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Common Process Errors in Geometry Committed by Students from Private and Public Secondary Schools in Anambra State, Nigeria

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Abstract:
The study sought to identify the common process errors of senior secondary school students in geometry in Anambra State. A descriptive survey design method was used. Three research questions and two hypotheses guided the study. Multiple stage sampling procedure was used to sample 297 senior secondary three (SS3) students from a population of 6265 for the study. The Mathematics Diagnostic Test (MDT) was the instruments used for data collection which was validated by three experts. Theinter-rater method was used to establish the reliability of the instrument which yielded a reliability index of 0.88. The data collected were analyzed using frequency counts, percentages and Mann Whitney U test. Findings of the study showed among others that; students from public schools in Anambra state committed more common process errors in geometry than their private school counterparts; students from rural locations committed more common process errors in geometry than those from urban locations. There was significant difference in the frequencies of the common process errors committed by SS3 students based on school ownership: students from public schools committed more errors than those from private schools. Based on the findings, it was recommended among others that school administrators should constantly organize conferences, seminars and workshops for both the public and private schools' mathematics teachers. This will help to bridge any gap that might exist between teaching of mathematics in the public and private schools.

Keywords: *Error identification, common process errors, geometry, school ownership*

1. Introduction

The place of mathematics in the development of any nation cannot be overemphasized. This is because mathematics education is the bedrock of scientific and technological development in any country. According to Mgban and Julie (2020), mathematics education has been widely acclaimed to be the index of measuring any nation's socio-economic and geo-political development. Mathematics involves the kind of lower-level mathematical skills one may need to use daily, for instance, calculating costs and change in transactions, basic percentages, averages or company weights (Sanders, 2019). Mathematics plays a vital role in the development of science and technology. Such importance justifies its inclusion as a compulsory subject in the primary and secondary school levels of education system, especially in Nigeria. Mathematics has many branches such as algebra, geometry, statistics, arithmetic and others.

Geometry is a branch of mathematics which deals with the study of different shapes or figures and their properties (Ahmad, 2018). Geometry could be a plane or solid shape and their properties. According to Sanders (2019), plane shape is a geometrical object with length and width/breadth or base and height/altitude. Plane shapes are also called 2-dimensional shapes such as square, rectangle, circle, polygon, triangle, and so on. A solid shape is a geometrical object with length, breadth and height or base area and height. Solid shapes are also called 3-dimensional shapes such as a cone, pyramid, sphere, cylinder, prism, cube, and cuboids.

Geometry as part of secondary school mathematics curriculum in Nigeria plays a significant role in the world of science and technology in Nigeria and other countries. It provides a rich source of visualization for understanding arithmetical, algebraic, and statistical concepts (Etsu& Ahmad, 2018). Geometry also provides a complete appreciation of the world we live in; hence it appears naturally in the structure of the solar system, a geological formation, rocks and crystals, plants and flowers, and even in animals. It is also a major part of the synthetic world such as art, architecture, cars, machines, and virtually everything humans create. In the same vein, studies example Okigbo and Ezeanyi (2020) revealed that geometry is applicable and relevant to employment in everyday live and other subjects in the curriculum such as science, arts, and technology.

Despite the important role of geometry, West African Examinations Council (WAEC) chief examiners report (2020) noted that candidates were generally weak in mathematics especially in areas of geometry and trigonometry. The

report attributed the weakness to geometry concept among other reasons as; inadequate coverage of the syllabuses, poor knowledge of the subject matter, inability of the candidates to show any firm grasp of the details needed to answer the questions and teachers' inability to properly explain the concept of geometry to the students. Also, Okigbo and Ejikeme (2017) identified geometry among others as one of the areas in mathematics teachers and students find difficult to teach and learn respectively. There is therefore the need to conduct further studies in order to diagnose and solve these problems by identifying the errors committed by secondary school students in geometry.

