

**EFFECTS OF COOPERATIVE AND INDIVIDUALIZED
INSTRUCTIONAL STRATEGIES IN DYSCALCULIA REDUCTION
AMONG JUNIOR SECONDARY MATHEMATICS STUDENTS**

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Effects of Cooperative and Individualized Instructional Strategies in Dyscalculia Reduction Among Junior Secondary Mathematics Students

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Abstract

This is a quasi experimental research designed to determine the differential effects of the cooperative, individualized and combine cooperative/individualized learning approaches in dyscalculia reduction among Junior Secondary Mathematics students. The population consisted 212 JSS1 students in a Public Secondary School in Port Harcourt, Rivers State. A sample of 67 students from four (4) intact classes (A, B, C, and D had 18, 16, 17, and 16 students) respectively were drawn using Diagnostic Mathematics Test (DMAT) to determine students with dyscalculia problem. The experimental groups A, B, and C belonged to the experimental group, D belonged to the control group. Students in the experimental group were taught with the cooperative, individualized and combined cooperative/individualized instructional strategies while those in the control group were taught with the teacher's own conventional method. The treatment lasted for 8 weeks of 16 sessions. Students Mathematics Achievement Test (SMAT) was administered on the subjects at the end of treatment. Both the DMAT and SMAT were validated by experts and their reliability assessment produced co-efficients of 0.73 and 0.81 respectively. Data collected were analyzed with Mean (\bar{x}), Standard Deviation (SD), t-test, One Way and Two Way analysis of Variance (ANOVA). Results got after data analysis indicated that there was significant effect of the cooperative, individualized and combined cooperative/individualized instructional approaches in dyscalculia reduction among students; the cooperative/individualized approach emerged the most effective in dyscalculia reduction; there was significant difference in dyscalculia reduction between students in the experimental and control groups, in favour of those in the experimental group. Finally, gender was found to be a factor in the effects of treatment in dyscalculia reduction, in favour of the males students. Based on these results, recommendation was made for the adoption of combined cooperative/individualized instructional approach in dyscalculia reduction among secondary school students.

Introduction

Education aims at preparing young people for life. This can be achieved through exposure of students to knowledge which is acquired through studying different school subjects including English Language, Mathematics, Biology, Chemistry, Physics, Arts, etc. Acquisition of knowledge for productive living is facilitated through students' application (to learning) of important mental/intellectual skills including ability to perceive, reason, and judge situations effectively; ability to engage in critical thinking, and ability to solve problems. In effect a student learns better when he/she is able to put the mind to work.

Among all school subjects, Mathematics appears, by its nature to be the one that mostly requires the learners of the above mentioned mental skills for its effective study. In effect, a student is required to use his/her mental skill to be able to solve Mathematical problem. Unfortunately, experience has shown that most students perform poorly in Mathematics. Some of the reasons for students' poor performance in Mathematics include anxiety, phobia, lack of good self-concept, lack of Mathematics teachers, poor teaching methods, and so on (Olaogun, 2001). However, efforts have been made in the past, and are still being made today to help students understand the concepts and language of Mathematics. The challenges are still steering teachers in the face. The problem is compounded when it comes to teaching students with learning disabilities, like in the case of dyscalculia.

Dyscalculia is a term used to describe difficulty in learning Mathematics concepts (such as quantity, place value, and time), difficulty in memorizing Mathematics facts, difficulty in organizing numbers, and understanding how problems are organized on the page (Wikipedia, 2009). Dyscalculia in clarity is associated with difficulty in learning new concepts, skills, trouble with learning about time, difficulty in remembering facts, impulsive behaviour, transposing number sequences and confusing arithmetic signs, etc. It is obvious that where dyscalculia exists among students, failure in Mathematics at any level of its presence is significant.

