



EFFECT OF PEER TUTORING AND COOPERATIVE LEARNING INSTRUCTIONAL STRATEGIES ON MATHEMATICS ACHIEVEMENT OF STUDENTS WITH LEARNING DISABILITIES IN OYO STATE, NIGERIA

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ABSTRACT

This study examined the effect of peer tutoring and cooperative learning instructional strategies on mathematics achievement of students with learning disabilities in Oyo State, Nigeria. The study adopted a pre-test, post-test control group quasi experimental design with 3x2x2 factorial matrix, sampling one hundred and fifty six (156) students with learning disabilities in Mathematics selected through random sampling with the use of the Pupil Rating Scale, Mathematics Tests (A and B) for JSS1 Students, Extroversion and Introversion Scale, and Checklist for School Environment. Participants were exposed to eight weeks of instruction in mathematics, using the three instructional strategies and a control group. Analysis of Covariance (ANCOVA) was used to analyze the three hypotheses generated at 0.05 level of significance, with the results showing a significant effect on participants' achievement scores in mathematics ($F_{(2,143)} = 32.497; P < 0.05$). This implies that there is a significant difference in mathematics achievement of participants exposed to peer tutoring, cooperative learning, and the control group. Further analysis revealed that students exposed to cooperative learning instructional strategy performed better than students exposed to peer tutoring and the control. Also, results indicated that both personality and school environment did not have significant main effects on mathematics achievement of students with learning disabilities. Based on these findings, it was recommended that teachers of students with learning disabilities should incorporate the use of peer tutoring and cooperative learning in teaching Mathematics to students with learning disabilities.

Key Words: *peer tutoring, cooperative learning, learning disabilities, personality types, school environment*

INTRODUCTION

Mathematics pervades literally every field of human endeavour and plays a fundamental role in the social, intellectual, vocational, and economic development of an individual and society. It is a branch of science that deals with numbers and their operations. It involves calculation, computation and problem solving. Many individuals find mathematics handy on a daily basis in solving their problems and most jobs require some knowledge of mathematical skills. Indeed, the knowledge and application of mathematics theories are of utmost importance in the technological advancement of all nations of the world.

Olorundare (2011) posited that the development of any nation is usually barometered by the degree and extent of the socio-cultural, socio-economic and political improvement that are brought to bear through the enterprises of science, technology and mathematics. This explains why at the national level, the Federal Government of Nigeria (2004) through her National Policy on Education reiterated that education in mathematical skills provide a solid foundation for everyday living, as well as stimulate and encourage creativity.

Despite obvious gains of Mathematics, an estimated six percent of students have difficulties with Mathematics (McNamara, 2007) while within the special education population, approximately, more than fifty percent of students with learning disabilities also have difficulties with Mathematics (Fuchs & Fuchs, 2001). Typical evidence is the result of 2010 November/December West African Senior School Certificate Examination which revealed that only 20.04% of 310,077 candidates obtained five credits in core subjects including Mathematics and English Language (Olorundare, 2011).



In general, Mangal (2007) enumerated certain characteristics common to all students with learning disabilities in Mathematics as follows: fail to write numerals and mathematics symbols correctly; have difficulty in counting, doing mathematical calculation and computation work; may encounter difficulty in following proper steps and reasoning for solving mathematical problems, particularly the word problems; and may experience difficulty in acquiring proper understanding of the basic mathematical concepts like place value, directed numbers, directions and dimensions, and measuring units. Earlier, Kroesberger and VanLuit (2003) stated that students with learning disabilities in Mathematics often have difficulty with memory and use Mathematics strategies inadequately.

In the past, attempts have been made to address major causes of poor academic performance among students with learning disabilities such as Okilwa and Shelby (2010) and Lazarus (2009); however, students with learning disabilities still have difficulties in Mathematics. Therefore, this study examined the effects of peer tutoring and cooperative learning instructional strategies in enhancing mathematics achievement of students with learning disabilities.

Peer tutoring is an instructional strategy in which one student provides instruction or academic assistance to another. It provides the opportunity for students with learning disabilities to become active learners, as it offers a functional way for these students to learn mathematics skills. Peer tutoring is characterized by specific role taking: at any point someone has the job of tutor, while the other(s) are in role as tutee (s). Research on peer tutoring has demonstrated that peer tutoring can be successfully implemented with tutors of various ability levels, including children with advanced skills and children with learning disabilities (Fuchs, Fuchs Yazdin, & Powell, 2002). A synthesis of the literature on the effects of peer tutoring on academic performance of students with disabilities in Grades 6 through 12 was carried out by Okilwa and Shelby in 2010. Twelve studies met all the criteria for this synthesis. Peer tutoring was reported as effective for special education students in both general education and special education settings. Peer tutoring implemented across subject areas also showed positive academic effects. Each of the twelve studies implemented peer tutoring in at least one content area (such as language arts, mathematics, science, and social studies).