Error is a mistake especially one that causes problems or affects result of an activity (Homby, 2016). Inekwe (2017) defined error 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. The author also viewed mistake as an oversight that may lead to an error in problem solving which is not due to one's lack of knowledge of the correct algorithm. Errors could be procedural or conceptual in nature. Errors committed in the procedure of solving given numerical exercises are referred to as procedural errors while conceptual errors are called misconceptions. Misconceptions are terms ascribed to individual thinking pattern that create problems with respect to science learning and teaching.

School location refers to the particular place, in relation to other areas in the physical environment (rural or urban), where the school is sited (Moore, 2019). In Nigeria, rural life is uniform, homogenous and less complex than that of urban centers, with cultural diversity, which often is suspected to affect students' academic achievement. This is because urban centers are better favored with respect to distribution of social amenities such as pipe borne water, electricity, healthcare facilities while the rural areas are less favored. This is also true in the distribution of educational facilities and teachers. These prevailing conditions imply that learning opportunities in Nigerian schools differ from school to school. It would appear therefore that students in Nigerian urban schools have more educational opportunities than their counterparts in rural schools have. While some studies (Ayanwoye, 2019; Oginni, 2018) have shown positive influence, others (Ella, 2019 and Adeneye, 2016) have shown negative influence of school location on the students' learning outcome or achievement.

Nwogu (2018) found that location was significant in learning aspects of mathematics that involve angles, with rural students exhibiting more learning difficulties than their urban counterparts do. Ahiaba and Igweonwu (2017) investigated the influence of school location on the performance of mathematics students in rural and urban schools at the SSCE and found that mathematics students in urban schools performed better with superior grades, than their rural counterparts. Some studies (Bosede, 2020; Ezeh, 2018) showed no difference in academic achievement of students because of location. Others showed that rural students performed better on practical skills in mathematics than their urban counterparts did. Bosede (2020) showed that there is no difference in performance of students because of location. Since the argument on the influence of school location on students'academic performance in mathematics is still not a concluded issue, the present study will examine the efficacy of a prepared remediation package in reducing the frequency of the common process errors committed by senior secondary students in mathematics based on school location.

School ownership is in terms of establishment and management of the school. In Nigeria, school ownership is either private or public. A private school is defined as one rightly owned and cared for by an individual, group of people, or public organization such as higher institutions, army, police or road safety. A public school was defined as one owned and cared for by a government, normally through its agency charged with the responsibility of administration and supervision of educational system. The debate on public versus private education has gained increasing importance in recent years throughout the world (Adetutu, 2017). As the preference for private school education become more widespread in Nigeria, the debate on the relative merits of public and private education has gained increasing relevance and importance (Akaguri, 2019). Like other countries, the perception in Nigeria is that private schools offer a better education, an environment more conducive to learning, additional resources, and better policies and management practices.

Odual (2015) reported that students in private secondary schools achieved higher scores in mathematics than those in public schools. This is at variance with the report of David and Beegle (2018) who found that students from public senior secondary schools have higher test scores in their sectional results than those from private senior secondary schools. Alimi, Ehinola and Alabi (2019) investigated school ownership, facilities and academic performance of students in senior secondary schools in Ondo State, Nigeria and reported that there is no significant difference in academic performance of students in the two types of secondary schools based on ownership. Harry (2016) argued that private schools are not only resourced and funded but also have parents and guardians whose socio-economic class is higher than their counterpart, and are more involved in their children's education welfare, yet Harry agreed that public schools have more professionally trained and qualified teachers than the private schools. The present study intended to identify the common process errors committed by students based on school location and ownership; this is expected to help in proffering solutions to the identified problems.

1.1. Statement of the Problem

In Anambra state, research and statistical information from examination bodies like WAEC indicated a fluctuating academic performance of candidates that have sat for SSCE in mathematics. A statistic of entries and results for mathematics in Nigeria; May/June WASSCE from 2016 to 2020 indicated an average pass of about 42% for the state. The information on percentage pass in mathematics is an indication of the state of poor performance of students in mathematics. Specifically, WAEC chief examiners report (2020) identified geometry as an area in mathematics where students committed most common process errors contributing to the general poor performance. The report further identified the factors responsible and clustered them into student-related, teacher-related and systemic factors. Some of the students' related factors include misconceptions, errors committed in tests and examination and cognitive ability of

students among others. As a result, the researcher deemed it fit to investigate the types and frequency of errors committed in mathematics by senior secondary three (SS3) studentsfrom public and private schools.

