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THE SEVERITY OF DYSCALCULIA AND STUDENT MATHEMATICS PERFORMANCE IN OBIO/AKPOR LOCAL GOVERNMENT AREA

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Abstract
The main aim of the study was to find out the relationship between dyscalculia and the performance of students in mathematics. The correlational research design was adopted. A sample of 137 Senior Secondary Students with dyscalculia took part in the study. A diagnostic test was administered to the students to identify students with dyscalculia. The criteria for inclusion of the dyscalculic students in the study was that; students with scores less than Mean($\bar{x}$) – 1(SD) were assumed to have mild dyscalculia while those with a score less than Mean ($\bar{x}$) – 2(SD) were assumed as having severe dyscalculia, where $\bar{x}$ is the mean score of all the students in the diagnostic test. A Mathematics Achievement Test (MAT) was used for data collection. It contained 25 multiple-choice questions with five (5) standardized questions each from five (5) themes in the senior secondary curriculum mathematics (Number and Numeration, Algebraic Process, Mensuration, Trigonometry and Statistics). The Phi-coefficient was used to answer the research questions whereas the hypotheses were tested using the Chi-square test. The result established that the academic performance of the students in number and numeration was significantly related to the severity of dyscalculia. The result however showed that the academic performance of the students in Algebraic Process, Mensuration, Trigonometry and Statistics were not significantly related to the severity of dyscalculia. Three (3) of the five (5) themes explored respectively showed an inverse relationship with severity of dyscalculia. It was recommended among others that dyscalculic students should be diagnosed to know the severity of their dyscalculia to identify a remedial approach to teaching them because a student can be dyscalculic in one branch of mathematics and another not dyscalculic.

Keywords: Severity, Dyscalculia, Senior, Secondary, Student, Performance

Introduction

Experience shows that some learners struggle with mathematical problem-solving whereas some others do not. Those who struggle with mathematical problem-solving usually score lower than those who do not struggle with it. Those who have Mathematics Difficulties (MD) are said to have Mathematics Learning Disability (MLD). Irrespective of their positive attitude towards mathematics, they still perform poorly in mathematics. Dyscalculia is one of the MLDs. Dyscalculia comes from Greek and Latin which means: "counting badly." The prefix "dys" comes from the Greek and means "badly". "Calculia" comes from the Latin "calcular" which means "to count". Dyscalculia is a specific learning disability involving innate difficulty in learning or comprehending simple mathematics. The American Psychiatric Association. (2018) defined dyscalculia as a mathematics learning disability that hinders a student's ability to perform accurate mathematics calculations, learn number-related concepts, reason, solve problems and execute other mathematics skills. Soares and Patel (2015) established that dyscalculia is prevalent in about 11% of the learners with Attention Deficit Hyperactivity Disorder (ADHD or ADD) whereas Morsanyi, et al. (2018) indicated that the prevalence of other learning disorders such as dysgraphia and dyslexia is about 45% with learners with ADHD.

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Students with dyscalculia may show signs including difficulties: processing quantities and numbers, subsidizing/ recognizing quantities without counting, recalling fundamental mathematics facts, connecting symbols and numbers, problem-solving and mental mathematics, estimating quantities and making sense of money, telling time on an analogue clock, spatial orientation and poor visual, sorting out directions, and sequencing and recognizing patterns (Haberstroh, & Schulte-Körne, 2019; Bird, 2017). Mathematics disabilities can also occur as the result of some types of brain injury in which case the proper term is acalculia, to distinguish it from dyscalculia which is innate, genetic and of development origin (Ardila & Rosselli, 2019). Neuroscientists have identified parts of the brain that we use when we do arithmetic and are looking for the difference that would explain why some children have so much difficulty learning how to perform even basic calculations. Some educational professionals and cognitive psychologists such as Dehaene (2004) and Butterworth (2005) see dyscalculia as a more fundamental inability to conceptualize numbers as abstract concepts of comparative quantities (a deficit in the number sense) which these researchers considered a fundamental skill, upon which other mathematics abilities are built.

Wilson and Dhaene (2007) wrote a review revolving around the idea of Developmental Dyscalculia (DD) being because of a core numerical deficit. They still suggested that other subtypes of Developmental Dyscalculia could exist and would involve brain areas other than the intraparietal sulcus. That is, difficulties in performing and acquiring basic mathematics skills. It is related to genetics and brain development (Szűcs & Goswami, 2013). American Psychiatric Association (2014) established that dyscalculia is categorized under Specific Learning Disorder (SLD) in the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5). The criteria are:

