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DIAGNOSIS AND INSTRUCTIONAL REMEDIATION AMONGST LEARNERS WITH DEVELOPMENTAL DYSCALCULIA IN NUMBER AND NUMERATION

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Abstract
The study is an educational intervention to improve the learning outcomes of junior secondary students with Developmental Dyscalculia (DD) in Number and Numeration (NAN) using the Collaborative Learning Model (CLM) in Port Harcourt Local Government Area (LGA). A quasi-experimental design was adopted in the study. A total of 68 Junior Secondary Class 2 (JSC2) students with DD in Number and Numeration took part in the study. Two randomly selected junior secondary schools were used for this study. One school was assigned to the experimental group, whereas the other was assigned to the control group. The processes of the diagnosis, identification, and selection of students with DD for participation in the study involved three phases, viz: The use of existing school results, administration of the Developmental Dyscalculia Diagnostic Test (3DT) and Teachers' judgments. The Number and Numeration Performance Test (NANPT). The NANPT was used to measure the performance of the students in NAN. Experts in Mathematics Education validated the instruments, and Kuder-Richardson, KR-21 was used to ascertain the reliability of the instruments, which gave indices of 0.87 and 0.84 for NANPT and 3DT respectively. The students in the experimental group learned NAN using the CLM whereas those in the control group were taught the same topics using the Traditional Teaching method (TTM). Two research questions and two hypotheses guided the study. The mean, standard deviation and Analysis of Covariance (ANCOVA) were used for data analysis. The result established that the CLM was more effective than the TTM in advancing the performance of students with DD in Number and Numeration . The students did not differ significantly in their performance in NAN based on gender. It was recommended, among others, that mathematics teachers should employ CLM in their classroom teaching and ensure that all students participate and cooperate effectively with one another to enhance student-learning outcomes.

Keywords: Collaborative Learning Model**,** Gender, Mathematics, Junior Secondary, Developmental dyscalculia

Introduction

Mathematics as a universal subject is very dynamic. It has different interlinking shades of concepts and models. In the school structure, it is made a compulsory subject at the primary and secondary levels of education in Nigeria. This makes mathematics a core subject with high relevance among all other subjects. It can be said, therefore, that the teaching and learning of mathematics should be taken with the utmost seriousness, as it is one of the determining subjects to be passed at credit level for the furtherance of study in almost all courses of study in higher institutions in Nigeria. As dynamic as mathematics is, it has been established by Ogunkunle (2009) that different instructional models in connection with related mathematics topics should be used for effective teaching and learning. Ogunkunle further suggested that teachers should be open to the use of appropriate learning strategies for the enhancement of effective learning. Similarly, Dorgu (2015) supported this by revealing that incorporating different instructional strategies brings about effective teaching that leads to the attainment of objectives of the curriculum irrespective of mathematics. Dorgu suggests the use of other instructional strategies rather than being restrained to the conventional

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teaching method. This does not mean the conventional teaching method is not effective, rather, it cannot be used effectively with all mathematics topics (Omwirhiren, 2015). It was discovered that the student performances were very poor as a result of the non-versatile use of instructional strategies by the teachers. Teachers' use of only one or a few methods is counter-productive, thereby leading to underachievement in mathematics among students (Ogunkunle, 2009). The use of learning strategies that promote learner activities and the creation of mental models of the supposed mathematics topic should be encouraged. This, in turn, aids quick understanding and retention of the mathematics concepts discussed (Paas & Sweller, 2012). On the contrary, not using appropriate instructional models can lead to poor performance of the students and Mathematics Learning Disabilities (MLD) such as Developmental Dyscalculia (DD) and Attention Disorder (AD) among others. Experience shows that DD can worsen as learners go higher in class, encountering more difficult mathematics concepts due to the vertical integration of the mathematics curriculum.

Developmental Dyscalculia is defined as a persistently recurring poor mathematics performance among learners. It has a developmental origin, that is, it is related to cognitive functions that occur when there is a lack of motivation to study mathematics or access to mathematics education (Denes & Usha, 2013). However, it is important to make it obvious that studies have shown different views on the definition of developmental dyscalculia. From the point of cognitive functions, Rubestein (2009) established that developmental dyscalculia originates from the impairment or weakness of a single cognitive function or representation. This implies that it may result from a wide unlimited representation/function or maybe an umbrella term denoting mathematical weakness of unrelated or variable functional origins (Kaufman, 2008). On the other hand, some scholars relate developmental dyscalculia as hereditary. It is seen as a deficiency in cognitive development that is inherent in an individual. It has a genetic basis (Kosc, 1974) and is believed to be beyond environmental factors such as motivational factors, inadequate factors, etc., which were not present at the right time earlier in the developmental history. However, it still holds that DD has led to poor performance in mathematics. Therefore, appropriate remedial educational intention geared towards mitigating the impact of DD on the students learning to advance their performance is worthwhile.