1.2. Purpose of the Study

The purpose of this study was to identify the common process errors of SS3 students in geometry in Anambra State, Nigeria. Specifically, it determined:

- The common process error types committed by SS3 students in mathematics in Anambra state.
- The difference in the frequencies of the common process errors in geometry committed by SS3 students from private and public secondary schools.
- The difference in the frequencies of common process errors in geometry committed by SS3 students from urban and rural schools.

1.3. Research Questions

The following research questions guided the study.

- What are the common process error types committed by SS3 students in Anambra State?
- What is the difference between the frequencies of the common process errors in geometry committed by SS3 students from public and private schools in Anambra State?
- What is the difference in the frequencies of the common process errors in geometry committed by SS3 students based on school location (urban and rural) in Anambra state?

1.4. Hypotheses

The following null hypotheses were tested at 0.05 alpha levels.

- There is no significant difference in the frequencies of the common process errors in geometry committed by SS3 students from public and private schools.
- There is no significant difference in the frequencies of the common process errors in geometry committed by SS3 students from urban and rural schools in Anambra state.

2. Methodology

This study adopted a descriptive survey research design. The population consisted of 6,265 senior secondary three (SS3) mathematics students in Awka Education Zone of Anambra state, Nigeria. The sample for the study was 297 SS3 mathematics students sampled through multi-stage sampling. From the state, stratified and simple random sampling technique were used to select eight schools (four private and for public) from the zone. One intact class each was drawn using simple random sampling technique (balloting). A total of 297 SS3 students were obtained from the eight intact classes comprising of 148 public school students and 149 private school students as well as 142 and 155 from urban and rural locations respectively.

Mathematics Diagnostic Test (MDT) was the instrument used to investigate the common process errors in geometry. The instrument was made of two parts I and II. Part I was used to obtain the personal data of the respondents like school ownership, school location. Part II consisted of 20 essay questions in geometry adapted and modified from WAEC past questions for different years. These questions were within the curriculum for geometry aspect of mathematics covered in senior secondary schools.

The instrument was face and content validated by three experts and also trial tested. The reliability of MDT items was determined using inter rater method by administering them to 20 SS3 students from Community Secondary School Uli, Anambra state which is outside Awka Education zone. Their scripts were graded by five independent raters. Scores obtained were correlated and analyzed using Kendall's coefficient of concordance (W). This yielded reliability coefficient of 0.88 which was considered high enough to be used for the study.

The researcher used the mathematics teachers from the different schools to administer the MDT in order to identify the common process errors committed by the students. The students used pen and paper to show all their workings. After collecting the scripts, the five (5) common process errors (factual, algorithm, diagrammatic, blunder and accuracy errors) were identified in each item in the MDT from each respondent. For example, where a student was asked a question that required formula, substitution, diagram, mathematical operations or final answer and could not accomplish any of the tasks, the student was considered to have committed factual, algorithm, diagrammatic, blunder or accuracy error respectively. The frequencies of these errors were determined and grouped accordingly.

The data collected from the MDT were analyzed using descriptive and inferential statistics. The research questions were answered using frequency counts and percentages; while Mann Whitney U test was used for testing the hypotheses at 0.05 level of significance. In taking decision, if the probability value is less than or equal to significant value of 0.05 ($P \leq 0.05$), the null hypothesis was rejected but if otherwise ($P > 0.05$), the null hypothesis was accepted.

3. Results

S/N	Error Type	Frequency	Percentage
1.	Factual	6805	42.7
2.	Algorithmic	1332	8.4
3.	Diagrammatic	2396	15.0
4.	Blunder	1731	10.9
5.	Accuracy	3670	23.0
	Total	15934	100.0

Table 1: Percentage Distribution of the Common Processes Error Types Committed by SS3 Students in Mathematics

From the result in Table 1, the most frequent error-type committed was factual errors with 6805 (42.7%) followed by accuracy errors with 3670 (23.0%). The third highest percentage error committed was on diagrammatic errors with 2396 (15.0%) followed by blunder with 1731 (10.9%) and finally algorithmic errors with 1332 (8.4%).

