Vol. 10, No. 2, pp. 106 – 120 e-ISSN: 2715–856X p-ISSN:2338-1183

Jurnal Pendidikan Matematika

Universitas Lampung

http://jurnal.fkip.unila.ac.id/index.php/MTK

Identification of Mathematical Errors Committed by Senior School Students in Calculus

Khadijat Saka AMEEN[1], Semiu Ayinla SALAWU[2*], and Hammed Bidemi ARABA[3]

[1,2,3]Department of Science Education, Faculty of Education, University of Ilorin, Ilorin, Nigeria

E-mail: ameen.sk@unilorin.edu.ng[1]
semiusalawu2017@gmail.com[2*]
ameen.sk@unilorin.edu.ng[3]

Received: 1 Dec 2021 *Accepted: 10 Mar 2022* *Published: 13 Jun 2022.*

Abstract

This study aimed to identify mathematical errors committed by senior school students in calculus. Specifically, this study analyzes the various types of errors committed when solving problems involving calculus. The study is a descriptive study that employed a mathematics performance test on calculus (MPT-C) as the research instrument. The study considered two independent variables which are: error type and gender. The research sample for the study comprised all senior secondary school three (SS III) students. A random sampling technique was used to select the participating schools. A total of 300 senior secondary school students were involved in the selected schools. All research questions were answered using mean gain difference while all research hypotheses were tested using chi-square. All the research hypotheses were tested at a 0.05-significance level. The results of the analysis indicated that: there were no significant differences in the frequencies of structural, supposition, translation, operation, and random errors committed by male and female senior secondary school students in word problem-solving involving calculus.

Keywords: calculus; error; identification; gender; mathematics

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi kesalahan matematika yang dilakukan oleh siswa sekolah menengah atas dalam materi kalkulus. Secara khusus, penelitian ini menganalisis berbagai jenis kesalahan yang dilakukan ketika memecahkan masalah yang melibatkan kalkulus. Penelitian ini merupakan penelitian deskriptif dengan instrumen penelitian berupa tes kinerja matematika pada kalkulus. Penelitian ini mempertimbangkan dua variabel independen yaitu: jenis kesalahan dan jenis kelamin. Sampel penelitian untuk penelitian ini adalah seluruh siswa sekolah menengah atas (SS III). Teknik pengambilan sampel secara acak digunakan untuk memilih sekolah yang berpartisipasi. Sebanyak 300 siswa sekolah menengah atas terlibat di sekolah-sekolah yang terpilih. Semua pertanyaan penelitian dijawab dengan menggunakan rata-rata perbedaan gain, sedangkan semua hipotesis penelitian diuji menggunakan chi-square. Semua hipotesis penelitian diuji pada tingkat signifikansi 0,05. Hasil analisis menunjukkan bahwa: tidak ada perbedaan yang signifikan dalam frekuensi kesalahan *struktural, anggapan, terjemahan, operasi, dan acak yang dilakukan oleh siswa sekolah menengah laki-laki dan perempuan dalam pemecahan masalah kata yang melibatkan kalkulus.*

Kata Kunci: *identifikasi; jenis kelamin; kalkulus; kesalahan; matematika*

INTRODUCTION

Mathematics may be described as fundamental science, it is that branch of science that studies and explains numbers, quantities, measurements, and the relationships between them. Fajemidagba, Salman, and Ayinla (2012) described mathematics as a tool for the development of any science-based discipline such as technology, astronomy, graphics, and analytical reasoning in daily living in modern society. Mathematics may be broadly described as the science of space, time, measurement, quantities, shapes, and numbers and their relationships with each other (Pawan, 2013).

Iyase (2018) described mathematics as a catalyst for achieving technological advancement and reducing the scientific and technological gap that exists between developed nations and developing nations like Nigeria. Students seeking entry into tertiary institutions in Nigeria are expected to be competent in mathematics and passed it at credit level. Students at the secondary level of education must not acquire only an empirical but also an abstract understanding of mathematics. It is the only language and culture common to all studies.

Mathematics is one of the core subjects at primary and secondary school levels of education due to its importance and usefulness in everyday activities (Salman, 2017). This is because students are expected to apply the knowledge of mathematics in both familiar and unfamiliar situations. In Nigeria, Mathematics is taught as a core subject for all students at the primary and secondary school levels to provide a solid foundation for scientific and reflective thinking and also prepare them for the next level of education (Federal Republic of Nigeria (FRN), 2013). In addition, mathematics is one of the compulsory subjects that must be passed at credit level by students before getting admission into any tertiary institution in Nigeria.

