

Learning-While-Doing Instructional Model and Everyday Arithmetic Performance of Students with Developmental Dyscalculia

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Abstract – This study was on enhancing the performance of junior secondary students with Developmental Dyscalculia (DD) in Everyday Arithmetic through Learning-While-Doing (LWD) instructional model in Ogba/Egbema/Ndoni Local Government Area (LGA) of Rivers State. The quasi-experimental design was adopted. A total of 118 JSS2 students took part in the study. The instruments for data collection were the Developmental Dyscalculia Diagnostic Test (3DT) and the Teacher Made Arithmetic Test (TMAT). The 3DT was a 10-item test to diagnose students with DD, while the TMAT was a 15-item multiple-choice test with four options to measure the performance of the students with DD in Everyday Arithmetic. The instruments were subjected to face and content validation. The reliability coefficients of 0.85 and 0.93 respectively were obtained through the test-retest method. The descriptive statistics and Analysis of Covariance (ANCOVA) were used for data analyses. It was found that the performance of students taught arithmetic using LWD instructional model was better than that of their counterparts taught using problem-solving strategy. Female students taught arithmetic using LWD instructional model performed slightly better than their male counterparts. There was a significant difference between the performance of students with DD taught Everyday Arithmetic using the LWD model and those taught using problem-solving strategy. There was no significant difference in the performance of male and female students with DD taught arithmetic using LWD instructional model. It was recommended among others that Mathematics teachers should employ the use of the LWD instructional model in teaching to improve the performance of students in the subject.

Keywords – Everyday arithmetic, Developmental dyscalculia, Learning-while-doing, instructional model, Performance.

I. INTRODUCTION

The application of mathematical knowledge to solving societal problems dates back to the existence of man. The knowledge of Mathematics plays a significant role in enhancing the country's social and economic systems. Everyone uses Mathematics in solving daily problems and improving the standard of living. Mathematics plays a central role in modern culture. The importance accorded to Mathematics in the school curriculum from the primary to even the tertiary school levels accurately reflect the vital role played by the subject in today's contemporary society. The importance of Mathematics to nation-building has led the Federal Government of Nigeria to make Mathematics a core subject to be offered by all students at the basic and post-basic levels of education in Nigeria (Federal Republic of Nigeria, 2014).

Despite its importance, Mathematics has been considered difficult and boring for many students. Senior secondary students perceived 33% and 88.20% of the General Mathematics and Further Mathematics curriculum content difficult to learn

respectively (Zalmon & George, 2018; Zalmon & George, 2020). Barbeau (1989) as cited in Baykul (1999) indicated that people viewed Mathematics from an absolutist perspective and undoubtedly this is what reflects from the Mathematics they studied in school rather than an insight into the discipline. The absolutists perceived Mathematics as a cold and austere discipline that creates no scope for creativity. Teaching Mathematics with the absolutist view promotes anxiety, mathophobia and under-achievement among students of Mathematics. Students consider Everyday Arithmetic which is a major aspect of Mathematics to be complex, trivial and difficult.

Everyday Arithmetic is a branch of Mathematics that consists of the study of numbers and the properties of the traditional operations on them. The traditional operations are addition, subtraction, division and multiplication. Everyday Arithmetic is the basic calculations we make in our everyday life. Everyday Arithmetic is a critical aspect of Mathematics that is very essential for daily living. The knowledge of Everyday Arithmetic acts as a significant criterion for individual growth and improvement. The importance of Everyday Arithmetic cannot be underestimated. It is through the help of Everyday Arithmetic that humans can solve real-world phenomenon. Meanwhile, students perceived addition, subtraction and multiplication in Everyday Arithmetic, particularly modular arithmetic difficult to learn (Zalmon & George, 2018). This learning difficulty in Everyday Arithmetic is easily noticed among students with developmental dyscalculia.

Dyscalculia is a term used to describe learning difficulty in Mathematics. Shalev (2004) defined dyscalculia as the learning difficulty affecting the normal development and acquisition of arithmetic skills. Dyscalculia is a specific learning difficulty in Mathematics (Wonu & Zalmon, 2017). Dyscalculia is of two types namely: acquired and developmental dyscalculia. According to Munro (2003), dyscalculia which occurs as a result of cerebral trauma is called acquired dyscalculia while dyscalculia without proof of cerebral trauma is known as developmental dyscalculia. Developmental Dyscalculia (DD) is specific dyscalculia that is characterised by impairments in learning basic arithmetic facts, processing numerical magnitude and performing accurate and fluent calculations (Wonu & Zalmon, 2017). Developmental dyscalculia portends great challenge to students' performance in Everyday Arithmetic. Hence, there is a need to render extra support to students who are challenged with the menace of developmental dyscalculia and help to enhance their learning outcomes in Everyday Arithmetic through the use of suitable diagnostic, remedial and learner-centred practical teaching and learning model such as Learning-While-Doing (LWD).