Additionally, Bowman-Perrott, Davis, Vannest, Williams, Greenwood, and Parker, (2013) conducted a meta-analysis on the effects of peer tutoring across 26 single-case research experiments for 938 students in Grades 1-12. Five potential moderators of these effects were examined: dosage, grade level, reward, disability status, and content area. Findings suggest that peer tutoring is an effective intervention regardless of dosage, grade level, or disability status. Among students with disabilities, those with emotional and behavioural disorders benefitted most.

Similarly, cooperative learning involves structuring classes around small groups that work together in such a way that each group member's success is dependent on the group's success. According to Johnson, Johnson and Smith (2006), five key elements - positive interdependence, individual accountability, face-to-face (promotive) interaction, interpersonal and small group social skills, and group processing differentiate cooperative learning from simply putting students into groups to learn. Sharan (2010) maintained that cooperative learning methods and procedures are designed to promote cooperation and mutual assistance among learners and often carry over to relationships outside the school.

Furthermore, Shihab (2011) noted that a benefit of cooperative learning is to provide students with learning disabilities, who have mathematics disabilities and social interaction difficulties, an instructional arrangement that enhances the application and practice of mathematics and collaborative skills within a natural setting (that is, group activity). In addition, in an extensive meta-analysis across hundreds of studies, cooperative arrangements were found superior to either competitive or individualistic structures on a variety of outcome measures, generally showing higher-achievement, higher-level



reasoning, more frequent generation of new ideas and solutions, and greater transfer of what is learned from one situation to another (Barkley, Cross & Major, 2005).

Personality attributes in terms of whether a student is an introvert or an extrovert is one important variable considered in this study. Jung (1923) asserted that introverts have a preference for working alone or in small groups and are drained by being around people while extroverts enjoy working with many others, and are more focused on the world around them. As a result extroverts become energized by large group interaction and tend to give more attention to relationships. According to Vidya (2013) extroversion plays some role on academic performance of students because it has effect on intelligence and cognitive functions. In contrast, Srivastava, Angelo, Vallereux (2008) reported that extroverts did not respond stronger to social situations than introverts, nor did they report bigger boosts of positive effect during such interactions.

Another variable identified in this study is school environment, which was classified into stimulating and non-stimulating environments. Dahar, Dahar, Dahar and Faize, (2011) reported that some indicators of school environment that may affect students' academic achievement are: teaching-learning process, commitment of leadership, teachers' and students' discipline, design and condition of building with cross-ventilation, school grounds, medical facilities and arrangement for physical health. Earlier, Tableman (2004) had not only identified four kinds of school environment as physical, social, natural climate and academic but also concluded that the school environment and teacher-related factors have powerful and positive influence on student achievements. Moreover, Adesoji and Olatunbosun (2008) hypothesized that the school environment and teacher-related factors have powerful and positive influence on student achievement. In the light of the foregoing, this study investigated the effect of peer tutoring and cooperative learning instructional strategies in mathematics achievement of students with learning disabilities, while considering introversion/extroversion personality types as well as stimulating and non-stimulating school environments as moderating variables.

Hypotheses

To guide the conduct of the study, three hypotheses were formulated and tested at 0.05 level of significance.

Ho₁: There is no significant main effect of treatment on students with learning disabilities' achievement in mathematics.

Ho₂: There is no significant main effect of students with learning disabilities' personality type (extroversion and introversion) on their achievement in Mathematics.

Ho₃: There is no significant main effect of students with learning disabilities' school environment on their achievement in Mathematics.

Design

The study adopted a pre-test, post-test control group quasi experimental design with a 3x2x2 factorial matrix with instructional strategies at three levels: peer tutoring, cooperative learning and the control; personality type at two levels: introversion and extroversion; and school environment at two levels: stimulating and non-stimulating.

Population

The target population for the study was students in Junior Secondary School in Akinyele Local Government Area of Oyo State, Nigeria.

Sample and Sampling Techniques

Multi-stage sampling, purposive and simple random sampling techniques were adopted in the selection of study sample. First, Oyo State was delineated into 3 senatorial zones, out of which one senatorial zone (Oyo Central) was selected through random



sampling. Within the senatorial zone, one local government area which is (Akinyele Local Government Area) was randomly selected. Next, was the selection of six public secondary schools from Akinyele, LGA. For the initial selection, teachers in the six schools selected for the study nominated nine hundred (900) low achieving Junior Secondary School 1 (JSS1) students based on their past academic performance.