In consideration of various innovative instructional models, many scholars have implemented and recommended some teaching strategies that can enhance student problem-solving abilities, thereby advancing their mathematical performance (Ogunkunle, & Wonu, 2012; Wonu & Ojimba, 2015; Wonu & Arokoyu, 2016; Wonu, & Charles-Ogan, 2017). Regarding students with MLD, Wonu and Okpobiri (2012) explored the effect of metacognitive strategy on the evaluation skills of students with DD in Number and Numeration in Rivers State and found that metacognition was able to advance the problem-solving skills of the students. Wonu and Paul-Worika (2019) worked on enhancing metacognitive knowledge of cognition among junior secondary students with mathematics disabilities in everyday arithmetic. The study found improvement in the explored dimension of metacognition in the mathematical problem-solving episode. Also, Wonu, (2020) conducted an educational intervention to improve the everyday arithmetic learning outcomes of students with Attention Deficit Hyperactivity Disorder (ADHD) and/or Developmental Dyscalculia (DD). This study used metacognition to find improvements in problem-solving learning outcomes. A recent study by Osiagor et al. (2021) investigated the efficacy of the Learning-While-Doing instructional model in advancing the everyday arithmetic performance of students with DD and found improvement in the performance of the students.

Instructional models are diverse (Onwunedo & Wonu, 2013), and the collaborative instructional model is an example. The collaborative instructional approach was designed in the 1950s and 1960s through the efforts of British teachers and researchers (Bruffee, 1996). A collaborative instructional strategy is a model of learning anchored on social constructivism and involves a situation where two or more persons attempt to learn together. Olanrewaju (2019) revealed that the collaborative learning model is a special strategy in learning that leaves a rather long effect on the learners. Taking into consideration students with mathematics anxiety, the study revealed that mathematics learning achievement among secondary school students improved distinctly as compared to the recurring poor performance in mathematics. The CLM can be as effective in any other learning environment. In the application of the CLM to students' conceptual understanding of electromagnetic induction, it was revealed that the learners had an increased understanding of the subject matter. With an additional twist to consider if there will be any significant gender difference, the study revealed that there was no gender difference in the performance of the

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students (Adolphus et al., 2016). In consideration of these upheld studies, the question unanswered will be whether the collaborative learning model will have any significant change in the performance of students with an MLD. This is why this research is of utmost importance as some studies have upheld the outstanding effect of the collaborative learning model when used. Mbacho and Githua (2013) established that the collaborative learning model was found to be more effective in use when compared with the traditional method of teaching secondary school students. It led to an increase in student achievement and interest. Moreover, on the other side in consideration of gender differences, Njoroge and Githua (2013) made a revelation on the positive effect the use of the collaborative learning model brings on gender differences in student achievement. The study revealed that the use of collaborative learning in teaching mathematics minimizes gender differences in student achievement in mathematics. This is rather outstanding as lapses in mathematics achievement concerning a certain gender will be decreased when a collaborative learning model is implemented.

Statement of the problem

The underachievement of students in mathematics in both external and internal examinations is a recurring decimal. This poor performance of students is even worse among students with MLD. Stakeholders in Mathematics Education have made multifarious efforts to advance the learning achievement of students in mathematics, not excluding those with MLD in Port Harcourt LGA. To the best of the researchers' knowledge, no study has tried out the efficacy of CLM in advancing the performance of students with developmental dyscalculia in Number and Numeration in junior secondary schools in Port Harcourt LGA. To plug this gap, this study seeks to research how effective CLM will be in advancing the performance of JSS students with developmental dyscalculia in Number and Numeration in the Port Harcourt Local Government Area of Rivers State.

Aim and Objectives of the study

The main purpose of this study is to investigate the effect of the CLM on the performance of students with developmental dyscalculia in Number and Numeration of junior secondary school students with developmental dyscalculia in the Port Harcourt Local Government Area. Specifically, the objectives of the study are to:

1. determine the difference in the performance of students with developmental dyscalculia taught Number and Numeration using CLM and those taught with Traditional Teaching Method (TTM)
2. find out the difference in the performance of the male and the female students with developmental dyscalculia taught Number and Numeration using CLM

Research Questions

The following research questions guided the study:

1. What is the difference in the performance of students with developmental dyscalculia taught Number and Numeration using CLM and those taught with the TTM?
2. What is the difference in the performance of the male and the female students with developmental dyscalculia taught Number and Numeration using CLM?

