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Helping Dyscalculia Children Reduce Difficulty in Mathematics Learning in Upper Basic Schools in Okigwe Education Zone of Imo State

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ABSTRACT

This article focuses on the problems related to mathematics learning due to dyscalculia and effective ways of delivering mathematical content in the classroom to support students with dyscalculia. However, two hypotheses guided the study. A survey design was adopted. A sample of 79 teachers was used. The instrument for data collection was a questionnaire. It was validated by one expert from Special Needs Education and two experts from Measurement and Evaluation from the Alvan Ikoku Federal University of Education, Owerri. The Cronbach Alpha method was used to obtain a reliability index of 0.81 for the instrument. The data collected were analysed using mean, standard deviation and correlational analysis statistics. Findings revealed the causes of poor performance in Mathematics due to dyscalculia, and the effects of dyscalculia among secondary school students in Okigwe Education Zone. It recommends that students with dyscalculia should be provided with specialised instructions and dedicated time.

Keywords: *Dyscalculia, mathematics learning, learning difficulties, dyscalculia children, mathematical concepts.*

INTRODUCTION

Dyscalculia is a specific learning difficulty that results from accidental brain damage or disorder, and inability to retain mathematical skills related to calculating numbers. About 3 to 6% of students are currently facing problems associated with number comparison,

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symbol identification and reasoning. The abstract nature of Mathematics makes it appear a difficult subject. This scenario of difficulty in learning Mathematics is seen as a worldwide issue. Its difficulty in understanding notwithstanding, Mathematics remains a crucial subject whose concepts cut across every field of human endeavour. Its relevance has made it a fundamental and compulsory subject in the school curriculum. The belief that students need special ability and utmost brilliance to achieve well in Mathematics, rather than interest, perseverance, good strategies, and the like, has often caused them to develop a negative attitude towards learning the subject with ease. Many students have a phobia of the study of Mathematics; even just hearing the word Mathematics, their anxiety rises.

It has been shown that learners can be taught effectively using Piaget's child developmental stages philosophy, which states that a child will understand space, time and number, classes and relations of invariance and change. In recent times, however, modern research has focused on the causes of mathematics learning difficulties as well as the procedural and neurobiological foundations of the learner. Mathematics is conceived as a product of human activities in the process of adapting to the external environment (Baccaglini-Frank, 2020). According to Chinn (2015), the precise acquisition of mathematical abilities involves a broad range of cognitive skills, including auditory and visual working memory, a pattern of recognition, speed of information processing, spatial perception, and attention. According to Kunwar (2020), these skills enable students to perform different mathematical functions and improve their performance. Among them, working memory is a strong predictor of mathematical skills across time, achievement and achievement growth in mathematics. Working memory enables adolescents to perform accurate calculations faster.

According to Kunwar *et al.* (2021), the deficit in working memory, a brain-related condition, genetic cause, environment and brain difference is considered dyscalculia. The deficits affect the learner's mathematical capability, particularly computation and reasoning. Going further, Kunwar posits that such problems of the learner as enumerated above gradually tend to create frustration to learn mathematical problems regarding computation & application. It is on this premise that this discourse looks at effective support systems and content delivery for children with dyscalculia in mathematics learning. Meanwhile, some of the components that come to mind when learning Mathematics include:

(i) Language component is a key component used to describe Mathematical terms, notations, concepts, ideas and procedures to develop mathematical knowledge and understanding. It is also used in conceptualising and communicating mathematical information.

(ii) Conceptual Component refers to an understanding of the actual meaning and is intended to increase literacy in Mathematics, rather than stepwise teaching to find

the solutions. It focuses on explaining the processes (why) rather than performing the processes (how). Conceptual learning begins in early childhood by using effective methods, modern tools and techniques.

(iii) Procedural component refers to the ability to apply procedures accurately, efficiently and flexibly; transfer procedures to different problems and contexts; build or modify procedures from other procedures and recognise when one strategy or procedure is more appropriate to apply than another. It is more than memorising facts or procedures.