- individuals with dyscalculia exhibit at least one of six outlined symptoms related to difficulties with learning and using academic skills. Difficulties with mastering number sense and mathematical reasoning are included in the list.
- the affected academic skills are below what is expected for the individual's age, which also causes trouble with school, work, or daily life.
- the learning difficulties began in school, even if problems only became acute in adulthood.
- other conditions and factors are ruled out, including intellectual disabilities and neurological disorders, psychosocial adversity, and lack of instruction

Mathematics-based learning disabilities resulting in SLD or mathematical impairment are equivalent to dyscalculia. Dyscalculia can be mild, moderate or severe (Ashraf & Najam, 2020). The intervention to be adopted sometimes depends on the severity level of the MLD. The severity of dyscalculia could affect only the mathematical performance of some students. It can also affect some students in terms of their lifetime interaction with numeracy. Wonu (2020) carried out an educational intervention to improve the everyday arithmetic learning outcomes of students with Attention Deficit Hyperactivity Disorder and/or Developmental Dyscalculia and found that metacognitive instructional strategy was useful in advance the problem-solving task performance of the students.Wonu and Zalmon (2017) diagnosed and remediated senior secondary students common difficulties in mathematics using the chief examiners' report. Wonu and Ogunkunle (2015) explored the efficacy of metacognitive strategy in enhancing the planning skills of students with developmental dyscalculia in number and numeration. A study trying to associate the severity of dyscalculia with the performance of students in different aspects of mathematics is worthwhile and timely.

Statement of the Problem

The West African Examination Council (WAEC) and Joint Admission and Matriculation Board (JAMB) annually publish the percentage of students who passed or failed mathematics. The percentage of those who failed is usually higher than the percentage of those who passed. This failure rate is published but not much is done to change this trend. Most of the students who fail mathematics are dyscalculic and dyscalculia like other learning disabilities cannot be treated medically. The rationale for treatment is to figure out a lifetime coping mechanism. This is achieved through accommodation, special instruction and other interventions. However, the knowledge of the severity of the dyscalculia is vital for the identification of the intervention method suitable for dyscalculic students. This study, therefore, intends to find out the relationship between the severity of dyscalculia and the performance of students in the various themes of the senior secondary class I mathematics curriculum. The five themes of the

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senior secondary mathematics curriculum such as the number of numeration, algebraic process, mensuration, trigonometry and statistics were considered.

Aim and Objectives of the study

The main aim of the study was to find out the relationship between severity of dyscalculia and the performance of students in mathematics. Specifically, the study determined:

1. the relationship between the severity of dyscalculia and the performance of students' in Number and Numeration
2. the relationship between the severity of dyscalculia and the performance of students in the Algebraic process
3. the relationship between the severity of dyscalculia and the performance of students in Mensuration
4. the relationship between the severity of dyscalculia and the performance of students in Trigonometry
5. the relationship between the severity of dyscalculia and the performance of students in Statistics

Research Questions

The following research questions were answered to guide the investigation.

1. What is the relationship between the severity of dyscalculia and the performance of students in Number and Numeration?
2. What is the relationship between the severity of dyscalculia and the performance of students in the Algebraic process?
3. What is the relationship between the severity of dyscalculia and the performance of students in Mensuration?
4. What is the relationship between the severity of dyscalculia and the performance of students in Trigonometry?
5. What is the relationship between the severity of dyscalculia and performance of students in Statistics?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant relationship between the severity of dyscalculia and the performance of students in Number and Numeration.
2. There is no significant relationship between the severity of dyscalculia and the performance of students in the Algebraic Process.
3. There is no significant relationship between the severity of dyscalculia and the performance of students n Mensuration.
4. There is no significant relationship between the severity of dyscalculia and the performance of students in Trigonometry.
5. There is no significant relationship between the severity of dyscalculia and the performance of students in Statistics.

Methods and Materials

Research Design

The design of the study is correlational. Correlational design seeks to establish what relationship exists between two or more variables. It is a correlational study because it gathered data from performance of students and severity level of dyscalculia identified (either severe or mild).

Participants

A sample of 137 SSCI students in Obio/Akpor Local Government Area was used for the study. The Taro Yamane formula was used to estimate the minimum sample size selectable from the accessible population of 1003 students in five(5) randomly selected senior secondary schools in Obio/Akpor LGA to allow generalization. A minimum sample size of 399 was obtained. However, the sample of 400 students was then chosen using the random sample technique. Then a diagnostic test was administered to the 400 students earlier selected to identify the dyscalculic students. On using the Mathematics Disability Diagnostic Test (MDDT) the criteria for inclusion of the dyscalculic students in the study are: 1). students with scores less than mean ($\bar{x}$) – 1(SD) were assumed to have mild dyscalculia. 2). those with a score less than mean ($\bar{x}$) – 2(SD) were assumed as having severe dyscalculia, where $\bar{x}$ is the mean score of all the students using the MDDT. Finally, a sample of 137 dyscalculia students was obtained with 69 students having mild dyscalculia and 68 with severe dyscalculia. The America Psychiatric Association (1987) suggests various approaches to identify students with dyscalculia as well as its severity.