S/N	Error type	Frequency	Public		Private		Percentage Difference
			Frequency	Percentage	Frequency	Percentage	
1	Factual	6805	**4661**	**68.5**	**2144**	**31.5**	37.0
2	Algorithmic	1332	649	48.7	683	51.3	2.6
3	Diagrammatic	2396	1428	59.6	968	40.4	19.2
4	Blunder	1731	891	51.5	840	48.5	3.0
5	Accuracy	3670	2319	63.2	1351	36.8	26.4
Total		15934	9948	62.4	5986	37.6	24.8

Table 2: Frequency Distribution of the Common Process Errors in Geometry Committed by SS3 Students Based on School Ownership (Public and Private)

Table 2 showed that students from public schools recorded higher frequency count of 4661, 1428, 891 and 2319 in factual, diagrammatic, blunder and accuracy errors respectively than their counterparts from private schools who had frequency counts of 2144, 968, 840 and 1351 in the same error types. Students from private schools had a higher frequency count of 683 in algorithmic error than their public-school counterparts who had frequency count of 649 in the same error type. Generally, students from public recorded a frequency count of 9948 representing 62.4% of the sample while those from private schools had a frequency count of 5986 representing 37.6%. The percentage difference is 24.8% indicating that students from public schools committed more common process errors than their counterparts in private schools.

S/N	Error type	Frequency	Urban		Rural		Percentage Difference
			Frequency	Percentage	Frequency	Percentage	
1	Factual	6805	**2463**	**36.2**	**4342**	**63.8**	27.6
2	Algorithmic	1332	551	41.4	781	58.6	17.2
3	Diagrammatic	2396	946	39.5	1450	60.5	21.0
4	Blunder	1731	547	31.6	1184	68.4	36.8
5	Accuracy	3670	2140	58.3	1530	41.7	16.6
Total		15934	6647	41.7	9287	58.3	16.6

Table 3: Frequency Distribution of the Common Process Errors in Geometry Committed by SS3 Students Based on School Location (Urban and Rural)

Table 3 indicates that students from rural location had higher frequency counts of 4342, 781, 1184 and 2264 in factual, algorithmic, blunder and accuracy respectively than their male counterparts who had 2463, 551, 547 and 1406 in the same error types. The urban students had higher frequency count of 1426 in diagrammatic error than the rural school students who had 970 in the same error type. Generally, students from rural locations had higher frequency count of 9541 representing 59.9% than their urban counterparts with a frequency count of 6393 representing 40.3% of the sample. The percentage error difference was 19.8% showing that the students from rural locations committed more common process errors than their urban counterparts.

Ownership	N	Mean ranking	U	Sig
Public	148	193.06		
			17546.500	0.000
Private	149	105.24		

Table 4: Summary of Independent – Samples Mann Whitney U Test of Frequencies of Common Process Errors in Geometry Committed by Students from Public and Private Schools

The result in Table 4 indicated that the mean rankings for students from public and private schools were 193.06 and 105.24 respectively yielding a U value of 17546.500. The p value of 0.000 was obtained which is less than the level of significance set at P≤ 0.05. The null hypothesis three was therefore rejected. This indicated that there is significant difference in the frequency of common process errors committed by students from public and private locations implying that students from public schools committed more common process errors than their counterparts in private schools since their mean ranking is higher.

Location	N	Mean Ranking	U	Sig
Urban	143	108.51		
			16801.500	0.000
Rural	154	186.60		

Table 5: Summary of Independent – Samples Mann Whitney U Test of Frequencies of Common Process Errors in Geometry Committed by Students from Urban and Rural Locations

The result in Table 5 indicated that the mean rankings for students from urban and rural locations were 108.51 and 186.60 respectively with a U value of 16801.500. The p value of 0.000 was obtained which is less than the level of significance set at P≤ 0.05. The null hypothesis two was therefore rejected. This indicated that there is significant difference in the frequency of common process errors committed by students from urban and rural location which implies that students from rural location committed more common process errors than their counterparts in urban locations since their mean ranking is higher with.