Meaning of Dyscalculia

The word dyscalculia is Greek or Latin, Calculare meaning to count. Therefore, according to Czechoslovakian researcher, Kosc in 1974, dyscalculia is difficulty in Mathematics as a result of impairment to particular parts of the brain involved in Mathematical cognition, but without a general difficulty in cognitive function. Dyscalculia could be developmental dyscalculia, a congenital condition that affects the learner's ability to develop arithmetical skills or competencies. Dyscalculia may be caused by accidental brain damage (acquired dyscalculia). In other words, dyscalculia is also known as difficulty with numbers, being bad at Mathematics or number blindness. Hornigold (2015) states the dyscalculic learner always struggle with the deficit in Mathematics such as remembering number facts and time tables, counting backwards in steps, learning to tell the time, calculations involving money and fractions, decimals and percentages, place value, the principle of exchange and their mathematical procedures as well as other basic numerical processes in Mathematical procedures as well as other basic numerical processes in Mathematics. However, mostly, these difficulties can be overcome with extra support and intensive intervention. It is noteworthy that dyscalculia is the result of specific challenges in basic numerical processing, rather than the consequence of deficits in other cognitive abilities (Kunwar, 2020).

According to Grant (2017), the specific learning deficits in Mathematics include number sense, memorisation of arithmetic facts, accurate or fluent calculation and accurate mathematical reasoning. Among them, number sense can be classified as dyscalculia, and the core deficit of dyscalculia is the inability to understand the concept of more than or less than. Hornigold (2020) states that around 6% of children have dyscalculia, and this lies within the range of 3 – 6% of school-age children. Sharma (2020) claims that it occurs in 6 – 8% of the school-age population. King (2016) posits that dyscalculia is a brain-based disorder as indicated by genetic, neurobiological and epidemiological evidence.

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Types of Dyscalculia

Researchers in the field of mathematical learning disability have to categorise dyscalculia based on different dimensions of acquiring mathematical ability. Kosc (2015), in his focus, categorised it into six:

(i) Verbal dyscalculia – where children can read or write but find it difficult to recognise them when presented verbally.
(ii) Prognostic dyscalculia – children can understand mathematical concepts but have trouble in listening, comparing, and manipulating mathematical equations.
(iii) Lexical dyscalculia – a reading disability of mathematical symbols (digits, numbers, mathematical expressions, and/or equations).
(iv) Graphical dyscalculia – disability in manipulating mathematical symbols in writing. Learners can understand but feel troubled while writing or using the correct corresponding symbols. They may also be unable to copy them if written.
(v) Ideognostical dyscalculia – children have difficulty in completing mental operations and remembering mathematical concepts after learning them.
(vi) Operational dyscalculia – having calculation problems due to interchange of operations, e.g., doing addition instead of multiplication or subtraction in place of division.