Learning models are particular approaches or techniques employed by teachers for effective instructional delivery. Learning models refer to self-generated thoughts, feelings, and actions, which are systematically oriented toward the attainment of learning goals. Such learning models may consist of mental or behavioural activity that is related to some specific stage in the overall process of the acquisition of arithmetic skills. An effective learning model can determine the outcomes of learning. It is worthy of note that active instructional models like LWD can make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferrable to new situations. Learning-while-doing instructional model is one of the different approaches used to provide educational interventions to students with Mathematics disability (Wonu, 2020). This approach emphasizes the need to effectively teach students with DD in regular education classrooms. To remediate the effects of DD on students' Mathematics learning outcomes require teaching models that engage the students in project development activities during mathematical problem-solving task performance (Wonu, 2020).

The manner in which LWD strategies are displayed depends on information on how individuals learn. The LWD depends on the constructionist theory of Seymour Papert. Any learning climate with satisfactory learning materials for investigation, project development and wealth of interaction openings among students can support LWD process. The LWD model was developed by Schlumberger Excellence in Education Development (SEED) as a contribution to the collection of educational practice (www.planetseed.com). Some particular highlights of the manner by which learning is coordinated while utilizing LWD in the classroom is summed up by Tempel (2007) as a learning situation where learning is active, collaborative, integrated and learner centered. People of all ages and abilities learn together. Everyone is at once a learner and a teacher.

The Learning-While-Doing instructional model is a form of Project-Based Learning (PBL). The PBL is designed for the engagement of learners in the exploration of the real-world task to create relevant and meaningful experiences (Wonu & Arokoyu, 2016). This instructional model gives children with developmental dyscalculia the chance for the acquisition of knowledge or arithmetical skills through direct experience gained in a practical task. Therefore, this study investigated the effectiveness of the use of LWD instructional model in improving the performance of developmental dyscalculic students in Everyday Arithmetic. The effect of LWD instructional model on the performance of developmental dyscalculic students in Everyday Arithmetic by gender was also investigated.

II. STATEMENT OF THE PROBLEM

There is a nationwide outcry on the poor academic performance of students in Mathematics. The performance of Mathematics students has been worrisome to all ranging from teachers, researchers, government and even the parents of the students. The percentage of junior secondary school leavers that have failed to perform to an acceptable extent remains high because of high failure in Mathematics examinations. Hence the investigation on enhancing the performance of students with developmental dyscalculia in Everyday Arithmetic using LWD instructional model is worthwhile and timely.

III. PURPOSE OF THE STUDY

The purpose of the study was to find out whether there is an enhancement in the performance outcomes of students with developmental dyscalculia in arithmetic when taught using Learning-While-Doing instructional model. The objectives of the study are to:

- i) Determine the effect of LWD instructional model on the performance of students with developmental dyscalculia in Everyday Arithmetic.
- ii) Investigate the effect of gender on the performance of students with developmental dyscalculia in Everyday Arithmetic when taught using LWD instructional model

IV. RESEARCH QUESTIONS

The following research questions guided the study:

- i) What is the difference in the performance mean scores of students with developmental dyscalculia taught Everyday Arithmetic using LWD instructional model, and those taught with problem-solving strategy?
- ii) What is the difference in the performance mean scores of the male and the female students with developmental dyscalculia taught Everyday Arithmetic using LWD instructional model?

V. HYPOTHESES

The following null hypotheses were formulated for the study:

1. There is no significant difference in the performance mean scores of students with developmental dyscalculia taught Everyday Arithmetic through LWD model and problem-solving strategy.
2. There is no significant difference in the performance mean scores of male and female students with developmental dyscalculia taught Everyday Arithmetic using LWD instructional model.

VI. RESEARCH DESIGN

The study adopted a quasi-experimental design with a non-equivalent control-group pretest-posttest approach. The independent variable is the instructional model whereas the response variable is the student performance in Everyday Arithmetic.

