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Effects of E-leaning Technology on Pupils for Inclusive Education: A Dyscalculia-Focussed Approach

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Abstract
Since 1991 when World Wide Web (WWW) was launched, there was a surge of interest in technological learning through digital education, particularly E-learning. This study identified one area of special needs in learning disability among secondary school students in Nigeria: dyscalculia. This learning disability is one of the major causes of school drop-out among primary school pupils. This study is geared towards the use of e-learning technology as an inclusive education to solve the problem in Nigeria. Quasi experimental research design was used for the study. The study population was 2000 primary five school pupils having this learning disorders in two different states in Nigeria, while the sample was 300 pupils. Two research questions were raised and one hypothesis was tested at 0.05 level of significant. Instruments for data collection were two E-learning technological tools namely the Talking Calculator and Electronic worksheet. The Mean (×) and standard deviation (SD) were used to answer the research questions while analysis of variance (ANOVA) was used to test the hypotheses. Findings from the study after analysis indicated a higher academic achievement of the pupils taught with the two E-learning tools than those not taught with the tools. It was concluded that, based on the findings, recommendations were made such as: government making available some of these E-learning tools in the school system to help pupils with this kind of learning disability to achieve highly academically. This will reduce the number of drop-outs in the school system in Nigeria.

Keywords: E-Learning, Dyscalculia, Talking Calculator, Electronic Worksheets, Pupils.

Introduction

Special technological programs for learners with disabilities have been a major focus of many countries over the past 50 years. According to Garry and Oliver (2025) in Dickson, (2017), the program aims at a comprehensive career development and transition approach for all children with disabilities. It is an inclusive education with the aim and concern of protecting, assisting and developing the child with disabilities to learn what alternatives there are and how to make decisions about their independent living. Nigeria as a country has a customized educational program, designed to meet the unique needs of children with special needs. The National Policy on Education (2014) categorized these special needs children among others as:

- The gifted and talented, multiple disabilities, and
- Learning disabilities made up of (psychological, neurological, phobia or challenges).

The aim of this special needs program among others is to:

i. Equalize educational opportunities for all persons irrespective of their genetic composition, social, physical, sensory, mental, psychological or emotional disabilities.
ii. Provide adequate education for all persons with special needs in order that they may fully contribute their quota to the development of the nation.
iii. Design a diversified and appropriate curriculum/tool for the different target groups. (NERDC, 2014)

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In recent years, the global education landscape has witnessed a rapid transformation driven by the integration of digital technologies. Among these, e-learning technology has emerged as a powerful tool for expanding access to quality education, especially for learners with diverse needs. (Ally, 2019). Inclusive education which seeks to accommodate and support all learners regardless of their physical, cognitive, or emotional challenges, finds in e-learning unique opportunity to bridge existing educational gaps. (UNESCO, 2020).

The school environment provides the mean-stream integration for the actualization of the various programs mapped out for special needs children. According to Abang 2017 in Ugoma (2022), the school routes the educational growth, individual, personal growth, development and adjustment of the individual to fit into the complex society. In the school, various forms and characteristics of individuals come to learn and to grow. Each of the individual come to the school with his or her own nature, abilities, and the ability to cope with learning tasks. Some learners are able to learn and make adjustment with ease, while other learners encounter varying degrees of difficulties with related attendant behaviour output. The learners with varying degrees of difficulties in learning can be termed challenged learner either physically or emotionally. This study identified a peculiar learning challenge most school children in Nigeria face in their school system, called dyscalculia. (Butterwoth & Lauillard,2011). Dyscalculia is a learning disorder that affects brain areas that handle mathematics and number related skills and understanding leading to low academic achievements and self esteem, (Nelson & Powell, 2018). While this problem affects children most in their few years of elementary schools between the ages 6 and 9, many adults are also affected. Adults and children with this disabilities, according to Anderson and Abdelmalek (2020), struggle to understand numbers and encode or transform them into useful information. They fail to see logical meaning or coherence between numbers, including right sequences from logical order of smallest to biggest. Cipolla et al. (2021) gave an example of how dyscalculic struggled to encode and transform a useful information. A student was taught to invert and multiply the figure below; but the student over generalized the logic with division to other operation;

Figure 1; $\frac{6}{5} \div \frac{1}{5} \rightarrow \frac{6}{5} \times \frac{5}{1}$

Figure 2; $\frac{6}{5} - \frac{1}{5} \rightarrow \frac{6}{5} \times \frac{5}{1}$

From the above, it is clear that dyscalculia usually have trouble recalling basic mathematical facts confusing the signs +, -, and x. They find it difficult linking numbers and symbols to amounts and directions. Some may find it challenging to connect the word ''ten'' to the figure ''10''. Others struggle to visualize things in their minds, hence finding it difficult to get around, use maps or follow directions. Major cause of dyscalculia is unknown, according to Ladislaw a researcher who discovered it in 1974. But the impairment is found in the brain parts meant for mathematics, without an impairment in general to mental function. It is a hereditary problem that runs in a family.