Much as it is agreed that students experience some problems in studying Mathematics, teachers and experts in Mathematics have suggested some instructional strategies such as individualized and cooperative strategies as means of facilitating understanding among students (Carson, 1990; Johnson & Johnson, 1987). Individualized instruction is a teaching strategy in which content, instructional materials and pace of learning are based on the ability and interest of each individual learner (Wikipedia, 2011). This strategy is helpful to students with learning disabilities as small, sequential steps are used in structured materials to teach Mathematics. There is enough information, questions, feedback. Moreover, students have the advantage of independent use of resources (texts, audio-visual material, etc) and can always rehearse each module and learn more about it, as against group classroom instruction.

Individualized instruction can be administered in two ways. Students can be exposed to specially designed instructions like Computer Assisted Instruction (CAI) with the use of audio, video multimedia etc or receive direct instruction from the teacher in the area of subject concerned. Whichever mode of individualized instruction that is given, it is believed that the method enhances progressive achievement on subject matter and uniformity of time for performance which is needed for assimilation and understanding.

Another instructional strategy suggested is cooperative or collaborative strategy. According to Chiu (2008), cooperative instruction is “an approach to organizing classroom activities into academic and social learning experiences”. Cooperative learning is particularly recommended for students with learning disabilities resulting to low achievement. In cooperative instructional strategy, students are made to work together on a given tasks and are expected to make individual and collective contributions to the task given, for the overall success of the task, as against individualistic approach to learning (Abu & Flowers, 1997). In this regard, the teacher serves as a guide by providing requisite information to facilitate students’ learning (Chiu, 2004 and Cohen, 1994). In applying this strategy, small teams, each with students of different ability levels, use a variety of learning activities to improve their understanding of a subject. Each of the students will feel that he or she is an important member of the class. Cooperative or

collaborative instructional approach require that instructors attend to the formation of the group, the composition of the group, the dynamics of the group, the assessment of students work, and the design of group tasks (Ventimiglia, 1994)

Cooperative instructional strategy has six basic and essential elements which Brown & Parker (2009); Johnson & Johnson, (1995)) enumerated to include; Positive Independence which enhances the student's ability to work on his own despite being a member of the group; Face-to Face Positive and successful interaction among members of the group in seeking individual and collective success of the assigned task; Individual Accountability of each member of the group to learning and working together as performance of each member is assessed; Enhanced Social skills through interpersonal and small group skills which promote leadership, decision-making, trust building, communication and conflict management skills; Group processing where the effectiveness of the group is assessed while working on the assigned task and decisions are made on how to help and improve on the task; finally, it affords equal participation of all members of the group.

Earlier researchers (Qaisara, Sheikh, Azhar, and Manzoor 2011; Adeyemi, 2008; A Abu & Flowers, 1997; Johnson & Johnson, 1995) had concentrated efforts in investigating the effects of cooperative and individualized instructional strategies on students overall achievement in Mathematics. However, not much is known to the authors of this present research and possibly most other people concerning the effects of these two instructional strategies in the management of any specific learning/mental disability associated with Mathematics. Specifically, the effects of cooperative and individualized instructional strategies in the reduction of dyscalculia (a mental/learning disability associated with studying Mathematics) is not certain.

Again, these two strategies (cooperative and individualized) have been studied singly in determining their effects on Mathematics achievement. Their combined (cooperative/individualized) effect in dyscalculia reduction and consequently in improved Mathematics achievement among learners is not certain. The question that needs to be answered in this work therefore is – “what are the effects of cooperative, individualized and combined cooperative/individualized

instructional strategies in dyscalculia reduction among Junior Secondary School Mathematics students? This experiment was properly designed to answer the above question.

Purpose

The purpose of this study was to determine the effects of cooperative, individualized and combined cooperative/individualized instructional strategies in dyscalculia reduction among Junior Secondary Mathematics students.

Specifically, the study was also designed to:

- a. determine the difference in dyscalculia reduction between subjects in the experimental and control groups.
- b. determine the influence of gender on the effects of cooperative, individualized and combined cooperative/individualized instructional approaches in dyscalculia reduction among Junior Secondary Mathematics students.