4. Discussion of Findings

The findings of this study showed that different common process errors were identified to have been committed by senior secondary school students in mathematics with different frequencies. The identified common process errors were classified into factual, algorithm, diagrammatic, blunder and accuracy error-types based on the classification of WAEC Chief Examiners report (2020). Frequencies of common process errors types indicated in Table 1 showed that factual error has the highest frequency and algorithmic error having the least. The factual errors and algorithmic errors are due to several causes related to the concept that is being learnt, the students' previous knowledge and ability. The factual error being the highest in frequency is in agreement with the findings of Ezeanyi (2021) but in disagreement with the findings of Etsu and Ahmad (2018) who identified accuracy error as the highest occurring in learning quadratic equations. The finding also disagrees with finding of Odual (2015) who found computational errors highest in whatever form or type and causes some anomaly in the teaching and learning of mathematics which is needed for national developmentas and as such studying error-types with a view to remediating them is highly required.

The findings of this study had shown that public senior secondary school students committed more common process errors than those from private schools. There was significant difference between the frequency of common process errors of public and private SS3 senior secondary school students in geometry with public school students committing more error frequency than those from private schools. These finding concur with the finding by Odual (2015) that there was significant difference between the frequencies of errors committed students from public and private schools with those from public schools committing more than their private school counterparts. Finding by Harry (2016) also confirmed the findings of the present study. Ahmad (2018) found that children in private schools did not commit more errors in mathematics than their counterparts in public schools, that both public and private schools' students are equally comparable.

The discrimination in the frequency of common process errors in geometry between public and private schools should be explicated by the reason that private schools owned by individuals or a religious group give better and closer monitoring and supervision to the teachers by the owners since their academic performance will keep them in business while their public counterparts may not have such. There is also the possibility that most students in private schools come from influential homes and so may have opportunity for home lesson teachers together with the compulsory extra classes in most private schools.

This study sought to find out whether some or all common process errors identified are peculiar to students in urban or rural areas. The findings from results in table 3 revealed that the rural students committed more common process errors than their urban counterparts with a percentage difference of 16.6%. Furthermore, the result on table 3 indicated a significant difference in the frequency of common process errors committed by students from urban and rural locations with students from rural locations committing more errors. These findings are in agreement with the findings by Okigbo and Ejikeme (2017) that students from urban areas perform better than in mathematics those from rural areas.These findings were not akin to the findings by Ezeh (2018) that the location of the school had no significant effect on students' mastery of mathematics concepts. Nwogu (2018) found that rural and urban students had comparable levels of mathematics skills. That rural students possessed more skills than their urban counterparts in some other provinces. Also, Ihiaba and Igweonwu (2017) found that there was significant difference in the use of mathematics skills learning strategies between urban and rural school students.

These findings all disagree with the present study. The present findings may be because schools in the rural locations suffer dearth of teaching and learning facilities. Most teachers posted to rural locations abscond and reject their postings thereby leaving the rural schools and their students with insufficient or no teaching staff.

5. Conclusion

This study has provided empirical evidence that common process error types committed in geometry by senior secondary three students include factual, algorithmic, diagrammatic, blunder and accuracy errors. Also, students from public and rural schools committed more errors than their counterparts in private and urban schools.

6. Recommendations

Based on the findings of this study, the following recommendations were proffered:

- Mathematics teachers should constantly engage the students in the classroom with diagnostic tests with a view to identifying common process errors in mathematics.
- Mathematics textbook authors and other textbook developers should adopt the instrument (MDT) developed in this study as a guide in developing future textbooks, so as to help reduce some of these errors committed by the students.
- Mathematics teachers from rural and public schools should put more efforts in teaching their subjects in secondary schools.

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