In Nigeria, studies carried out in dyscalculia, are done to identify the learning disorder among children. For example, Iji and Takor (2019) isolated several types of dyscalculia which are as follow:

i. Verbal interpretation of mathematics
ii. Operational or performing basic arithmetic operation.
iii. Lexical-reading written mathematics terms and symbol.
iv. Graphical manipulations of symbols
v. Ideognostic or mental calculation of arithmetic.
vi. Practogonostic, which is Pictorial representation.

Apart from these, there are other studies carried out to identify dyscalculia. For example, Sharma (2015) identify the following:

i. Qualitative dyscalculia failure to master skills required for operation.
ii. Quantitative, deficit in the skill of counting and calculating arithmetic.
iii. Intermediate dyscalculia, the inability to operate with symbols and operation such as $<,\ >,\ \pi, -, \times, +, \surd$.

Moreover, Iji and Takor (2019),opined that these types of dyscalculia can put children at high risk of learning mathematics. Studies by Ogbogo and Opera (2021) using Quantitative and Qualitative Analysis M-H DIF Statistics (Mantel-Haenszel Differential Item analysis) test, isolated various types of dyscalculia such as; severely dyscalculics, moderate dyscalculics, mildly dyscalculics and those without dyscalculics. The test was based on age, gender and educational level of the dyscalculics, as well as their ethnicity in Nigeria.

There is paucity of studies in Nigeria mapping out technological tools to help dyscalculics achieve academically like their counterparts who do not have this learning disorders. This study recognizes electronic teaching and

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learning (E-learning technology), as a major tool that can be used to help dyscalculics in various schools in Nigeria which is an inclusive education.

Digital learning in the 21st century is making teaching and learning easier than the usual traditional teaching and learning methods. For example, acronyms like CBT (computer Based Training), IBT (Internet Based Training) or WBT Web (Based Training) are being used as synonyms to e-learning today in Nigeria by JAMB, universities examinations for their year one students. Even now, WAEC Chairman in Nigeria, has proposed the CBT examinations for 2026 West Africa School Certificate Examinations, before it was turned down in the House of Assmbly for lack of capacity.

In this study, a good example of e-learning technological tools that can be used to assist dyscalculic in Nigeria, among others are: Talking Calculators and Electronic worksheets. These are referred to as Assistive Tech tools (AT). According to Fatwana etal (2023), talking calculator includes a speech synthesizer that reads aloud each number, symbols or operation key pressed by the user as well as the solution to the problem. Interestingly, talking calculators make it easier to check assignments, read numbers and perform calculations. The auditory feedback may assist the learner in checking the accuracy of the keys they press and verifying the answer before transferring it to their paper. With this tool, pupils and students struggling to learn basic mathematics facts, can learn higher-level skills in math concepts. Electronic worksheets on the other hand, are software program in organizing, aligning and working mathematics problems on computer screen. It also uses speech synthesizer that are useful in solving math problem with pencil and paper.

These e-learning tools have helped pupils and students with dyscalculia in many countries learn higher level skills in mathematics concepts. For example, Aimee (2003), in Virginia Commonwealth University opined that after 54 research studies conducted were integrated through meta-analysis to determine the effects of calculators on students achievement and attitude levels, it was found out that students using talking calculators especially those with dyscalculia, had better attitude towards mathematics than their counterparts who did not use the talking calculators. It also revealed their operational skills and problems solving skills improved when calculators were an integral parts of their instruction and testing. If e-learning technological tools such as talking calculators and electronic worksheets can be an integral part of instruction and testing, to assist dyscalculia achieve a high level skills in mathematic concepts, this study is therefore aimed at finding out the difference in training pupils, their achievement levels with these e-learning technological tools to have an all-round inclusive education that can cater for all calibre of pupils especially those with mild and severe dyscalculia in Nigeria.

Purpose of the Study

The study is therefore aimed at finding out differential academic achievements using e-learning tools to instruct and access pupils in primary schools with dyscalculia.

Research Question

1. what is the difference in math achievement of pupils with dyscalculia exposed to e-learning tools, using talking calculator and electronic worksheets and pupils with dyscalculia not exposed to it?

Hypothesis

This hypothesis was tested at 0.05 level of significant:

1. There is no significance difference in mathematic achievement of pupil with dyscalculia exposed to e-learning tools of talking calculators and electronic worksheet and pupils with dyscalculia not exposed to e-learning tools.