Ambali (2014) said that mathematics is important in our everyday life and development, stressing that the subject is critical to the survival of the world today and future generations. Mathematics is an important subject because its usefulness cuts across all spheres of life such as computer processing, engineering, and music. There are a lot of branches of mathematics that are known to man and important in our everyday life and achieving technological advancement. One of the foremost branches of mathematics is calculus; it is a mathematical discipline that is primarily concerned with functions limits, derivatives, and integrals. In the new mathematics curriculum, Calculus is a newly introduced topic, which shows how important this topic is to Nigerian senior secondary students. Differential Calculus and Integral Calculus are sub-topics under calculus in the mathematics curriculum (Nigerian Education Research and Development Council (NERDC), 2011).

Calculus is the mathematical study of continuous change and it is a part of modern mathematics education. American Heritage Dictionary (2010) defined calculus as a branch of mathematics that deals with limits, the differentiation, and integration of functions of one or more variables. Calculus also refers to the branch of mathematics that deals with the finding and properties of derivatives and integrals of functions, by methods originally based on the summation of infinitesimal differences (Merriam-Webster, 2017). The two main types are differential calculus and integral calculus. Calculus is a very difficult topic that a lot of students have trouble with and affect their performance.

One of the reasons why calculus seems to be difficult arises from a lack of understanding about the nature of the topic. Bowman (2016) reported that people fail in calculus courses because it is at a slightly higher conceptual level than algebra, trigonometry, fraction, etc. Many students react to this confusion by ignoring the conceptual aspects of the subject and relying on memorizing rules and procedures. Calculus requires a lot of work doing practice problems that are solving calculus problems, which is something a lot of students aren't willing to do, and it is one crucial aspect of calculus that most students find difficult. Nevertheless, failure to solve problems turns out to be one of the principal reasons for poor academic performance.

Problems are meant to be solved and when they are being solved, they bring about efficiency. To find solutions to any problem; one has to identify the problem itself because the problem known is already half solved. In Mathematics Education, a word problem is a mathematical question where significant background information on the problem is presented as text rather than in mathematical notation (Verschaffel, Greer & De Corte, 2000).

Here are mathematical problems in mathematical notation:

(i) Solve for J:

$J = A - 20$

$J + 5 = (A + 5) / 2$

The same problem might be presented in the form of a word problem as follows:

“John is twenty years younger than Amy, and in five years he will be half her age. What is John’s age now?”

The answer to the word problem is that John is 15 years old, while the answer to the mathematical problem is that J equals 15 (and A equals 35).

(ii) Find the first derivative of f(x) = x^2

The first derivativeis:

f′(x) = $2x^{2-1}$ = $2x$ or $\frac{dy}{dx}$ = $2x$

The anti-derivative (integral) of the latter is given by:

$$\int 2xdx = x^2 + C.$$

According to Salman (2017), problem-solving is a means or art by which an individual uses previously acquired knowledge, skills, and understanding to satisfy the demand of an unfamiliar situation. Word problems can inspire the exploration of important mathematical ideas, nature persistence and reinforce the need to understand and use various strategies, mathematical properties, and relationships. Tiamiyu (2014) analyzed the errors committed to solving word problems involving set theory in mathematics by senior secondary school students. The study identified 5 types of errors committed by students in solving word problems involving set theory. These errors include structural, supposition, translation, operation, and random errors. It was further affirmed that the errors were committed as a result of a language problem.

Adigun (2016) examined the type of errors committed to solving fraction problems by SSII students. The findings of the study revealed that students committed seven, six, and four types of errors in the compound, algebraic and word problems involving fractions respectively; fact error of least common multiple (LCM) was committed (523 times), incorrect operations (117 times), incorrect procedures (349 times), missing steps (145 times), comprehension (428 times), transformation (427 times), procedure (427 times), and encoding errors (427 times). The results of the study lead to the conclusion that errors in solving fraction problems are common among secondary school students irrespective of gender and school location. This study aimed at identifying gender and school differences in errors made by senior school students in solving a mathematical problem.