VII. PARTICIPANTS

The population of the study comprised 3,854 Junior Secondary School II students (1,885 males & 1,969 females) from the twenty-four (24) public junior secondary schools in Ogba/Egbema/Ndoni LGA of Rivers State (Rivers State Universal Basic Education Board, 2019). The sample of this comprised of 118 Junior Secondary School two (JSS 2) students. A sample of two (2) co-educational public junior secondary schools were drawn from the 24 public Junior Secondary Schools in the study area. One of the schools served as an experimental group while the other school served as the control group. The sample distribution of the JSS 2 students in the schools is tabulated below:

Table 1: Sample Distribution

School	Male	Female	Total
A	34	20	54
B	32	32	64
Total	62	56	118

Source: Fieldwork, 2019

The purposive sampling technique was adopted to ensure that the participants that were chosen (both males and females) had a similar background, experience, and environmental exposure. The selected sample of developmental dyscalculic students was chosen based on their previous terminal performances and results, class teacher's remarks and referral, and the results obtained from the Diagnostic Developmental Dyscalculia Test (3DT) administered to them before the commencement of the study.

VIII. INSTRUMENTATION

Two instruments were developed and used for the data sourcing; these are the Diagnostic Developmental Dyscalculia Test (3DT), and Teacher Made Arithmetic Test (TMAT). The Diagnostic Developmental Dyscalculia Test (3DT) consisted of ten (10) items designed to diagnose Dyscalculia problems from the students, while the Teacher Made Arithmetic Test (TMAT) consisted of 15 multiple choice questions with four options labelled A-D, used to test and measure the performance of the students before and after exposure to the treatment. The research instruments were subjected to face and content validity check and modified in a way the students would easily understand. The test-retest method was used to establish the stability of the instruments to obtain reliability indices of 0.85 and 0.93 respectively for 3DT and TMAT.

First, consent to carry out the study in the schools was obtained from the administrations of the schools used for the study. The researchers then collected the performance details of the students for the last term from the Mathematics classroom teachers. Students who have been performing poorly in Mathematics were then selected. The researchers then administered the 3DT to the students who have been underachieving mathematically in the two (2) co-educational public junior secondary schools, and thereafter the results were used to discover 54 and 64 developmental dyscalculic students from the sampled schools. These students were identified and their details were taken. Since the researchers used intact classes for the study; sampling was not carried out, however, only the scores of the affected students were used for the study. Consequently, students from school A were used as the experimental group while students from school B were used as the control group.

The Pre-TMAT was then administered to the two groups of students on the first day of classes. The Pretest was administered by the class teachers. All the lessons for teaching were then prepared by the researchers. The topic was prepared for the experimental group and taught with LWD instructional model, while the same topic was also prepared for the control group and taught with a problem-solving strategy. The regular intact class Mathematics instructors carried out the teaching. The regular intact Mathematics teachers of the sampled students were trained by the researchers for two (2) consecutive days on how to carry out the teaching using the researchers' constructed lesson plans. This was then followed by the teaching of the contents of the lesson for two weeks. Each group was taught by their Mathematics teacher, under similar environmental conditions using the same lesson plans. The experiment was not revealed to the partaking learners. The experimental group was instructed using the LWD model, while the benchmark group was taught utilizing the problem-solving model. The Post-TMAT was then administered to both groups of students after a two-week treatment. Both groups of students received identical exercises concerning the amount and level of difficulty.

IX. DATA ANALYSIS

Descriptive statistics and Analysis of Covariance (ANCOVA) were used for data analysis.

X. RESULTS

Table 2: Mean and standard deviation of the difference in the performance mean scores of students with developmental dyscalculia taught arithmetic through learning-while-doing instructional model (LWD), and those taught with Problem-Solving Strategy (PSS).

Model	N	Pre-TMAT		Post-TMAT		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
LWD	54	17.69	9.40	47.78	8.45	30.09
PSS	64	17.34	8.77	35.63	8.52	18.29

Table 2 shows the difference in the performance mean scores of students with developmental dyscalculia taught arithmetic using the LWD instructional model, and those taught with problem-solving strategy. The result indicated that students taught arithmetic through learning-while-doing instructional model performed better (Pre-TMAT: $\bar{x}$ = 17.69, SD = 9.40, Post-TMAT: $\bar{x}$ = 47.78, SD = 8.45, mean gain = 30.09) than those taught using problem-solving strategy (Pre-TMAT: $\bar{x}$ = 17.34, SD = 8.77, Post-TMAT: $\bar{x}$ = 35.63, SD = 8.52, mean gain = 18.29). The implication of the mean difference of 18.38, in favour of students in the LWD group, is that the performance of students taught arithmetic through LWD instructional model is better than that of those taught using the problem-solving strategy.