Research Questions

1. What are the effects of cooperative, individualized and combined cooperative/ individualized instructional approaches in dyscalculia reduction among junior secondary Mathematics students as measured by their pre-test and post-test scores in the Student Mathematics Achievement Test (SMAT)?
2. What is the difference in dyscalculia reduction among subjects in the experimental and control groups as measured by their post-test scores in the Student Mathematics Achievement Test (SMAT)?
3. To what extent is gender a factor in the effects of cooperative, individualized and combined cooperative/individualized instructional approaches in dyscalculia reductions among subjects as measured by their post-test scores in the Student Mathematics Achievement Test (SMAT)?

Hypotheses

The following null hypotheses were tested at 0.05 alpha levels.

1. The effects of cooperative, individualized and combined cooperative/individualized instructional approach in dyscalculia reduction

- among the subjects do not differ significantly as measured by their post-test scores in the Student Mathematics Achievement Test (SMAT).
2. The difference in dyscalculia reduction between subjects in the experimental and control groups is not significant as measured by their post-test scores in the Student Mathematics Achievement Test (SMAT).
 3. The difference in dyscalculia reduction among male and female students in the experimental groups is not significant as measured by their post-test scores in the Student Mathematics Achievement Test (SMAT).

Method

This is a quasi-experimental research aimed at determining the differential effects of cooperative, individualized and combined cooperative/individualized learning strategies on dyscalculia reduction among Junior Secondary Mathematics students. The randomized, control pre-test/post-test experimental design was adopted. The research was conducted in a public Secondary School in Port Harcourt, Rivers State of Nigeria. The population consisted of all the 212 Junior Secondary School Class One(JSS 1) students; while a sample of 67 students was drawn from 4 intact arms (A, B, C & D) of the class under study. A “Diagnostic Mathematics Achievement Test” (DMAT) was used to determine students with dyscalculia problem. This test was used to assess the students’ level of understanding of Mathematical concepts and skills such as time, place value, number line, addition and subtraction of quantities, etc which are peculiar to dyscalculia problem. Only those who scored below 40 percent in the DMAT were used in the experiment. They consisted 18 in group A, 16 in group B, 17 in group C and 16 in Group D, totaling 67 students. Groups A, B and C served as experimental groups, while Group D served as control group. Simple random sampling technique (balloting) was used to assign learning strategies to the experimental groups. Students in the experimental groups A, B, and C were taught mathematics using cooperative, individualized and combined cooperative/individualized instructional strategies. Those in the control group (D) were taught using the teacher’s own conventional teaching strategy. The teachers in the experimental groups were thoroughly

educated in the application of each of the instructional strategies under study. The instructional content covered topics relating to time, place value, number line, addition of quantities, etc. Before the commencement of the experiment, the “Students Mathematics Achievement Test” (SMAT), a fifty item objective test, based on the content of instruction was administered on the students to determine their baseline data or pre-test scores. Both the DMAT and SMAT were constructed by three experts in Mathematics. They were validated by three experts, one in each of Mathematics, Educational Psychology and Measurement and Evaluation. Test-retest reliability assessment of the instruments produced reliability coefficients of 0.73 and 0.81 respectively. The treatment lasted for 8 weeks of 16 sessions. At the end of treatment, the SMAT was administered again on the students to determine their post-test scores, which indicated the extent of dyscalculia reduction achieved after treatment. Since the same SMAT was used for pre-test and post-test, the researchers took some precautionary measures, which included rearranging the test items in the subsequent administration and reframing some of the questions while retaining their contents. Students’ test scores were analyzed using Mean (\bar{x}), Standard Deviation (SD), t-test, One-Way and Two-Way analysis of variance (ANOVA).

Results

Results got after analysis were presented in the tables below.