Hypotheses

The following null hypotheses were tested at a .05 level of significance

$H_{01:}$ There is no significant difference in the performance of students with developmental dyscalculia taught Number and Numeration using CLM and those taught with the TTM

$H_{02:}$ There is no significant difference in the performance of the male and the female students with developmental dyscalculia taught Number and Numeration using CLM

Methods and Materials

This study adopted the quasi-experimental design. It was used to determine the effectiveness of CLM in improving the performance of students with developmental dyscalculia taught Number and Numeration at Junior Secondary Schools in Port Harcourt LGA. A total of 68 students with DD participated in the study. Two randomly selected junior secondary schools were used for this study. One school was assigned to the experimental group, whereas the other was assigned to the control group. The processes of the diagnosis, identification and selection of students with DD for participation in the study are discussed below:

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Phase 1: The mean score of two terms of mathematics test scores (scores from continuous assessment, first and second term results) of all the JSC2 students in each selected school was computed. Students with mean scores greater than the overall mean were classified as non-dyscalculic students for inclusion in this study, while those with mean scores below the overall mean score were considered students with developmental dyscalculia.
Phase 2: Following the categorization of DD students, a teacher-made Developmental Dyscalculia Diagnostic Test (3DT) was administered to all the identified students with DD in the selected schools to substantiate the result of phase 1 as well as to identify the dyscalculics among them.
Phase 3: The remaining underachieving students with scores outside the range of scores were adjudged by the classroom teachers for inclusion in the study. Teachers' judgments were used since reviews indicated that those judgments were worthy assessments of the achievement-related behaviours of the students (Winne & Perry, 2000).

The instruments used for data collection were the Developmental Dyscalculic Diagnostic Test (3DT) and the Number and Numeration Performance Test (NANPT). The 3DT was used for the diagnosis and identification of the students with DD whereas the NANPT was used for quantifying the performance of the students in Number and Numeration. Experts in Mathematics Education established the face and content validation of the instruments. Both instruments had 25 items of multiple-choice options. Kuder-Richardson, KR-21 was used to ascertain the internal consistency of the instruments, which gave indices of 0.87 and 0.84 for NANPT and 3DT respectively. Firstly, a letter of introduction was sent to the principal of each of the selected schools to seek their approval to involve the JSC2 students in the study. Upon approval, the researchers commenced the study by diagnosing and identifying the students with DD for inclusion in the study. Thereafter, the teacher in the experimental group was trained on the practical and theoretical application of the CLM in teaching students with DD using lesson plans designed by the researchers. Before the commencement of the instructions, the students in both groups were made to take a pretest on NANPT to ascertain their entry behaviour or baseline performance in Number and Numeration . Immediately after the pre-test, the scripts were retrieved from the students. The instructions commenced in both groups.

After the pre-test on NANPT, instructions commenced in both groups. The students in the experimental group were taught using the CLM. The stages involved in the use of a CLM or its strategic components are: Devising a plan; Executing; and Getting feedback. These formed part of the objectives of the study. The drive of learning through problem-solving activities is to enhance student class productivity and enhancement through collaboration with each other as pairs or groups. Each pair or group of students were asked to act following the instructions given by the teacher. The role of the teacher during the activities was to supervise the operation of the activities and guide the students by asking questions to trigger responses which made the process proceed properly and lead the students to engage in practices amongst themselves as a group to yield the answer. At the end of 3 weeks, NANPT was re-administered to the students as a post-test. The scripts were collected, marked and scored over 100 for both the pre-test and post-test. The data obtained were organized and subjected to analysis using Statistical Product and Service Solutions (SPSS). The data collected were analyzed with both descriptive and inferential statistics. Specifically, Mean and standard deviation were used to answer the research questions, whereas the Analysis of Covariance (ANCOVA) was used to test the null hypotheses at a .05 level of significance.

Results

Table 1: Summary of descriptive statistics and ANCOVA results on the differences in the performance of JSC2 students with DD in NAN taught using CLM and those taught with TTM

Group		**Pretest**		**Posttest**		**Gain**	
	N	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
CLM	33	36.73	8.39	59.64	10.26	22.91	9.96
TTM	35	32.00	8.68	47.31	13.03	15.31	10.69
	F1, 65=12.239, p=.001, Partial Eta Squared=.158						

The information in Table 1 above demonstrated the results of ANCOVA and descriptive statistics on the performance disparities between junior secondary students with DD in Number and Numeration who were taught

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using CLM and those who were taught using TTM. It was discovered that whereas the performance mean on the pretest for the students taught using the CLM was (Mean=36.73, SD=8.39), the performance mean on the posttest was 59.64±10.26, and the mean gain was 22.70±9.96. On the other hand, the pre-test performance for students exposed to the TTM was 32.00±8.68 whereas the post-test performance mean score was 47.31±13.03, with a mean gain of 15.31±10.69.