To identify students with learning disabilities, the researchers administered the Pupil Rating Scale by Myklebust (1981). Out of the nine hundred low achieving students two hundred and eighty (280) scored between zero and fifty nine (0-59) on the screening instrument and this qualified them as students with learning disabilities. To get the actual number that have learning disabilities in Mathematics, a further assessment using the Mathematics Test for JSS 1 students (Test A) was administered to these two hundred and eighty students with learning disabilities. Test scores showed that one hundred and fifty-six of them had specific learning disabilities in Mathematics.

Through random sampling 156 students identified as experiencing learning disabilities in Mathematics were assigned to experimental groups and control. Each of the two experimental groups and control comprised fifty-two (52) participants. Since six schools were used, twenty six students were chosen from each school. This showed that four schools represented the two treatment groups and two schools represented the control group respectively. The participants were between ten and sixteen (10-16) years of age.

Research Instruments

The following instruments were used to carry out the study:

The Pupil Rating Scale

The Pupil Rating Scale is a screening instrument for students with learning disabilities. It was designed by Myklebust in 1971 and revised in 1981. The pupils rating Scale is a standardized scale. The author normalized it on a large population and found the instrument to be valid as a screening device. The scale consists of five major behavioural indices which are: Auditory comprehension, Spoken language, Orientation, Motor co-ordination, and Personal- social behaviour. These behavioural characteristics are grouped under two categories- verbal and nonverbal. Auditory comprehension and spoken language were classified as verbal, while orientation, motor coordination and personal social behaviour, as non verbal. On the whole, the scale contains twenty four (24) items. Each item was assessed on a five point scale, with an average of three. Ratings which fell below the average received either one or two scores, while ratings above average received four or five scores. A score below the average result would suggest the presence of learning disabilities. The maximum obtainable score is one hundred and twenty (120), while persons with learning disabilities would have a score that is below seventy two (72). Lazarus (2009) obtained a reliability coefficient of 0.76 for the Pupil Rating Scale, using the Guttman- split half formula.

Mathematics Test for JSS1 (Tests A & B)

Two sets of Mathematics Tests that is, Test A (15 questions) and Test B (15 questions) were drawn for junior secondary school class 1 (J.S.S. 1) students with learning disabilities in Mathematics. The questions were taken from The New General Mathematics for Junior Secondary School 1, UBE Edition by Macrae, Kalejaiye, Chima, Garba, Ademosu, Channon, Mcleish Smith and Head (2008). The Mathematics tests have face validity. The questions set were given to experts in the field of Mathematics, before the questions were given to the students at the screening (Test A was used), pre-test evaluation and post-test assessments (Test B was used). Using the Kuder- Richardson reliability formula, a reliability coefficient of 67.44 was found for the Mathematics tests.

Extroversion and Introversion Scale (EIS)



A ten-item Extroversion and Introversion Scale was developed by the researcher to classify participants into two groups according to their personality types which are extroverts and introverts. All sentences describing personality traits of extroverts are represented with even numbers namely 2, 4, 6, 8, 10, and 12 while sentences represented with odd numbers signify characteristics of introverts specifically sentences 1, 3, 5, 7, 9 and 11. Each student's personality was identified by his positive responses or negative responses that tally with either extrovert or introvert characteristics in the EIS.

Checklist for School Environment (CSE)

Similarly, researchers developed the School Environment Checklist to differentiate the school environment that is stimulating from the school environment that is non-stimulating. There are two columns of fifteen items describing the characteristics of the stimulating and non-stimulating school environment. Respondents were asked to indicate 'yes' or 'no' option to items that correspond with their opinions on school environment.

Procedure for Data Collection

The study lasted for eight (8) weeks. First, training of research assistants, screening of participants and the pre-test were carried out in week 1. Three research assistants were trained using three operational guides for instruction (with each reflecting one Mathematics instructional strategy – Peer Tutoring, Cooperative Learning and Conventional Method respectively). After ascertaining that the research assistants had mastered the treatment procedures, the researcher allowed them to conduct the training in Mathematics for the participants in their various schools for six weeks. That is, Experimental Group 1 made use of peer tutoring strategy during their training sessions; Experimental Group 2 received Mathematics Lessons while working in cooperative learning groups while participants in the control group continued to receive instruction on the same mathematics topics treated by the experimental groups using the conventional method of learning (explanation and solving Mathematics questions).