Research Question 1: What are the effects of cooperative, individualized and combined cooperative/ individualized instructional approaches in dyscalculia reduction among junior secondary Mathematics students as measured by their pre-test and post-test scores in the SMAT?

Table 1: Mean (\bar{x}) and Standard Deviation (SD) of the effects of Cooperative, Individualized and combined Cooperative/Individualized Instructional Approaches in Dyscalculia Reduction among Junior Secondary Mathematics Students.

Instructional Strategy	Pre-Test			Post-Test		
	N	X	SD	N	X	SD
Cooperative	18	17.78	3.59	18	31.94	5.23
Individualized	16	18.50	3.85	16	25.94	4.25
Cooperative/Individualized	17	17.35	2.32	17	35.94	7.00

Table 1 showed that the pre-test and post test mean scores of dyscalculia students taught with Cooperative Instructional strategy were 17.78 and 31.94 respectively.

For dyscalculia students taught with Individualized instructional strategy, their pre-test and post-test mean scores were 18.50 and 25.94 respectively while those taught with combined Cooperative/Individualized instructional strategy had their pre-test and post-test mean scores as 17.35 and 35.94 respectively.

A critical look at Table 1 indicated that in all the experimental groups, the post test scores were higher than the pre-test scores. The subjects taught using cooperative/individualized combined instructional strategy obtained the highest score, followed by those taught with the cooperative strategy and then those taught with Individualized instructional strategy who obtained the least score.

The above result is an indication that all the instructional strategies were effective in dyscalculia reduction among students. However, the combined cooperative/individualized instructional strategy was found to be the most effective.

Research Question 2: What is the difference in dyscalculia reduction among subjects in the experimental and control groups as measured by their post-test scores in SMAT?

Table 2: Mean (x) and Standard Deviation (SD) of dyscalculia reduction between students in the Experimental and Control groups

Group	N	X	S.D
Cooperative	18	31.94	5.23
Control	16	19.56	4.15
Individualized	16	25.94	4.25
Control	16	19.56	4.15
Combined Cooperative/Individualized	17	35.94	7.00
Control	16	19.56	4.15

Data in Table 2 showed that subjects in all the experimental groups obtained higher mean scores than their counterparts in control group. This means that greater reduction in dyscalculia was achieved among subjects in experimental groups than those in the control group.

Research Question 3: To what extent is gender a factor in the effects of cooperative, individualized and combined cooperative/individualized instructional approaches in dyscalculia reductions among subjects as measured by their post-test scores in the SMAT?

Table 3: Mean (x) and Standard Deviation (SD) of influence of gender on the effect of Cooperative, Individualized and combined Cooperative/Individualized instructional strategies in dyscalculia reduction among subjects.

Instructional Approaches	Gender	N	X	S.D
Cooperative	Male	9	36.22	3.23
	Female	9	27.67	2.55
Individualized	Male	9	28.22	3.23
	Female	7	23.00	3.65
Combined Cooperative/Individualized	Male	9	41.22	4.84
	Female	8	30.00	3.02

Data in Table 3 showed that male and female subjects taught with cooperative strategy obtained 36.22 and 27.67 in the SMAT respectively. Again, male and female subjects taught with individualized instructional strategy scored 28.22 and 23.00 in the SMAT respectively, while male and female subjects taught using the combined cooperative/individualized strategy scored 41.30 and 30.00 respectively. The males in all the experimental groups scored higher than the females. This is an indication that greater effect of treatment on dyscalculia reduction was found among the males than the females.

Hypothesis 1: The effects of cooperative, individualized and combined cooperative/individualized instructional approach in dyscalculia reduction among the subjects does not differ significantly as measured by their post-test scores.