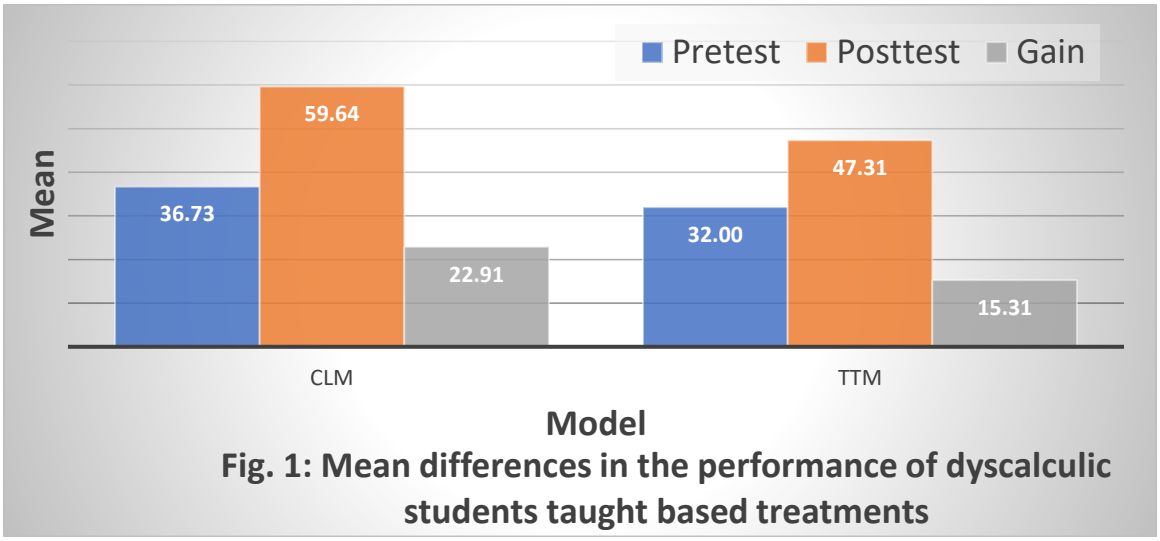

Fig. 1: Mean differences in the performance of dyscalculic students taught based treatments

Further evidence from the results showed a statistically significant difference in the academic performance between junior secondary students with developmental dyscalculia who were taught Number and Numeration using the CLM and those who were taught using the TTM (F1,65=12.050, p.=0.001). The 0.05 threshold of significance was used to reject the null hypothesis one. According to Cohen's proposal, the Partial Eta Square is 0.158, which indicates a moderate effect. This explains variances by roughly 15.8%.

Table 2: Summary of descriptive statistics and ANCOVA results on the difference in the performance of the male and female JSC2 with DD taught using CLM

Sex		Pretest		Posttest		Gain	
	N	Mean	SD	Mean	SD	Mean	SD
Male	19	35.79	9.38	60.84	12.04	25.05	11.30
Female	14	38.00	6.97	58.00	7.32	20.00	7.19
	F1, 30=1.564, p=.221, Partial Eta Squared=.050						

The information in Table 2 above provided descriptive statistics and ANCOVA results on the performance differences between junior secondary male and female students with DD who were taught using CLM. They had a pretest performance mean score of 35.79±9.38 for the male junior secondary school students with DD who were taught utilizing CLM. However, they had a post-test performance mean score of 60.84±12.04 with a mean gain of 25.05±11.30. The female junior secondary students with DD who were taught with CLM had mean performance scores of 38.00±6.97 on the pretest and 58.00±7.32 on the post-test, with a mean gain score of 20.00±7.19 overall.

