Fieldwork, 2017

The result in Table 4 showed that grammatical error has the highest frequency of occurrence with 158, followed by spelling error which occurred 146 times, followed by wrong result and conclusion

129, followed by algorithm error 92, followed by factual/wrong explanation of concept and wrong/absence of unit respectively with 46 frequencies each.

Research Question 3

Is there any difference in the frequency of type of errors committed by senior secondary male and female students of Sokoto Metropolis in physics examination? To answer this question, the frequencies of each type of error were sorted by student's gender and presented in Table 5.

Table 5: Frequency of Errors Committed by Male and Female Students in Physics Examination

S/N	Type of Error	Frequency committed by Male	Frequency committed by female	Total
1.	Factual/wrong explanation of concepts	16	30	46
2.	Grammatical	68	90	158
3.	Spelling	56	90	146
4.	Algorithm error	50	42	92
5.	Wrong result/conclusion	54	75	129
6.	Wrong/absence of unit	27	19	46
	Total	271	346	617

Source: Fieldwork, 2017

The result in Table 5 showed that male students committed 16 factual/wrong explanation of concepts error while female students committed 30; male students had 68 grammatical errors while females had 90; male students made 56 spelling errors while females made 90; male students committed 50 algorithm errors while females committed 42; male students had 54 wrong result/conclusion errors while females had 75. Male students had 27 wrong/absence of unit type of errors while females had 19. Male students committed a total of 271 errors while female students committed 346 errors. This indicated that female students committed more errors than males. Despite this, male students committed more of algorithm and wrong/absence of unit errors than female students.

Null Hypothesis 1

There is no significant difference between the frequency of errors committed by male and female students in physics examination in Sokoto Metropolis. To test this hypothesis, the frequencies of errors committed by male and female students are compared using chi-square test and presented in Table 6

Table 6: Chi-square Result on Frequencies of Errors Committed by Male and Females Students in Physics Examination

Variables	Observed Frequency	Expected Frequency	Df	X ² Cal	Pvalue	Decision
Male	271	119				
			5	313	.000	Reject Ho ₂
Female	346	194				

$$P < 0.05$$

The result in Table 6 showed that the P value was .000 which is less than the α value 0.05. This indicated that the hypothesis should be rejected and that there was significant difference in the frequency of errors committed by male students and their female counterparts in physics examination in Sokoto Metropolis.

SUMMARY OF MAJOR FINDINGS

Based on outcomes of the analysis of data collected for present study, the following were the major findings of the research

1. Six types of errors were committed by senior secondary school students in physics examination with different frequencies. Factual and wrong explanation of concepts occurred 46 (7.4%) times, wrong or absence of unit 46 (7.4%) times, algorithm error 92 (14.9%) times, wrong result and conclusion 129 (20.9%) times, spelling error 146 (23.6%) times and grammatical error 158 (25.6%) times.
2. Female students committed more errors than male students in factual/wrong explanation of concepts, grammatical spelling and wrong result/conclusion error types while male students committed more algorithm and wrong/absence of unit error types than female students.
3. There was statistically significant difference in the frequency of errors committed by male and female students in Sokoto metropolis.

DISCUSSION OF FINDINGS

The finding of the study showed that six types of errors were committed by secondary school students of Sokoto metropolis, at different frequencies in physics examination. This finding was in agreement with the findings of Ekwueme and Ali (2012) as well as Mohammed (2000) who reported significant differences among the type of errors they identified in their separate studies.

The study showed significant difference between the errors committed by male and female students in physics examination in Sokoto metropolis. This finding is in agreement with the findings of Lawan (1996), Melle (1996) and Ekwueme and Ali (2012) who found significant differences among frequency of errors committed by male and female students.