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Instruments for data collection

Two instruments, Mathematics Disability Diagnostic Test (MDDT) and Mathematics Achievement Test (MAT) were used for data collection. The MDDT contained 20 multiple-choice questions in mathematics with three distractors and one correct option. It was utilized to diagnose and identify dyscalculic students and categorize them into mild and severe levels. The MAT is another test with 25 multiple-choice questions. This was used to measure the performance of the students in different themes of mathematics taught at their level. Section A is the demographics and Section B contains five subsections of five standardized questions in each theme of the senior secondary class I curriculum mathematics, viz: Number and Numeration, Algebraic Process, Mensuration, Trigonometry and Statistics. The reliability coefficients of the tests were determined using the Kuder-Richardson formula to obtain indices of 0.83 and 0.75 for MAT and MDDT respectively.

Data collection

Following the conclusion of the diagnosis, identification and classification of the students using MDDT, the researchers administered MAT to only the identified 137 students with dyscalculia on another occasion. The intention was to quantify the mathematics performance of the dyscalculics to relate their scores to the severity of the dyscalculia.

Data analysis

The Phi-coefficient was used to answer the research questions whereas the Chi-square test was used to test the hypotheses at a .05 level of significance.

Results

Table 1: Phi-Correlate of the Relationship between Severity of Dyscalculia and performance of students in Number and Numeration (NAN)

	NAN Performance			Ø	χ^2 cal	χ^2 crit	Decision
Severity of Dyscalculia	**Pass**	**Fail**	**Total**				
Mild	69	0	69	0.175	4.180	3.84	S^{+ve}
Severe	64	4	68				
Total	**133**	**4**	**137**				

Key: S^{+ve} =Positive and significant relationship

Table 1 shows that there is a weak and positive relationship between the severity of dyscalculia and the performance of students in Number and Numeration (Ø=0.175). Furthermore, since χ^2 cal (4.180) is greater than χ^2 crit (3.84) at the df of 1 and 0.05 level of significance. We reject the null hypothesis one, the result that there is a significant relationship between the severity of dyscalculia and the performance of students in Number and Numeration.

Table 2: Phi-Correlate of the Relationship between Severity of Dyscalculia and the Performance of Students in Algebraic Process (ALP)

	ALP Performance			Ø	χ^2 cal	χ^2 crit	Decision
Severity of Dyscalculia	**Pass**	**Fail**	**Total**				
Mild	35	34	69				
Severe	44	24	68	-0.141	1.866	3.84	NS^{-ve}
Total	**79**	**58**	**137**				

NS^{-ve}=Inverse and not significant relationship

Table 2 shows that there is a weak and inverse relationship between the severity of dyscalculia and the performance of students in the Algebraic Process (Ø=-0.141). Furthermore, since χ^2 cal (1.866) is less than χ^2 crit (3.84) at the df of 1 and 0.05 level of significance. We retain the null hypothesis two, the result that there is no

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significant relationship between the severity of dyscalculia and the performance of students in the Algebraic Process.

Table 3: Phi-Correlate of the Relationship between Severity of Dyscalculia and the performance of students in Mensuration (MSR)

	MSR Performance			Ø	χ^2 cal	χ^2 crit	Decision
Severity of Dyscalculia	**Pass**	**Fail**	**Total**				
Mild	16	53	69				
Severe	18	50	68	-0.03	0.19	3.84	***NS^{-ve}***
Total	**34**	**103**	**137**				

NS^{-ve}=Inverse and not significant relationship

Table 3 shows that there is a weak and inverse relationship between the severity of dyscalculia and performance of students in Mensuration (Ø=0.037). Furthermore, since χ^2 cal (0.19) is less than χ^2 crit (3.84) at the df of 1 and 0.05 level of significance. We retain the null hypothesis three, the result that there is a significant relationship between the severity of dyscalculia and the performance of students in mensuration.

Table 4: Phi-Correlate of the Relationship between Severity of Dyscalculia and the Performance of Students in Trigonometry (TRG)

	TRG Performance			Ø	χ^2 cal	χ^2 crit	Decision
Severity of Dyscalculia	**Pass**	**Fail**	**Total**				
Mild	41	28	69				
Severe	44	24	68	-0.05	0.40	3.84	***NS^{-ve}***
Total	**85**	**52**	**137**				

NS^{-ve}=Inverse and not significant relationship

Table 4 shows that there is a weak and inverse relationship between the severity of dyscalculia and the performance of students in Trigonometry (Ø=-0.05). Furthermore, since χ^2 cal (0.40) is less than χ^2 crit (3.84) at the df of 1 and 0.05 level of significance. We retain the null hypothesis four, the result that there is no significant relationship between the severity of dyscalculia and performance of students in Trigonometry.