In Experimental Group 1, the research assistant described how a peer tutoring lesson is conducted, modelled peer tutoring lesson procedure, asked participants to do verbal and controlled practice of peer tutoring procedure while he watched them to provide feedback. Then participants were paired to work one-on-one with each other while exchanging roles as tutors and tutees as they practiced peer tutoring while learning Mathematics.

Participants in Experimental Group 2 received training in Mathematics while working in cooperative learning groups. After demonstrating cooperative group procedure to the whole class, participants were assigned to small groups of between eight and ten students as they practised cooperative learning group activities. The control group was also taught using the conventional method. During the weeks of implementation the researcher observed the research assistants once a week to monitor implementation.

Thereafter, in week 8, a post-test was conducted using the pre-test instrument for all participants including those in the control group.

Methods of Data Analysis

Data collected was analyzed using the Analysis of covariance (ANCOVA), Multiple Classification Analysis (MCA) and Scheffe Post Hoc Analysis.



Results

Ho₁: There is no significant main effect of treatment on students with learning disabilities' achievement in mathematics.

Table 1: Summary of Analysis of Covariance (ANCOVA) Showing Post-Test Achievement Scores of Participants by Treatment, Personality Types and School Environment

Source of Variation	Sum of Squares	Df	Mean Square	F	Sig. P
Covariates Pre-test	8987.994	1	8987.994	268.609	.000
Main Effects (combined)	2258.318	4	564.579	16.873	.000
1. Treatment	2174.749	2	1087.374	32.497	.000*
2. Personality Types	50.174	1	50.174	1.499	.223
3. School Environment	33.394	1	33.394	.998	.319
2-Way Interactions (combined)	329.061	5	65.812	1.967	.087
4. Treatment x Person. Types	285.293	2	142.647	4.263	.016*
5. Treatment x Sch. Environ.	37.660	2	18.830	.563	.571
6. Personality x Sch. Environ.	5.544	1	5.544	.166	.685
3-Way Interactions					
7. Treatment x Personality Types x School Environment	14.666	2	7.333	.219	.803
Explained	11590.038	12	965.836	28.864	.000
Residual	4784.956	143	33.461		
Total	16374.994	155	105.645		

*= Significant at P < 0.05

From Table 1, treatment was found to have a significant effect on participants' achievement scores in mathematics ($F_{(2,143)} = 32.497$; $P < 0.05$). This implies that there is a significant difference in mathematics achievement of participants exposed to peer tutoring, cooperative learning, and the control group. Therefore, H₀₁ is rejected.

In order to determine the magnitude of the post-test mean scores obtained by each of the two treatment groups and the control, the Multiple Classification Analysis (MCA) is presented in Table 2 below:

Table 2: Multiple Classification Analysis (MCA) of Post-Test Scores by Treatment, Personality Types and School Environment

Grand Mean = 17.16

Variable + Category	N	Unadjusted Deviation	Eta	Adjusted for Factors and Covariates Deviation	Beta
Treatment					
1. Peer Tutoring	52	1.07		1.62	
2. Cooperative Learning	52	3.38		3.46	
3. Control	52	-4.45		-5.08	
			.32		.36
Personality Types					
1. Extrovert	76	6.56		.83	
2. Introvert	80	-6.24		-.79	
			.62		.08
School Environment					
1. Non-Stimulating	80	-.46		-.45	
2. Stimulating	76	.48		.48	
			.05		.05

Multiple R = .829



Multiple R Squared = .687

Table 2 reveals that participants in the Treatment Group 2 (Cooperative Learning) obtained the highest adjusted post-mean scores of 20.62. This group is followed by the Treatment Group 1 (Peer Tutoring) which had a mean score of 18.78 while the control had the lowest adjusted post-test mean score of 12.07. These mean scores were obtained by summing up respective adjusted deviations with the grand mean. This result can be summarized as Cooperative Learning > Peer Tutoring > Control group (CL > PT > Control).

Furthermore, the Scheffe Pairwise Comparisons were carried out to trace the source of significant main effects obtained.

Table 3: Scheffe Pairwise Comparisons

(I) Treatment	(J) Treatment	Mean Difference	Std. Error	Sig.	95% Confidence Level	
					Lower Bound	Upper Bound
1. PT	CL	-2.3077	1.9219	.488	-7.0583	2.4430
	Control	5.5192*	1.9219	.018	.7686	10.2699
2. CL	PT	2.3077	1.9219	.488	-2.4430	7.0583
	Control	7.8269*	1.9219	.000	3.0763	12.5776
3. Control	PT	-5.5192*	1.9219	.018	-10.2699	-.7686
	CL	-7.8269*	1.9219	.000	-12.5776	-3.0763

*=The mean difference is significant at $\alpha = .05$

Key: PT = Peer Tutoring, CL = Cooperative Learning

Ho₂: There is no significant main effect of students with learning disabilities' personality type (extroversion and introversion) on their achievement in Mathematics.