CONCLUSION

Based on the findings of this study, the following conclusions were arrived at:

- 1) Secondary school physics students in Sokoto metropolis committed factual/wrong explanation of concepts, grammatical, spelling, algorithm, wrong result/conclusion and wrong/absence of unit, types of error in physics examination.
- 2) Grammatical and spelling errors have the highest frequencies of occurrence while the other subject area-related errors have between lower frequencies
- 3) There was significant difference between the frequency of errors committed by male and female students in physics examination in Sokoto Metropolis. Female students were found to commit more factual/wrong explanation of concepts, grammatical, spelling and wrong result/conclusion errors than their male counterparts. While male students were found to commit more algorithm and wrong/absence of unit errors than female students.

IMPLICATION OF THE STUDY

The result of the study showed that students committed more language related errors than subject related errors. The implication is that students committed errors not because they lacked the knowledge of the subject but due to poor language proficiency, which suggests that some physics teachers neglected clarification of language across the curriculum.

RECOMMENDATIONS

In view of the findings of this study, the following recommendations were put forward.

1. Teachers should identify the types of errors committed by their students and design ways of reducing their frequency or preventing their re-occurrence e.g. by remediation.
2. Teachers should also inculcate the habit of clarifying complex terms associated with their subjects for better understanding of students (i.e. language across curriculum).
3. Teachers should also consider the frequency of errors committed per group of students in preparing remediation. Group with higher frequency of errors requires more consideration and professional initiatives in remediation than group with lower frequency.

SUGGESTION FOR FURTHER STUDIES

The present study focused on analysis of errors committed in physics theory examination. It is suggested that similar studies be conducted on practical physics, so as to have the type of errors committed in the practical aspect of the subject as well.

REFERENCES

Atodoga, M. M. (2000). A study of the strategies that senior secondary school students use in solving physics problems and their relationship to academic achievement. Unpublished Ph.D. Dissertation, ABU Zaria.

- Ekweme, C. O. & Ali, A. (2012). Process error and students' academic achievement in senior secondary certificate examination in mathematics in Nigeria. *Journal of Emerging Trends in Educational Research and Policy Studies*, 3(4), 600-603.
- Falalu, M. K. (2014). Identification of errors committed in physics examinations and effect of remediation package among senior secondary school students in Zaria. Unpublished Ph.D Dissertation A.B.U. Zaria.
- Federal Republic of Nigeria (2004). National Policy on Education. Abuja: NERDC.
- Lawan F. K. (2000). Effectiveness of a conceptual change and instructional strategies in remediating identified misconceptions in genetic concepts among senior secondary students in Kano State. Unpublished Ph.D. Dissertation, ABU Zaria.
- Melle, B. O. (1996). Identification of error types in chemistry amongst pre-service Nigerian Certificate in Education Teachers. Unpublished Ph.D. Dissertation, A.B.U Zaria.
- Mohammed, Z. B. (2000). Error analysis of the essays of applied science diploma students in Kaduna State Polytechnic. Unpublished M.Ed. Thesis, ABU Zaria.
- Mustapa, I. S. (2008). Study of relationship between senior secondary school students' attitudes and academic achievement in physics. Unpublished M.Ed. Dissertation. U.D.U Sokoto
- Ogunleye, A. O. (2000). An Introduction to Research Method in Education and Social Science. Lagos: Sunshine International Publication Limited.
- Piaget, J. (1977). The Development of Thoughts. New York. The Vicking Press.
- Sambo, A. A. (2005). Research Methods in Education. Ibadan: Nigeria Stirling Horden
- Shaibu, A. M. (1987). Problem solving difficulties experienced by Nigeria students of schools of basic Studies in mechanistic organic chemistry. Unpublished Ph.D. Dissertation, University East Anglia, England.
- WAEC (2013) Results Statistical Bulletin. Lagos: WAEC Press.
- Whitelegg, L. & Harding P. (1997). Girls in science education. *The Gender and Science Reader*. (373-385).
- Yakubu, N.U. (2003). Teaching-learning facilities in science and technology education in the Northern States: Minimum standard, current problems and strategies for development. *Revitalizing Education in the Northern States*. Vol. 3. Science and Technology, Kaduna.