Ameen and Salman (2015) examined students' mathematical language proficiency as a predictor of their performance in mathematical bearing word problems. However, having affirmed that students commit errors when solving mathematical word problems due to language deficiency, Salman (2002) investigated the type of errors committed in word problems by concrete and formal operational junior secondary school students in mathematics. The researcher identified three categories of errors committed by concrete and formal operational students in word problems leading to logarithms. These are syntactic, semantic errors, and meaningless translation. The semantic errors are in two categories. The first category involves language while the second category involves operation and computation. The third categories are responses considered meaningless in the context of the given problem.

Researchers have carried out studies on the factors related to the difference in the performance of boys and girls in mathematics (Abiam and Odok, 2006; Opolot-Okurut 2005). The researchers reported that for attitudinal variables such as anxiety, confidence, and motivation, males have higher mean scores than females. Thus, the idea that mathematics is for boys results in low motivation in girls and could widen the gap in mathematics in favor of boys and further opined that the different learning goals of girls and boys leave girls at a disadvantage in competitiveness.

A large-scale study in the United State of America (USA) by Hydea and Mertzb (2009) revealed that girls have reached parity with boys in mathematics performance, including a high school where a gap existed in earlier decades. Researchers affirmed that girls are doing better than boys even for tasks that require complex problem-solving. This implies that research studies have shown that gender can influence students' achievement in mathematics. Based on these previous studies, the impact of gender has not been stable on the mathematics performance of students, which calls for continued verification. Thus, this study will identify the mathematical error committed by male and female students in solving calculus.

Statement of the Problem

The acquisition of basic mathematics is to improve students' self-concepts concerning the abilities to solve a mathematical problem which is also one of the most important goals of senior secondary school mathematics curriculum in line with the objective of the Federal Government of Nigeria as stipulated in the National Policy of Education (FRN, 2013). Researchers are interested in identifying errors committed by secondary school students in solving mathematical problems which are sometimes responsible for the poor performance of students in mathematics. Odetola (2011) examined the effect of mathematical language on errors committed by senior school students in bearing word problems, revealed that the teaching of mathematical language had positive effects on the performance of students in solving bearing word problems in terms of the errors committed. Also, Salman (2005) researched the type of errors committed in word problem solving by concrete and formal operational junior secondary school students in mathematics. The study revealed that students committed both syntactic and semantic errors in solving word problems in mathematics.

Cecilia and Anthony (2013) identified four major types of errors committed by senior secondary school III students while solving Senior Secondary School Certificate Examination (SSCE) mathematics questions. Such as Arbitrary error (lack of loyalty to what was given in the question or ignoring part of the question while acting on the others), Structural Error (lack of understanding of the basic concept in mathematics), Executive Error (failure to carry out even reasonable strategy or inability to write the answer in acceptable form), and Clerical Error (Careless mistakes due to lack of concentration or cue words).

Also, Salman (2004) analyzed errors committed in word problems involving simultaneous linear equations by Nigerian secondary school students, the study revealed that there are six types of errors committed to solving word problems involving simultaneous linear equations by Nigerian secondary school students. The errors include supposition error, translation error, Operation error, elimination error, subtraction error, and unit error. Similarly, Ameen (2007) attributed errors committed by students in bearing word problems in mathematics to students' lack of adequate understanding of the technical language of concepts in the mathematics word problems.

To improve on the teaching of calculus and to avoid students committing errors when solving calculus problems, the researcher intends to identify the mathematical error committed by senior school students in solving calculus. A lot of research has been done on the analysis of errors (Fajemidagba, 1986; Salman, 2004; 2005; Ameen, 2007; Odetola, 2011 e.t.c) in other topics in mathematics but not in calculus. This is one of the reasons why the researcher is intended to carry out this study.

METHOD

This section describes the methodology that was used in the study under the following sub-headings. Research Design, Population, Sample and Sampling Techniques, Research Instrument, Validation of the Research Instrument, Procedure for Data Collection, and Data Analysis Techniques.

Research Design

The research design for this study is a descriptive research of survey type and it is one of the most reliable research methods which involve the collection of data to analyze and describe existing conditions, prevailing practices, and ongoing situations. This study is authentically a descriptive one because the nature of the problem of this study involves the collection of data from a sample to identify errors committed when solving problems involving calculus in a population. Also, it's the type that is appropriate for a large population as the researcher will deal with a large population.