Table 4: One-Way ANOVA of the effect of cooperative, individualized and combined cooperative/individualized instructional approaches in dyscalculia reduction among subjects

Source of Variation	Sum of Squares (SS)	Df	Mean Square (MS)	F-ratio	F-critical	Result
Between Groups	833.334	2	416.667	13.151	1.92	S
Within Groups	1520.823	48	31.684			
Total	2354.157	50				

Table 4 showed that the calculated F-value of 13.151 is greater than the critical F-value of 1.92 at dfs of 2 and 48 and 0.05 alpha level. The null hypothesis one was therefore rejected. This implied that there is significant effect of cooperative, individualized and combined cooperative/individualized

instructional approaches in dyscalculia reduction among students in favour of those taught with combined cooperative/individualized strategy.

Table 5: Scheffe' Post-Hoc Pair-Wise Comparison of Dyscalculia Reduction due to Treatment

		Cooperative	Individualized	Cooperative/Individualized
Instructional Strategy		31.94	25.94	35.94
Cooperative	31.94		*	*
Individualized	25.94	*		*
Coop/Individ	35.94	*	*	

Key *: Indicates pairs of means which are significant as 0.05 alpha level

The data of Table five (5) showed that:

1. Students taught with cooperative and individualized instructional strategies differed significantly in dyscalculia reduction, in favour of those taught with cooperative strategy.
2. Students taught with cooperative and combined cooperative/individualized instructional strategies differed significantly in dyscalculia reductions; in favour of those taught with combined cooperative/individualized strategy.
3. Students taught with individualized and combined cooperative/individualized instructional strategies differed significantly in dyscalculia reduction; in favour of those taught with combined cooperative /individualized strategies.

Hypothesis 2: The difference in dyscalculia reduction between subjects in the experimental and control groups is not significant as measured by their post-test scores in the SMAT.

Table 6: t-test analysis of difference in dyscalculia reduction between students in experimental and control groups.

Instructional Approach	N	X	S.D	Df	Cal t	Crit t	Remark
Cooperative	18	31.94	5.23	32	9.43	2.04	Rejected
Control	16	17.56	3.33				
Individual	16	25.94	4.25	30	6.21	2.04	Rejected
Control	16	17.56	3.33				
Cooperative/ Individualized	17	35.94	7.00	31	9.53	2.04	Rejected
Control	16	17.56	3.33				

Data in table 6 showed that all the calculated t values 9.43, 6.21 and 9.53, showing extent of difference in dyscalculia reduction between subjects in experimental and control groups, are respectively greater than the t-critical value of 2.04, at 0.05 alpha level and dfs of 32, 30 and 31. The null hypothesis two was therefore rejected. This implied that

significant difference in dyscalculia reduction existed between students in the experimental and control groups in favour of those in the experimental groups. Hypothesis 3: The difference in dyscalculia reduction among male and female students in the experimental groups is not significant as measured by their post test scores in SMAT.

Table 7: Two-Way ANOVA of difference in dyscalculia reduction in the experimental groups.

Sources of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-cal	F- critical	Result
Main effects	1286.808	5	257.362	10.851	2.34	S
Gender	303.204	1	303.204	12.783	4.03	S
Methods	180.763	2	90.381	3.811	1.90	S
2-way Interactions	77.050	2	38.525	2.624	1.90	NS
Gender and Methods	77.050	2	38.525	2.624	1.90	NS
Explained	2354.157	50				
Residual	1067.348	45	23.719			
Total	52613.000	51				

From Table 7 above, it was observed that all the F-calculated values were respectively greater than the F-critical values, at 0.05 alpha level and dfs of 1 and 45. The null hypothesis three was therefore rejected. The result showed that there was significant difference in dyscalculia reduction among male and female students in favour of the males.

The result in Table 7 also showed that the F-calculated value for gender by instructional strategies interaction (2.624) is greater than the F-critical value of 1.90 at 0.05 alpha level and dfs of 1 and 45. Hence, the interaction effect of gender and instructional strategies in dyscalculia reduction among students was significant.