Table 5: Phi-Correlate of the Relationship between Severity of Dyscalculia and the Performance of Students in Statistics (STA)

	STA Performance			Ø	χ^2 cal	χ^2 crit	Decision
Severity of Dyscalculia	**Pass**	**Fail**	**Total**				
Mild	29	40	69				
Severe	18	50	68	0.16	3.67	3.84	**NS^{+ve}**
Total	**47**	**90**	**137**				

NS^{+ve}=*Positive and not significant relationship*

Table 5 shows that there is a weak and positive relationship between the severity of dyscalculia and students' performance in Statistics (Ø=0.16). Furthermore, χ^2cal (3.67) is less than χ^2crit (3.84) at the df of 1 and 0.05 level of significance. We retain the null hypothesis five, the result that there is no significant relationship between the severity of dyscalculia and students' performance in Statistics.

Discussion

The result from Table 1 showed that there was a strong and direct relationship between the severity of dyscalculia and student performance in Number and Numeration (Ø=0.175) and when put to statistical test and result was that there was a significant relationship between severity of dyscalculia and student performance in Number and Numeration. The null hypothesis one was rejected at a .05 level of significance. The result from Table 2 showed that there was a weak and inverse relationship between the severity of dyscalculia and performance of students in the Algebraic Process (Ø=-0.141). When put to the statistical test, the result was that there is no significant relationship between the severity of dyscalculia and performance of students in the Algebraic Process. The null hypothesis two was retained at a .05 level of significance. The result implied that any increase in the severity of dyscalculia might lead to a corresponding decrease in the performance of the students in Algebraic Processes. The

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result from Table 3 showed that there was a weak and inverse relationship between the severity of dyscalculia and performance of students in Mensuration (Ø = -0.03). When put to the statistical test, the result was that there was no significant relationship between the severity of dyscalculia and the performance of students in Mensuration. The null hypothesis three was retained at a .05 level of significance. The result implied that any increase in the severity of dyscalculia might lead to a corresponding decrease in the performance of the students in mensuration. The result from Table 4 shows that there was a weak and inverse relationship between the severity of dyscalculia and performance of students in Trigonometry (Ø = -0.05). When put to the statistical test, the result was that there was no significant relationship between the severity of dyscalculia and performance of students in Trigonometry. The null hypothesis four was retained at a .05 level of significance. The result implied that any increase in the severity of dyscalculia might lead to a corresponding decrease in the performance of the students in Trigonometry. The result from Table 5 shows that there was a weak and positive relationship between the severity of dyscalculia and performance of students in Statistics (where Ø = 0.16). When put to the statistical test, the result was that there was no significant relationship between the severity of dyscalculia and performance of students in Statistics. The null hypothesis five was retained at a .05 level of significance. The result implied that any increase in the severity of dyscalculia might not lead to a corresponding decrease in the performance of the students in Statistics. The findings have established the severity of dyscalculia had an inverse and weak relationship with the performance of students in mathematics. This is because the study found a weak and inverse association between the severity of dyscalculia and the performance of students in three of the five response variables considered in the study. Dyscalculia can be mild, moderate or severe, (Ashraf, & Najam, 2020) and the severity of dyscalculia has shown to be strongly related to the performance of students in Number and Numeration.

Conclusion

This study is a revelation to mathematics educators who have neglected the fact that a student who passes a mathematics test in an area of mathematics can also be diagnosed dyscalculic in another aspect of mathematics. As such, this student can be identified to have mild or severe dyscalculic. Based on the findings, students performed poorly in mensuration. This implies mathematics teachers should pay more attention to this branch of mathematics by using an effective method of teaching to improve the performance of students in the subject. The severity of dyscalculia appears to have inverse but weak relationships with the performance of students in Algebraic processes, mensuration and trigonometry respectively. The relationship between the severity of dyscalculia and performance in Number and Numeration was strong and direct. A weak but positive relationship between the severity of dyscalculia and the performance of students in Statistics was established. It can be concluded that the severity of dyscalculia is inversely related to the performance of students in mathematics. An increase in the severity of dyscalculia can lead to a concomitant decrease in the performance of the students in mathematics.

Recommendations

Based on the findings the following recommendations were made:

1. dyscalculic students should be diagnosed to know the severity of their dyscalculia to identify a remedial approach to teaching them because a student can be dyscalculic in a branch of mathematics and another not dyscalculic.
2. the counselling units of these secondary schools in Obio/Akpor LGA should be revived for counsellors to have one-on-one interactions with students who have this learning disability.
3. teachers should pay more attention to mensuration to increase the rate of passes by using an effective method of teaching.

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