Population, Sample, and Sampling Technique

The population for the study was all the Senior Secondary School III students in Ilorin, Kwara State, Nigeria. The target population for this study was senior school III students in the Ilorin South Area of Kwara State. The reason for selecting senior students in (SSIII) is that calculus is being taught at the third (3^{rd}) years in senior secondary school and students at this level would have acquired adequate knowledge in calculus. The sample was drawn using the purposive sampling technique based on the fact that students fear calculus and it is a few mathematics teachers that teach calculus as a topic in most secondary schools. Thirty (30) students were selected using random sampling technique from each selected school to make a total of three hundred (300) students altogether for the study.

Research Instrument

The purpose of this study was to identify mathematical errors committed by senior school students in problem-solving involving calculus. Therefore, to carry out this research, the instrument that was used for this study is the Mathematics Performance Test on Calculus (MPT-C). The instrument was designed for data collection. The MPT-C was divided into two sections (A and B), section A consist of items about the personal data of the respondent and section B contain six (6) questions adopted from WAEC and NECO past questions that are three (3) word problems and three (3) numerical problems questions to be solved by the respondents. The items in section B were within the senior secondary school curriculum content. The items in section B of the instrument covered three-domain of calculus: limit, differentiation, and integration.

Validation of the Research Instrument

To ensure the validity of the instrument, the instrument was validated by two mathematics education lecturers in the Department of Science Education, University of Ilorin. The instrument for this study was drawn from standardized WAEC and NECO questions. The test instrument was administered to 25 students in SSIII of a nonparticipating school in the study. The test-retest method was used to determine the reliability of the instrument. A reliability coefficient of .79 was obtained using Pearson Product Moment Correlation Statistics at a .05 alpha level of significance, which shows that the instrument is reliable for the study.

Procedure for Data Collection

For valid data collection for this study, the researchers obtained an introduction letter duly signed by the Head of the Department, the Science Education University of Ilorin which was made available to the principal of the sample schools on the need to engage both teachers and students in the study. A consent notification letter was given to the selected SSIII students for endorsement by the students and their parents at home before administering the test to indicate their willingness. The researcher made it clear in the consent form that students' scores were treated confidentially for this study in line with the ethical practice of research. The selected students were allowed to participate voluntarily in the study in conformity with the ethical practice of research. Meanwhile, if any students decide to withdraw from the research at any time, such individuals might do so without any hindrance.

The researchers sought the appropriate day and time to come for the administration of the instrument as ordered by the school authority and after permission have been granted by the school authority, the researcher visited the various schools to administered and supervised the test question with the assistance of the schools' mathematics teachers. The researchers collected the scripts from the students immediately after the given time elapses to reduce the high frequency of missing or unreturned scripts and marked the script using WAEC and NECO standard marking guide.

Data Analysis Technique

All the research questions were answered using frequency mean gain differences while all research hypotheses were tested using the chi-square statistical tool. The research hypotheses were tested at 0.05 significant levels. SPSS version 23.0 was used for the analysis.

RESULTS AND DISCUSSION

This section presents the results of the data analysis using descriptive statistics. All research questions were answered using frequency count while all the research hypotheses were tested using chi-square. The research hypotheses were tested at 0.05 significant levels. SPSS version 23 was used for the analysis.

Results

Research Question 1: *What is the difference in frequency count of structural error committed in problem-solving involving calculus between male and female students?*

Table 1 shows the difference in frequency count of structural error committed by both male and female students. Their difference reveals that male students commit more structural error than their female counterparts with a mean gain difference of 16, as against female students 15.5

Table 1. Frequency of Structural Error Committed by Male and Female Senior School Students in Problem-Solving involving Calculus

Items	1	2	3	4	5	6	Total	Mean-gain Diff.
Male	18	15	-	17	23	23	96	16
Female	21	17	-	12	25	18	93	15.5
Structural Error	39	32	-	29	48	41	189	

H_{01}: *There is no significant difference in the frequency counts of structural error committed by male and female senior secondary school students in word problem solving involving calculus.*

It can be seen from Table 2 that chi-square calculated =1.8541 is less than chi-square table =9.488 at 0.05 level of significance. Hence $H0_1$ is not rejected. Thus, there is no significant difference in the frequency of each type of error committed according to gender.