Methodology

The study adopted Quasi-experimental research design of pre-test, post-test control group. This design was appropriate for the study because an intact or pre-existing groups were used. The experimental and control group. Population of the study was 2000 primary five pupils while the sample was 300. This class was chosen based on the age bracket of 9-10 years. Meanwhile, Quantitative and Qualitative analysis M-H DIF statistics test by Ogbogo and Opara (2021), was used to isolate mild, moderate and severe dyscalculics. Multistage sampling technique was used for the study. First, purposive sampling was used to select three states in Nigeria, (south, east, north). While random sampling was adopted to select 5 primary schools each from the state. The dyscalculics in these states were grouped into 1 and 2. Group 1 is the experimental group while 2 is the control group. A simple mathematic test involving additions and subtractions was given to all of them in the group. The scores obtained formed the pre-test. Group 1 pupils were then taught one on one on how to use the Talking Calculators and the Electronic Worksheet to solve simple mathematics for a period of two weeks. Group2 on the other hand were not given this

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training. Consequently, after the two weeks training, both groups were given the test on addition and multiplication, the scores obtained formed the post-test. Both pre-test and post-test scores are presented below.

Research Question 1: What is the difference in mathematic achievement of pupils with dyscalculia exposed to e-learning using talking calculator and electronic worksheet and pupils with dyscalculia not exposed to it?

Table 1*;* Mean (x) achievement scores and Sd of pupils in math exposed to talking calculator and electronic worksheet and those not exposed to it.

Group	No	Mean (x)	Std deviation
Control group 1	150	33.86%	10.160
Experimental group 2	150	64.64	16.499
Total	300	49.25	20.609

The table above showed the mean achievement of pupils in math with dyscalculia exposed to the training with e-learning tools and those not exposed to it. Those not exposed to the training, had a mean(x) score of 33.86 with std deviation of 10.160. Those exposed to the training had a mean score of 64.64 with std deviation of 16.499.

1. There is no significant difference in mathematic achievement of pupils with dyscalculia expose to e-learning tools of talking calculators and electronic worksheet and pupils with dyscalculia not expose to e-learning tools.

Table 2. Analysis of variance in mathematic achievement of pupils with dyscalculia trained using e-learning tools and those not trained.

Source	sum of square	Difference	Mean Square	F	sig	Partial Eta Square
Connected Model	71055.630	1	71055.630	378.519	000	.560
Intercept	727668.750	1	727668.750	3876.348	000	.929
Group	71055.630	1	71055.630	378.519	000	.560
Error	55940.620	298	187.720			
Total	854665.00	300				
Connected total	126996.250	299				

Table 2 above showed the summary of analysis of variance of math achievement of pupils with dyscalculia exposed to e-learning tools and pupils with dyscalculia not exposed to e-learning tools. The result showed an F-value of 378.519 and a P-value of .000. testing at 0.05 level of significant. The P-Value was less than alpha level. Therefore, the null hypothesis was rejected. This implies that there is a significant difference in mathematic achievement of pupils with dyscalculia exposed to e-learning tools and pupils with dyscalculia not exposed to e-learning tools.

Discussion

Findings from the study showed that an integral part of teaching and learning involving e-learning tools such as talking calculators and electronic worksheet which can tremendously improve operational skills and problem-solving skills of those with learning disability in mathematic-dyscalculia. This was indicated in table 1 and 2 whereby dyscalculics taught one on one on how to use simple taking calculators and electronic worksheet to solve simple mathematics problem improved their mathematic solving skills more than those not trained or exposed to it.This finding agreed with Aimee (2003), who opined that when 54 research studies were integrated through meta-analysis to determine the effects of calculators on students' achievement and attitude level, found out that students using calculators had more attitude toward maths than those not using it. The mean score of those trained to use talking calculator and electronic worksheet from the tables was 64.64, SD of 16.499 against those not trained with the electronic tools who had a mean of 33.86, SD of 10.160. The difference is high enough to take note of. This is in line with the conference theme that has to do with : Transformative Solution to the Inclusive Education, Practices and Assessibilities for Learners with Special Needs; by means of technology.

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Recommendations

The following recommendations from the study, based on the findings, are hereby given:

1. Pupils in the primary schools having problems of dyscalculia, be trained with e-learning technological tools such as the talking calculators and the electronic worksheets for quality assurance and inclusive education.
2. Teachers should reinforce dyscalculics positively on any efforts made by them to learn.
3. TETFUNDS should now be used to equip schools and train teachers in the use of e-leaerning technological tools such as the Electronic Worksheet, the Talking Calculators and other digital gadgets for inclusive education.
4. Primary school teachers are hereby encouraged to be patient with their pupils who have problem comprehending teaching and learning generally, especially those with dyscalculia and more understanding.

Conclusión

In the light of the findings, it is clear that pupils with dyscalculia can be exposed or trained with learning technologies such as the Talking calculators, and the electronic worksheet, as an inclusive education to include their skill in mathematics achievement. This is because digital education in the 21st century is gaining more grounds than the blackboard or whiteboard teaching and learning system, It is faster in terms of assimilation. Many institutions are keying into it in many countries. Children with dyscalculia benefit more when they are introduced to it. It is not mechanical; it removes boredom and highly interesting to growing children. It will give them the moral to develop skills and ability to conduct independent research, think critically and solve problems, use the technology to communicate and collaborate, and understand societal issues related to digital citizenship. The Federal Government of Nigeria can key into it completely, it will hasten her growth in science and technology, promote sense of belonging to the citizens in the society and reduce drop-out of school children.

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