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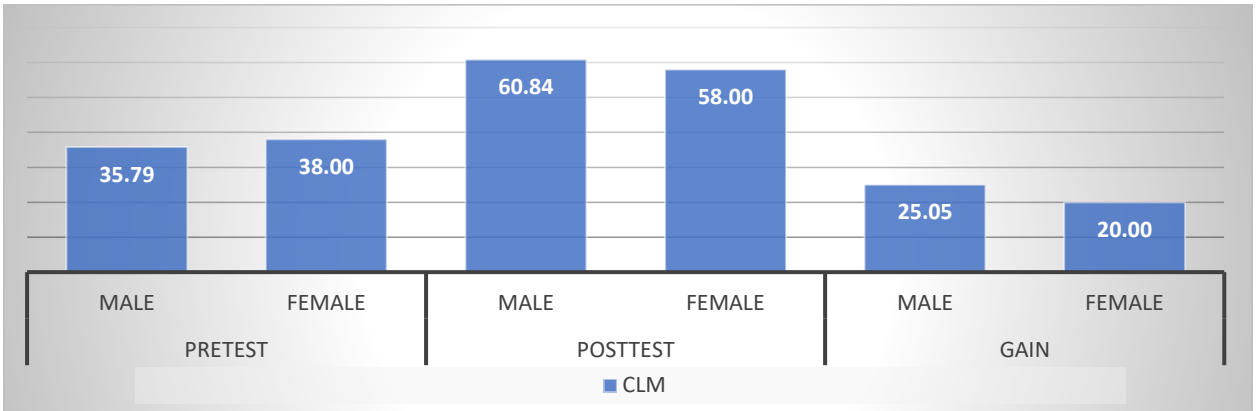

Fig. 2: Gender and the performance of students with developmental dyscalculia using CLM

Additionally, according to the data in Table 2 above, there is no discernible difference in the performance of junior secondary students with developmental dyscalculia who are being taught with CLM between male and female students (F1,30=1.564, p=.221). At a significance level of 0.05, the null hypothesis was maintained. Cohen's theory states that the Partial Eta Square of .050 indicates a low influence. This explains a 5% variation.

Discussion

When junior secondary students with DD were taught NAN utilizing the CLM and the standard teaching approach, different results from Table 1 were supplied by the study question. The outcome showed that JSC2 with DD who were instructed in NAN using the CLM outperformed those who were instructed using the TTM. The difference in leaning gain of 7.60 was shown by the mean gain between the CLM and TTM. According to the results of the ANCOVA, there is a significant difference between the performances of JSC2 students with DD who were taught NAN using the CLM and those who were taught using the TTM (F1,65=12.050, p.=0.001). Meaning that the 0.05 threshold of significance is used to reject the first null hypothesis. Based on Cohen's proposal, the Partial Eta Square is 0.158 indicates a moderate effect. This explains variances by roughly 15.8%. Since CLM groups are naturally activity-based, the students in these groups were exposed to real-world applications of the concepts they learned, which improved their performance in NAN. The study consolidated the previous research done by Yousef and Younis (2021), which investigated the effect of using the cooperative learning method on students' academic achievement in mathematics for elementary school students in Northern Israel. The study found that students' academic achievement in mathematics using the cooperative learning method was better than that of their counterparts who used the traditional learning method. Similarly, the finding was also supported by the findings of Eze and Lasisi (2018), Monoranjan (2016), and Bukar et al. (2020) respectively.

The results from Table 2 indicated that male JSC2 students with DD who were taught NAN through cooperative learning performed slightly differently from their female counterparts. The outcome showed that male students with DD who were taught NAN using the CLM did marginally better than their female counterparts, with a mean gain of 5.05. The ANCOVA results showed that there is no significant difference in the performance of JSC2 students with DD who were being taught using CLM between male and female students (F1,30=1.564, p=.221). At a significance level of 0.05, null hypothesis two was upheld. Cohen's Partial Eta Square of.050 indicated a low influence. This explains a 5% variation. The results are consistent with those of Adolphus and Omeodu (2016), who discovered that, when taught using a collaborative teaching approach, gender has little to no bearing on students' grasp of electromagnetic induction.

Conclusion

The study examined the efficacy of the CLM in advancing the performance of JSC 2 students with DD in NAN. The CLM was more effective than the TTM in enhancing the performance of the dyscalculic students in Number and

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Numeration. However, the study established that CLM was not gender-biased in advancing the learning performance of the students in mathematics. In general, the study concludes that CLM enhances student learning and promotes participation in the classroom. The collaborative learning model is important, as it will encourage student involvement in the teaching and learning process rather than being passive and observant alone. Hence, teachers are encouraged to integrate CLM into their classroom instructions.

Recommendations

Based on the findings of the study, it was recommended that:

1. mathematics teachers should employ CLM in their classroom teachings and ensure that all students participate and collaborate effectively with one another to enhance student-learning outcomes
2. while encouraging the teachers to adopt a collaborative learning approach in teaching and learning, the teachers should try as much as possible to make the classroom democratic enough for both male and female students

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