Table 2. Chi-square Analysis on the Structural Error Committed by Male and Female Senior Secondary School Students According to Items

Items	Male	Female	Total	X^2_{cal}	X^2_{tab}	Df	Significant level
1	18	21	39				
2	15	17	32				
4	17	12	29	1.8541	9.488	4	0.05
5	23	25	48				
6	23	18	41				
	96	93	189				

Research Question 2: *What is the difference in frequency count of supposition error committed in problem-solving involving calculus between male and female students?*

Table 3 shows the difference in frequency count of supposition error committed by both male and female students. Their mean gain difference reveals that male students commit more structural error than their female counterparts with a mean gain difference of 14.3, as against female students 10.8

Table 3. Frequency of Supposition Error Committed by Male and Female Senior School Students in Problem-Solving involving Calculus

Items	1	2	3	4	5	6	Total	Mean gain Diff.
Male	32	26	9	12	-	7	86	14.3
Female	29	15	8	10	-	3	65	10.8
Supposition Error	61	41	17	22	-	10	151	

H_{02}: *There is no significant difference in the frequency counts of supposition error committed by male and female senior secondary school students in word problem solving involving calculus.*

It can be observed from table 4 that calculated chi-square =2.1118 is less than table chi-square =9.488 at 0.05 significance level. Hence $H0_2$ is not rejected. Thus, there is no significant difference in the frequency of each type of error committed according to gender.

Table 4. Chi-square Analysis on the Supposition Error Committed by Male and Female Senior Secondary School Students according to Items

Items	Male	Female	Total	$X^2{}_{cal}$	$X^2{}_{tab}$	Df	Significance level
1	32	29	61				
2	26	15	41				
3	9	8	17	2.1118	9.488	4	0.05
4	12	10	22				
6	7	3	10				
	86	65	151				

Research Question 3: *What is the difference in frequency count of translation error committed in problem-solving involving calculus between male and female students?*

Table 5 shows the difference in frequency count of translation errors committed by both male and female students. Their mean gain difference reveals that male students commit more structural error than their female counterparts with a mean gain difference of 21.2, as against female students 20.8

Table 5. Frequency of Translation Error Committed by Male and Female Senior School Students in Word Problem-Solving involving Calculus

Items	1	2	3	4	5	6	Total	Mean gain Diff.
Male	36	39	32	-	10	10	127	21.2
Female	37	37	22	-	11	18	125	20.8
Translation Error	73	76	54	-	21	28	252	

H03:*There is no significant difference in the frequency counts of translation error committed by male and female senior secondary school students in word problem-solving involving calculus.*

It can be observed from table 6 that calculated chi-square =4.2561 is less than table chi-square =9.488 at 0.05 significance level. Hence $H0_1$ is not rejected. Thus, there is no significant difference in the frequency of each type of error committed according to gender.

Table 6. Chi-square Analysis on the Translation Error Committed by Male and Female Senior Secondary School Students According to Items

Items	Male	Female	Total	X^2cal	$X^2{}_{tab}$	Df	Significance level
1	36	37	73				
2	39	37	76				
3	32	22	54	4.2561	9.488	4	0.05
5	10	11	21				
6	10	18	28				
	127	125	252				

Research Question 4: *What is the difference in frequency count of operation error committed in problem-solving involving calculus between male and female students?*

Table 7 shows the difference in frequency count of operational error committed by both males and students. Their mean gain difference reveals that female students commit more structural error than their male counterparts with a mean gain difference of 24.6, as against male students 19.6

Table 7. Frequency of Operational Error Committed by Male and Female Senior School Students in Word Problem-Solving involving Calculus

Items	1	2	3	4	5	6	Total	Mean gain Diff.
Male	18	27	20	8	16	29	118	19.6
Female	19	35	28	16	27	23	148	24.6
Operation Error	37	62	48	24	43	52	266	

H_{04}: *There is no significant difference in the frequency counts of operation error committed by male and female senior secondary school students in word problem-solving involving calculus.*

It can be observed from table 8 that calculated chi-square =5.162 is less than table chi-square =11.071 at 0.05 significance level. Hence $H0_1$ is not rejected. Thus, there is no significant difference in the frequency of each type of error committed according to gender.