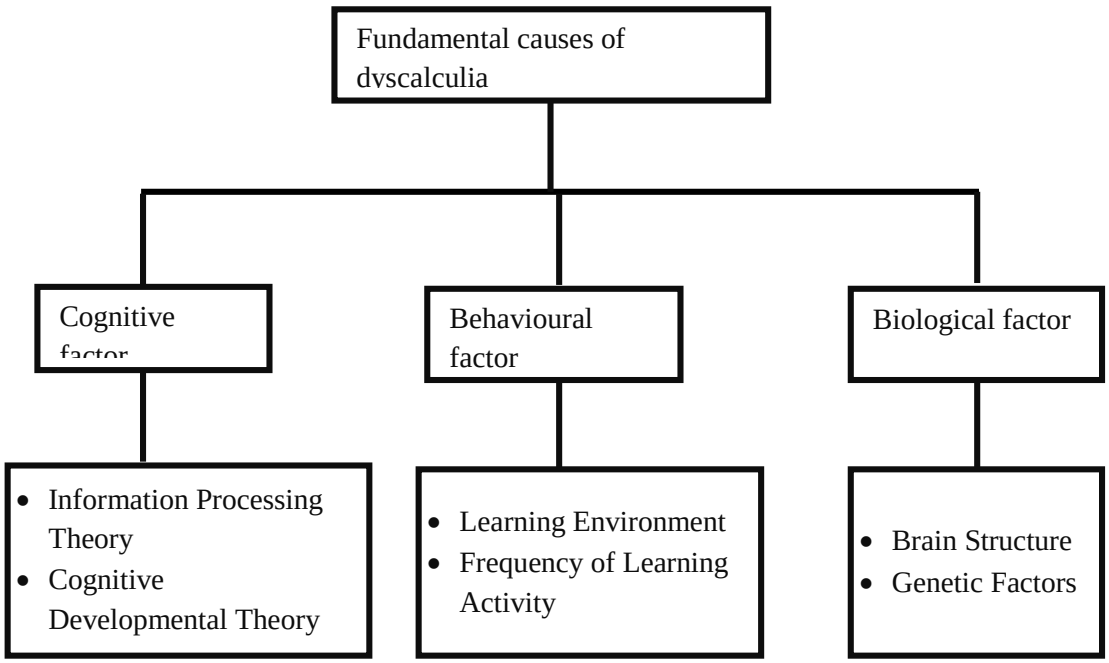

Fig. 1: The fundamental category of causes of dyscalculia

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Furthermore, Geary (2011) divided dyscalculia into three types, semantic memory, procedural memory and visuospatial memory, whereas Karagiannakis (2014) categorised it into four types, core number, reasoning, memory and visual spatial.

Causes of Dyscalculia

There are varied views about the causes of dyscalculia, but generally, researchers have common agreement that dyscalculia is a brain-based condition. Arguably, this maths learning difficulty can be categorised within the cognitive, behavioural and biological aspects contextualised in teaching and learning mathematics. However, some common areas of difficulty in mathematics for dyscalculic learners include: counting backwards and counting in steps, sequencing and recognising patterns, calculations, direction & orientation, estimation, time, assessing numerical quantity, money, mental mathematics and fractions. Furthermore, dyscalculia impacts children from the early age of schooling onwards.

Purpose of the Study

The purpose of this study is to find out how to help dyscalculia children to overcome their mathematics learning difficulties in secondary schools in the Okigwe Education Zone of Imo State. Specifically, it sought to:

(i) Find out the fundamental causes of dyscalculia among school children
(ii) Ascertain some of the major effects of dyscalculia on mathematics learning generally
(iii) Determine some of the ways dyscalculia children could be helped to overcome their mathematics learning difficulties in secondary schools.

The following questions guide the study:

(1) What are the fundamental causes of dyscalculia among secondary school children in the Okigwe Education Zone of Imo State?
(2) What are the major effects of dyscalculia on Mathematics learning generally?
(3) In what ways can dyscalculia children in secondary schools be helped to overcome their mathematics learning difficulties?

Hypotheses

1. There is no significant relationship between the causes of dyscalculia and students' weakness in understanding mathematics.
2. There is no significant relationship between the effects of dyscalculia and students' learning outcomes in mathematics.

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METHOD

The correlational design was adopted for the study. Four research questions and two null hypotheses were formulated to guide the study. Some related literature were reviewed and a population of 79 teachers of special education centres from across Okigwe Education Zone of Imo State which formed the sample size were used for the study. The instrument for data collection was a researcher-made-questionnaire which was validated by one expert in special needs education and two experts from measurement and evaluation. Cronbach alpha reliability method was used to obtain a reliability coefficient of 0.81 for the instrument. One research assistant followed the researcher to collect data from the special needs education centres using the validated instrument. Direct approach was adopted to collect the information from the respondents and this orchestrated a 100% return rate of the instrument. Data collected from the field work were assembled, tabulated, coded and analysed using mean and standard deviation for the research questions and correlational analysis for the null hypotheses.