Table 1 shows that there is no significant main effect of personality type (extroversion and introversion) on post-test achievement scores of participants ($F_{(1,143)} = 1.499$; $P > 0.05$). Hence, the null hypothesis is accepted. However, Table 2 shows that extroverts obtained an adjusted mean score of 17.99 while introverts had an adjusted mean of 16.37. Although this difference is not statistically significant, it suggests that extroverts performed better than their counterparts in the post test achievement score in Mathematics.

Ho₃: There is no significant main effect of students with learning disabilities' school environment on their achievement in Mathematics.

Table 1 shows that there is no significant main effect of school environment on post-test achievement scores of participants ($F_{(1,143)} = .998$; $P > 0.05$). Thus, the null hypothesis is accepted. However, Table 2 shows that students in stimulating school environment obtained an adjusted mean score of 17.64 while students in non-stimulating school environment had an adjusted mean of 16.71. Again, this difference is not statistically significant but it suggests that students in stimulating school environment outperformed their counterparts in non-stimulating school environment in the post test achievement score in Mathematics.

Discussion of Findings

The result in table 1 showed that there was a significant main effect of treatment on the mathematics achievement of students with learning disabilities. In other words, both peer tutoring and cooperative learning instructional strategies led to significant improvements in Mathematics scores of students with learning disabilities in Mathematics. This study therefore authenticates the finding that peer tutoring can be successfully implemented with tutors of various ability levels, including children with advanced skills and children with learning disabilities (Fuchs, Fuchs Yazdin, & Powell, 2002). This finding provides further



support to Okilwa and Shelby (2010) report that peer tutoring showed positive academic effects for special education students in both general education and special education settings.

Further analysis of table 1 showed that Experimental Group 2 (cooperative learning group) performed better than the peer tutoring group and the control group. This finding corroborates the position of Barkley, Cross and Major (2005) which indicated that cooperative arrangements were found superior to either competitive or individualistic structures on a variety of outcome measures, generally showing higher-achievement, higher-level reasoning, more frequent generation of new ideas and solutions, and greater transfer of what is learned from one situation to another.

Data from Table 1 showed that there was no significant main effect personality type (extroversion and introversion) on post-test achievement scores of participants. However, data from Table 2 showed that extroverts obtained an adjusted mean score of 17.99 while introverts had an adjusted mean of 16.37. Although this difference is not statistically significant, it suggests that extroverts performed better than their counterparts in the post test achievement score in Mathematics. This finding supports Vidya (2013) assertion that extroversion plays some role on academic performance of students because it has effect on intelligence and cognitive functions. In contrast, the finding contradicts the report of Srivastava, Angelo, Vallereux (2008) that extroverts did not respond stronger to social situations than introverts, nor did they report bigger boosts of positive effect during such interactions.

Table 1 also showed that there is no significant main effect of school environment on post-test achievement scores of participants. Thus, the null hypothesis is accepted. However, Table 2 showed that students in stimulating school environment obtained an adjusted mean score of 17.64 while students in non-stimulating school environment had an adjusted mean of 16.71. Again, this difference is not statistically significant but it suggests that students in stimulating school environment outperformed their counterparts in non-stimulating school environment in the post test achievement score in Mathematics. This finding is in line with Adesoji and Olatunbosun (2008) position that the school environment and teacher-related factors have powerful and positive influence on student achievement.

Conclusion and Recommendations

On the basis of the findings of this study, the use of peer tutoring and cooperative learning strategies in the classroom help students with learning disabilities to develop academic learning skills especially in mathematics. Thus, teachers of students with learning disabilities are expected to utilize peer tutoring and cooperative learning strategies in their classrooms. The following recommendations derive from the study:

Teachers should utilize peer tutoring and cooperative learning strategies in teaching their students mathematics, particularly students with learning disabilities. The government and policy makers in Nigeria, should incorporate in the education policy the use of these teaching strategies that is, peer tutoring and cooperative learning strategy in the education curriculum and give room for its use in the school system, since it has been found that it is useful in aiding the students with learning disabilities' academic performance especially in mathematics.

There should be intensive public awareness activities aimed at enlightening teachers, students and the general public on the importance and implementation procedures of peer tutoring and cooperative learning strategies.

Flexibility in strategy used should be encouraged among teachers as it has been established that there are diverse models of cooperative learning strategy and these models yield significant gains when implemented correctly.



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