Table 8. Chi-square Analysis on the Operation Error Committed by Male and Female Senior Secondary School Students According to Items

Items	Male	Female	Total	$X^2_{cal.}$	$X^2_{tab.}$	Df	Significance level
1	18	19	37				
2	27	35	62				
3	20	28	48	5.162	11.071	5	0.05
4	8	16	24				
5	16	27	43				
6	29	23	52				

Research Question 5: *What is the difference in frequency count of random error committed in problem-solving involving calculus between male and female students?*

Table 9 shows the difference in frequency count of random error committed by both male and female students. Their mean gain difference reveals that male students commit more structural error than their female counterparts with a mean gain difference of 13.1, as against female students 12

Table 9. Frequency of Random Error Committed by Male and Female Senior School Students in Word Problem-Solving involving Calculus

Items	1	2	3	4	5	6	Total	Diff.
Male	-	26	12	10	31	-	79	13.1
Female	-	26	16	9	21	-	72	12
Random Error	-	52	28	19	52	-	151	

H0$_5$**:***There is no significant difference in the frequency of random error committed by male and female senior secondary school students in word problem-solving involving calculus.*

It can be observed from table 10 that calculated chi-square =2.2184 is less than table chi-square =7.815 at 0.05 significance level. Hence H0$_1$ is not rejected. Thus, there is no significant difference in the frequency of each type of error committed according to gender.

Table 10. Chi-square Analysis on the Random Error Committed by Male and Female Senior Secondary School Students according to Items

Items	Male	Female	Total	X^2 cal.	X^2 table	Df	Significance level
2	26	26	52				
3	12	16	28	2.2184	7.815	3	0.05
4	10	9	19				
5	31	21	52				
	79	72	151				

Discussion

The main focus of this study was to analyze the mathematical errors committed by senior school students in problem-solving involving calculus in Ilorin, Nigeria. Therefore, this section presents a discussion of the major findings. The findings revealed the types of errors committed when solving word problems involving calculus such as translation, structural, supposition, random, and operational error.

The findings revealed that students committed more errors in solving items 1, 2, and 3 than other items, this is due to the inability to transform word problems into algebraic form. These findings are in line with Tiamiyu (2014) and Salman (2017), who affirmed that students commit errors in mathematical word problems as a result of the language problem. The findings also agree with Odetola and Salman (2014) in their study reported that students commit errors in word problems due to inadequate understanding of the mathematical language and inability to translate expression in bearing question to diagram correctly.

The findings also revealed that male and female students committed the same types of errors but the number of male students that committed errors was more than the number of female students in the word problem and numerical problem given to them to solve. This agrees with findings of Hydea and Mertzb (2009) in their study on Gender, Culture, and Mathematics performance reported that girls have reached parity with boys in mathematics performance, including at a high school where a gap existed in earlier decades and girls are doing better than boys even for a task that requires complex problem-solving.

The findings revealed that students had problems in solving calculus problems hence the number of students who could solve each problem is very low compared to those who could not. The findings revealed that there was no significant difference in the frequency count of each type of error committed by male and female senior students in word problem-solving involving calculus hence males and females committed the same types of errors while solving the question given to them.

CONCLUSION AND SUGGESTIONS

Conclusion

The following conclusions have been made in line with the findings: Five types of error have been identified with solving word problems involving calculus. These include structural, supposition, translation, operation, and random; It has been asserted that students committed errors in word problems involving calculus which contributed to students' poor performance in mathematics; It has been affirmed from this study that both male and female students experience difficulty in transforming word problems into algebraic form; Both male and female students committed all type of error identified in the study but it was more pronounced in male students than female students; The error committed were not gender influence hence there was no significant difference in the error committed by both male and female students in solving word problem in calculus.

Suggestions

Based on the findings of this study, the following suggestions are made:

1. Government should ensure engaging qualified mathematics teachers in teaching topics in mathematics involving word problems and ones on calculus in particular that have the conceptual knowledge.
2. Government should provide facilities that will aid the teaching and learning of word problems in mathematics.
3. Curriculum developers should develop instruction that will pay attention to the role of language in mathematics in general and thereby bring a reduction in the errors committed by the students in calculus problems in particular.

4. Mathematics teachers should guide students irrespective of their gender appropriately to avoid committing the identified errors taking them through the correct procedure in solving word problems.

REFERENCES

Abiam, P., & Odok, J. (2006). Factor in Students' Achievement in Different Branches of Secondary School Mathematics. *Journal of Educational and Technology, 1*(1), 161-168.