RESULTS

Table 1: Mean score responses on the causes of dyscalculia among school children

S/N	Item	X	SD	Remarks
1	Lexical misfunction is actually the root cause of dyscalculia in mathematics among discalculic learners	3.5	0.49	Agree
2	Dyscalculia is a brain-based condition which results due to some huddles during the developmental stages of piagets' child development theory leading to poor acquisition of number concepts and the inability to acquire arithmetical skills and understandings	3.0	0.87	Agree
3	The information processing theories can cause to accommodate the number concept and difficulty with numbers	3.2	0.95	Agree
4	Effective teaching and learning-related factors such as teaching methods, materials, motivation, stress, anxiety, classroom environment, socio-cultural factors, etc can cause the inability to acquire the number concept and arithmetic skills	3.3	0.74	Agree
5	Frequent learning activities or drills and practice can also aid to attain the learning problem related to numbers	3.2	0.81	Agree
6	The development of brain structure which depends upon prematurity and low weight birth and leads to differences in the surface area, thickness and volume of the different parts of the brain that are used in memory and keeping track of tasks (often identified by MRI scans) can cause dyscalculia in learners	3.2	0.84	Agree
7	Dyscalculia can also be caused by genetic factors like heredity	3.5	0.43	Agree
	Cluster Mean	**3.3**	**0.78**	**Agree**

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Table 1 shows the mean scores of 3.5, 3.0, 3.2, 3.3, 3.2, 3.2 and 3.5, and their corresponding standard deviations of 0.49, 0.87, 0.95, 0.74, 0.81, 0.84 and 0.43, respectively. The cluster mean score of 3.3 is greater than the criterion mean of 2.5, indicating that all the respondents accepted all the items-statements in the table.

Table 2: Mean score responses on the major effects of discalculia in mathematics learning among students

S/N	Item	X	SD	Remarks
8	The presence of dyscalculia in a learner tends to develop negative attitude in them and avoid the tasks like judging distances, direction, depth and as well distinguish between left and right, larger and smaller numbers	3.0	0.69	Agree
9	Dyscalculic students often have high level of poor memory and weaknesses in understanding mathematics	3.2	0.81	Agree
10	Dyscalculia de-motivate and make it difficult to learn mathematics because of poor understanding of maths concepts, rules, formulae and proper sequencing	2.7	1.09	Agree
11	It makes them unable to concentrate a long time continuously on mentally concentrated tasks	3.2	0.83	Agree
12	Dyscalculia can bring about students inability to read and write numbers, letters and inability to identify numbers	3.0	0.93	Agree
13	It leads students to be unable to make challenges I daily life due to their poor number sense and other mathematical skills	2.8	1.10	Agree
14	It makes them develop low self-esteem and always hesitate to argue or express the views related to mental arithmetic and numeric calculation, such as addition, subtraction, multiplication and division	3.3	0.52	Agree
15	Poor writing, poor pronunciation, inability to understand and interprete mathematical symbols and inability to solve equations in mathematics are the bane of dyscalculic students in our upper basic schools	3.1	0.87	
	Cluster Mean	**3.0**	**0.98**	**Agree**

Table 2 shows mean scores of 3.0, 3.2, 2.7, 3.2, 3.0, 2.8, 3.3 and 3.1 with their corresponding standard deviations of 0.69, 0.81, 1.09, 0.83, 0.93, 1.10, 0.52 and 0.87, respectively. The cluster mean score of 3.0 is greater than the criterion mean of 2.5. It implies that all item statements in Table 2 were accepted by the respondents.