Table 3: Mean and standard deviation of the difference in the performance mean scores of male and female students with developmental dyscalculia taught arithmetic using LWD instructional model

Gender	n	Pre-TMAT		Post-TMAT		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Male	34	18.38	9.59	46.76	8.43	28.38
Female	20	16.50	9.19	49.50	8.41	33.00

Table 3 shows the difference in the performance mean scores of male and female students with developmental dyscalculia taught arithmetic through LWD instructional model. The result indicated that female students performed better (Pre-TMAT; $\bar{x}$ = 16.50, SD = 9.19, Post-TMAT: $\bar{x}$ = 49.50, SD = 8.41, mean gain = 33.00) than their male counterparts (Pre-TMAT; $\bar{x}$ = 18.38, SD = 9.59, Post-TMAT; $\bar{x}$ = 46.76, SD = 8.41, mean gain = 28.38). The implication of the mean difference of 4.62, in favour of the female students, is that female students taught arithmetic through LWD instructional model performed better than their male counterparts.

Table 4: Summary of ANCOVA on the difference in the performance mean scores of students with developmental dyscalculia taught arithmetic using learning-while-doing strategy and problem-solving strategy respectively

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7531.33 ^a	2	3765.66	84.05	0.00	0.59
Intercept	24443.54	1	24443.54	545.55	0.00	0.83
Treatment	4184.28	1	4184.28	93.39	0.00	0.45
Pretest	3205.76	1	3205.76	71.55	0.00	0.38
Error	5152.57	115	44.81			
Total	212850.00	118				
Corrected Total	12683.90	117				

a. R Squared = .594 (Adjusted R Squared = .587)

Table 4 shows that there is a significant difference in the performance mean scores of students with developmental dyscalculia taught arithmetic using the LWD model and problem-solving strategy ($F_{1, 115} = 93.39$, $p = 0.00$). This led to the rejection of the null hypothesis one at the 0.05 alpha level.

Table 5: Summary of Analysis of covariance (ANCOVA) on the difference in the performance mean scores of male and female students with developmental dyscalculia taught arithmetic through learning-while-doing instructional model

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1055.38 ^a	2	527.69	9.87	0.00	0.28
Intercept	18919.15	1	18919.15	353.70	0.00	0.87
Gender	160.92	1	160.92	3.01	0.09	0.06
Pretest	961.16	1	961.16	17.97	0.00	0.26
Error	2727.95	51	53.49			
Total	127050.00	54				
Corrected Total	3783.33	53				

a. R Squared = .279 (Adjusted R Squared = .251)

Table 5 shows that there is no significant difference in the performance mean scores of male and female students with developmental dyscalculia taught arithmetic using the learning-while-doing instructional strategy ($F_{1, 51} = 3.01$, $p = 0.09$). Thus, null hypothesis three is rejected at the 0.05 alpha level.

XI. DISCUSSION OF FINDINGS

The result from Table 2 showed that students taught Everyday Arithmetic using LWD instructional model performed better than those taught arithmetic with PSS. These results agree with earlier finding by Wonu and Ogunkunle (2015) which established that an innovative instructional model is capable of advancing the learning outcome of students with DD. The ANCOVA result in Table 4 showed that there is a significant difference in the performance mean scores of students with developmental dyscalculia taught arithmetic using the LWD model and PSS. This led credence to the rejection of hypothesis one at .05 alpha level. The finding also supported the findings of Ahumaraeze and Ekwueme (2018) who found that students taught with Constructivist-Based Instructional Strategy (CBIS) had higher Mathematics performance than those in the control group. Similarly, the findings agree with Adaramola (2012) who concluded that students with dyscalculia exposed to the teaching of Mathematics with concept mapping performed significantly better and were more interested in Mathematics than their counterparts in the formula group.

The result from Table 3 showed that the female students slightly outperformed their male counterparts in Everyday Arithmetic when taught using the LWD model. The ANCOVA result in Table 5 showed no significant gender difference in the performance of dyscalculic students exposed to the LWD model. Adaramola (2012) found out that gender is not a significant factor regarding student learning outcomes. However, Ahumaraeze and Ekwueme (2018) revealed a significant difference in the mean scores of male and female students taught probability using CBIS, and this gender difference in performance favoured the male more than the female students.

XII. CONCLUSION

Learning-while-doing instructional model was found capable of advancing the performance of students with developmental dyscalculia in Everyday Arithmetic. There was no significant gender difference in the performance of the students taught Everyday Arithmetic using LWD instructional model. The use of the LWD instructional model enhances the performance of developmental dyscalculic students in Mathematics irrespective of their gender.

RECOMMENDATIONS

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

- i) Teachers should use LWD instructional model to improve student performance in Mathematics.
- ii) Mathematics teachers should be trained and encouraged to effectively employ LWD instructional model in their lesson delivery to ensure gender parity in Mathematics performance.

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