In order to determine pair of means that are significantly different, the Scheffe's post-hoc-test was conducted. Summary of the test is presented below:

Table 8: Post-Hoc Pair-Wise Comparison of Dyscalculia Reduction among male and female students due to Treatment

Instructional Approaches	Gender	X	
Cooperative	Male	36.22	*
	Female	27.67	
Individualized	Male	28.22	*
	Female	23.00	
Combined Cooperative/Individualized	Male	41.22	*
	Female	30.00	

Key *: Indicates pairs of means which are significant as 0.05 alpha level.

An observation of Table 8 showed that male and female students in all the three experimental groups studied, differed significantly in dyscalculia reduction in favour of the males. This means that the effect of the instructional strategies on dyscalculia reduction was not consistent across gender levels.

Discussion

The differential effects of cooperative, individualized and combined cooperative/individualized instructional strategies in dyscalculia reduction among students were investigated in this study. Findings indicated that there was dyscalculia reduction was highest among students who were taught with combined cooperative/individualized instructional strategy (35.94), followed by those taught with the cooperative approach who scored (31.94) and then the students taught with individualized approach, who scored 25.94. The combined cooperative/individualized instructional strategy was therefore found to be the most effective.

The result of hypothesis one also showed significant difference in dyscalculia reduction of students across the three instructional strategies in favour of those taught with combined cooperative/individualized strategy. This result serves as an eye-opener to teachers concerning the effectiveness of these strategies, especially the combined cooperative/individualized instructional strategy in dyscalculia reduction among students. The result corroborates with the finding of researches such as Qaisara, Sheikh, Azhar and Manzoor (2011), who found that cooperative instructional strategy results in both cognitive and affective growth of students. They also found that cooperative instruction had a significant improvement on students' achievement, self-esteem and academic motivation and social skills of students. Also, Kolawole (2008) concluded in his research that cooperative instructional strategy is more effective than competitive (individualized) instructional approach in teaching of Mathematics at Secondary School Level. Cooperative instructional strategy is adjudged a successful teaching strategy in which small teams, each with students of different ability levels, use a variety of learning activities to improve their understanding of a subject (Chiu, 2004, and Cohen, 1994).

That combined cooperative and individualized instructional strategy emerged the most effective in dyscalculia reduction could mean that it helped the students to interact with one another, collectively solved problems, with every member playing specific roles. This, it is believed might have helped them to work individually also. This strategy would have also helped students learn to work with others, gain better insight and have confidence to work on their own in solving Mathematical problems.

Results also indicated that there was a marked difference in dyscalculia reduction between students in the experimental and control groups. Subjects in all the experimental groups obtained higher mean scores than their counterparts in the control group. This difference in dyscalculia reduction between students in the experimental and control groups was found to be significantly different. The treatment received by in the experimental group must have led to this result.

Gender was found to be a factor in the effects of cooperative, individualized and combined cooperative/individualized instructional strategies in dyscalculia reduction among the students. This was corroborated by Kolawole (2008) who asserted that gender is a factor with respect to students' achievement in Mathematics, in favour of the males, as found in this present study too.

Conclusion

From the findings of this study, it was concluded that

- There was significant effect of cooperative, individualized and combined cooperative/individualized instructional approaches in dyscalculia reduction among Junior Secondary Mathematics students
- Specifically, combined cooperative/individualized instructional approach emerged the most effective in dyscalculia reduction among students.
- Significant gender difference in dyscalculia reduction was found among male and female students due to the effect of cooperative, individualized, and combined cooperative/individualized instructional approaches, in favour of the males.

Recommendations

- Based on the following findings, it was therefore recommended that
1. Combined cooperative/individualized instructional approach should be adopted by teachers in teaching mathematics, especially for the management of dyscalculia, to improve performance.
 2. Teachers should endeavour to bridge the gap in Mathematics achievement between male and female students through encouragement and motivation of female students during teaching.
 3. Teachers are enjoined to encourage team work in solving Mathematics problems to improve students intellectual functioning.

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