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Table 3: Mean responses on extent dyscalculic children's weaknesses to understanding mathematics

S/N	Item	X	SD	Remarks
16	Dyscalculic students have high level of poor memory and weaknesses in understanding mathematics.	3.2	0.81	High Extent
17	Poor mathematics performance in special schools are often caused by poor memory in calculia.	3.3	0.74	High Extent
18	Dyscalculic students' poor understanding f mathematics concepts are also caused by lack of retention and memorization.	3.2	0.84	High Extent
19	Poor use of basic principles in mathematics often result to lack of understanding of mathematics concepts.	3.0	0.87	High Extent
	Cluster Mean	**3.2**	**0.95**	**High Extent**

In Table 3 above, it was observed that items 19-19 had the following mean scores: 3.2, 3.3, 3.2, and 3.0 with their corresponding standard deviations of 0.81, 0.74, 0.84, and 0.87, respectively. The cluster mean score of 3.2 is greater than the criterion mean of 2.5, and it implies that the respondents accept all the item statements in the table. This means that the extent of weaknesses among dyscalculia students in understanding mathematics was high.

Table 4: Mean responses on ways dyscalculia learners could overcome their learning difficulties in mathematics.

S/N	Item	X	SD	Remarks
20	Dyscalculia children can be helped overcome their difficulties in learning mathematics by making learning real. Teachers while teaching number and concept should use varied concrete materials available around the locality as well as ready-made or prepared materials like Numicon, ABBACUS, etc.	3.3	0.52	Accept
21	Teachers should provide enough time for learners to manipulate a variety of concrete materials used to explore the meaning, concepts, mathematical facts, patterns and understanding of the subject matter.	2.9	1.02	Accept
22	Make learning fun in order to deliver the subject matter effectively because poor understanding of mathematics produces fear and unpleasant consequences in the learner.	3.1	0.81	Accept
23	Make learning multi-sensory: when learners are actively involved in learning, they learn sincerely and more such learning retains for a long time.	3.1	0.87	Accept
24	Use collaborative learning. Allow the students to learn in different groups to solve a given task while the teacher gives them clues and encouraged in collaboratively solving the problem.	3.0	0.93	Accept

25	Use of modern technology (ICT) makes learning faster, easier and fun and makes learning more effective and interactive as well as deepen basic skills in reading, writing and arithmetic.	2.8	1.10	Accept
26	Rapport building: through close teacher-pupil relationship helps to motivate students to freely and frequently ask questions and also enable the teachers to address the students learning difficulties instantly.	3.2	0.79	Accept
27	Use satellite learning approach where selected smart students who are good at mathematics are assigned to teach the other poor students in mathematics.	2.7	1.09	Accept
28	Teach less but regularly – here the subject matter is divided into small separable parts and taught regularly using different effective techniques. Learners feel more comfortable to learn small parts that take less time to teach and are easy to understand by students	3.0	0.69	Accept
	Cluster Mean	**3.0**	**0.83**	**Accept**

Table 4 shows mean scores of 3.3, 2.9, 3.1, 3.1, 3.0, 2.8, 3.2, 2.7 and 3.0 with their corresponding standard deviations of 0.52, 1.02, 0.81, 0.87, 0.93, 1.10, 0.79 and 0.69, respectively. The cluster mean score of 3.0, which is greater than the criterion mean of 2.5, implies that all the respondents agreed with the item statements in the table.

Table 5: Correlational analysis of significant relationship between effects of dyscalculia and students weakness in mathematics learning.

S/N	Variable	Total score	X	SD	r	Remarks
1	Effects of dyscalculia	22.9	3.3	0.78	0.13	Weak relationship
2	Students weakness in learning	24.3	3.2	0.95		

Table 5 shows an average mean score of 3.3 for the effects of dyscalculia and 3.2 for the weakness of students in learning mathematics in upper basic schools. The analysis result shows a correlation of 0.13, which indicates a weak relationship.

Table 6: Correlational analysis of significant relationship between causes and effects of dyscalculia on students' poor abilities in mathematics.

S/N	Variable	Total score	X	SD	r	Remarks
1	Effects of dyscalculia	22.7	3.0	1.02	0.74	Strong +ve relationship
2	Causes of dyscalculia	24.4	3.3	0.87		

Table 6 shows an average mean score of 3.0 for effects of dyscalculia and 3.3 for causes of dyscalculia on students' poor abilities in mathematics learning. The analysis shows a correlation of 0.74, which indicates a strong positive relationship between the variables cause and effect.