Adigun, O. T. (2016*). Analysis of Errors Committed in Solving Fraction Problems by Senior Secondary School Students in Oyo State, Nigeria.* (Unpublished Ph.D. Thesis). University of Ilorin, Ilorin, Nigeria.

Ambali, A. (2014). *Real Deal: Mathematics Education for Sustainable Development.* Unilorin Bulletin September 8, pg (4).

Ameen, S. K. (2007). *Effect of Mathematical Language Instruction on Senior Secondary School Students' Performance in Bearing Word Problems in Mathematics* (Unpublished M.Ed dissertation). University of Ilorin, Ilorin, Nigeria.

Ameen, S. K.,& Salman, M. F. (2015). Students' Mathematical Language Proficiency as a Predictor of Their Performance in Mathematics Bearing Word Problems. *ABACUS*: *Journal of the Mathematical Association of Nigeria,1*(40), 7- 8.

Cecilia, O. E.,& Anthony, A. (2013). Process Error and Students' Achievement in Senior Secondary Certificate Examination in Mathematics in Nigeria. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS),3*(4), 600-603.

Fajemidagba, M. O. (1986). Mathematics Word Problem Solving and Analysis of Errors Committed by Students. *Nigeria Journal of Guidance and Counseling, 2*(1), 23-30.

Fajemidagba, M. O., Salman, M. F.,& Ayinla, J. (2012). Effect of Teachers' Instructional Strategy Pattern on Senior Secondary School Students' Performance in Mathematics Word Problems in Ondo, Nigeria. *Journal of Education and Practice, 3*(7), 159- 164.

FRN (2013). *National policy on education* (6^{th} edition). Lagos: NERDC.

Hydea, J. S.,& Mertzb, J. E. (2009). *Gender, Culture, and Mathematics Performance.* Retrieved from http://tctvideo. madison.com/uw/gender.

Iyase, S. (2018). Mathematics: A Platform for Leapfrogging into Scientific and Technological Advancement. *14^{th} Inaugural Lecture of Covenant University, Ota, Ogun State.*

Meeriam-Webster. *(2017)* https://www.merriam-webster.com/dictionary/differential%20calculus

Nigeria Education Research and Development Council (2011). *Federal Ministry of Education Senior Secondary Education Mathematics Curriculum.* Abuja: NERDC.

Odetola, C. A. (2011). *Effect of Mathematical Language on Errors Committed by Senior School Students in Bearing Problems in Omuo-Ekiti, Nigeria*. (Unpublished Master's dissertation). University of Ilorin, Nigeria.

Opolot, O.C. (2005). Student Attitudes towards Mathematics in Uganda Secondary Schools. *Africa Journals of Research in Mathematics Science and Technology Education,9*(2), 167-174.

Pawan, S. (2013). *Mathematics: Meaning, importance, and Uses.* Retrieved from https://www.importantindia.com/8083/mathematics/

Salman, M. F. (2002). Types of Errors Committed in Word Problem Solving By Concrete and Formal Operational Junior Secondary School Students in Mathematics. *Ilorin Journal of Education, 2*(1), 155-126.

Salman, M. F. (2004). An Analysis of Gender Influence and Performance of JSS Students Technique in Solving Simultaneous Linear Equations by Graphical Method Gender Discourse. *Women Academics, 21*(1), 87-98.

Salman, M. F. (2004). Analysis of Errors Committed in Word Problems Involving Simultaneous Linear Equations by Nigerian Secondary School Students. *ABACUS: TheJournal of the Mathematical Association of Nigeria (MAN),29*(1), 39- 48.

Salman, M. F. (2005). Teachers' Identification of the Difficulty Levels of Topics in the Primary School Mathematics Curriculum in Kwara State. *ABACUS: The Journal of the Mathematical Association of Nigeria (MAN),30*(1), 20- 29.

Tiamiyu, M. A. (2014). *Errors Committed by Senior School Students in Solving Word Problems Involving Set Theory in Asa, Kwara State, Nigeria* (An Unpublished M.Ed. Dissertation). University of Ilorin, Ilorin, Nigeria.

Verschaffel L., Greer, B.,& De Corte, E. (2000). *Making Sense of Word Problems. Educational Studies in Mathematics, 42*(2), 211-213.

Wikipedia, the free Encyclopedia. (2012). *Problem-Solving.* Retrieved from http://en.wikipedia.org/wiki/Problemsolving.