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Discussion of Findings

The study investigates the causes and effects of dyscalculia on secondary school students in the Okigwe Education Zone of Imo State. On the causes of poor mathematics results or performance among students of the Okigwe zone secondary school system, findings as witnessed in Table 1 revealed that all the items stated therein were agreed to by the respondents in one way or another, causing poor performance in mathematics among secondary school students. This observation supports Khing (2016), who in his book titled Dyscalculia, its types, symptoms, causal factors and remedial programs stated some of the causes of dyscalculia to include: the cognitive, behavioural and biological brain-based conditions contextualised in teaching and learning mathematics.

On the major effects of dyscalculia in mathematics learning among secondary school students in Okigwe Education Zone of Imo State, the cluster mean score of 3.0 shows that all the item statements in the table were accepted by the majority of the respondents as the effects of dyscalculia. This outcome is in line with the findings of Kunwar *et al.* (2021), who in their study on "Are teachers aware of Mathematics learning disabilities?" posited that dyscalculia can cause mathematical disability, numerical learning disability and number fact disorder. It is also an inborn condition that affects the ability of the learner to acquire arithmetical skills. Hornigold (2015) also stated that dyscalculia learner always struggles with the common difficulties in Mathematics, such as remembering number facts, and time tables, counting backwards in steps, learning to tell the time, calculations involving money and fractions, decimals and percentages.

On the extent of dyscalculic children's weaknesses in understanding mathematics in secondary schools, the respondents with a cluster mean of 3.2 agreed to a high extent that the extent of weaknesses by dyscalculic students in the Zone of proximal mathematics is high. In line with this finding, researchers have generally believed that the deficit in working memory, a brain-related condition, is caused by genetic, environmental and brain differences, which is considered dyscalculia. The finding is in harmony with the views of Adler (2001) and Rubinstein and Tannock (2010), who believed that dyscalculia, in addition, can cause students to become frustrated and develop behavioural and social problems, which then becomes the focus of any teacher in the learning process. However, the findings of the hypotheses reveal that dyscalculia affects a targeted learning outcome from the subject (mathematics).

CONCLUSION AND RECOMMENDATIONS

Researchers believe that dyscalculia is a specific learning difficulty that affects the learner's ability to retain mathematical skills related to calculating numbers, not every branch of mathematics. It may be caused by accidental brain damage (acquired dyscalculia) because, mainly in mathematics and science, many students believe that it

takes inherent ability or even brilliance to achieve well, rather than perseverance, good strategies, help from others and learning over time. The mathematics subject has always been given special attention in school education globally. Historically, mathematics was regarded as the science of quantity or numbers, which was developed from counting, calculation, measurement and the systematic study of the shapes and motions of physical objects.

An inability or disorder in basic numerical processes in Mathematics results in dyscalculia. The range of dyscalculia is between 3 and 6% of school-age children. Researchers proposed that dyscalculia can be divided into six uniform categories, particularly focusing on the characteristics of knowledge deficits. Dyscalculia can be transformed by hereditary prematurity and low birth weight. Lastly, dyscalculia has a great effect on students' learning outcomes.

The following recommendations were proffered:

(1) Teaching in such difficult areas of mathematics, dyscalculia students should be provided with specialised instruction and dedicated time.
(2) Similarly, they should be cared for and well-treated at school through the provision of a classroom, an outside, and an inside learning environment.
(3) In a like manner, their parents should also provide sufficient time at their homes for doing homework, playing, or doing something meaningful.
(4) The following strategies: practice, give extra time, present the situation graphically, and evaluate the task, should be employed to reduce the level of dyscalculia in students.
(5) The difficulties can be overcome with extra support and intensive intervention. The efficiency of dyscalculia students can be improved through utilising effective pedagogical intervention strategies and creating a collaborative working environment.

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