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Effect of peer collaborative instructional strategy on students' achievement and interest in numerical processes at senior secondary school level in Kogi state

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Abstract
This study was designed to investigate the effect of peer collaborative instructional strategy (PCIS) on students' achievement and interest in numerical processes at Senior Secondary School level in Ankpa Local Government Area of Kogi State, Nigeria. The design of the study is quasi-experimental research design, specifically, the non-equivalent pretest posttest control group design. Four research questions guided the study and six hypotheses were tested at 0.05 level of significance. Ninety (90) SS I students selected out of the total population of 1200 SSI students in 24 secondary schools in the Local Government Area using simple random sampling technique. Two schools, one each was randomly assigned to experimental and control groups respectively. The 46 students in the experimental group were exposed to the use of peer collaborative instructional strategy while traditional method was used for the 44 students in the control group. Two instruments – Modular Arithmetic Achievement Test (MAAT) and Modular Arithmetic Interest Scale (MAIS) were used for data collection. The raw scores of students from MAAT and MAIS were used for data analysis. Research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA). The results revealed that the student taught Numerical Processes using Peer Collaborative Instructional Strategy had higher mean achievement scores and interest ratings than their counterparts in the control group. The study recommended that since the use of peer collaborative instructional strategy enhanced students' achievement and interest, new mathematics curriculum should be aimed at making mathematics learning interesting by considering the natural diversities among students.

Keywords: peer collaborative instructional strategy; traditional method, achievement, interest, mathematics education

Introduction

The relevance of Mathematics in everyday life activities cannot be over emphasized. It is the reason for its inclusion as an important school subject. Osagwu (2010) maintained that a developing country like Nigeria should give a priority attention to educational and utilitarian qualities derivable from such practical problem-solving oriented subject as Mathematics and engage in intensive teaching of the subject for the good of the citizens. The learning of Mathematics has become imperative in every society since the citizens need to cope with the fast-changing development in science and technology (Onah, Uchechukwu, Hope & Umeano, 2015) [14]. However, report from the WAEC Chief Examiner in Mathematics for 2018 showed that candidates' answers revealed an ignorance of the rudiments of Mathematics especially in Modular Arithmetic. Onyeshi (2014) [15] maintained that there is increasingly poor achievement in Mathematics among Secondary School Students.

Achievement is described as a measure of learner's level of knowledge, skills or performance (Ugwu, 2008) [18]. It was described as the level of goal accomplishment (Bassey, 2002). Achievement is the successful accomplishment of goals and how the students are able to demonstrate their intellectual abilities in Mathematics concepts through testing over a period of time. Some researchers have investigated the causes of poor achievement, particularly in Mathematics. WAEC (2017) and Olunloye (2010) [13] identified poor teaching approach and instructional strategy, while Abakpa and Iji (2011) [1] alluded to lack of confidence in the subject as reasons for students' underachievement in mathematics. In addition, Akinsola (2004) [2] stressed that part of the problems is that most of the teachers still believe that the most effective means of communicating knowledge is via the conventional "talk and chalk" strategy. Another important factor affecting achievement in Mathematics is interest.

George (2008) [8] maintained that interest means like and dislike or one's preference and aversion. Deductively, interest is the motivational drive to action towards a person or anything. It is the feeling of intentness, concern or curiosity about some objects. Obodo (2004) [11] held a view that lack of interest is one of the factors responsible for poor achievement of students in Mathematics. The WAEC Chief Examiner's Report (2009) suggested that teachers should help students improve their achievement and develop interest in Mathematics by removing abstraction of the subject.

Moreover, researchers are unanimous in their submissions that the prevalent traditional method (talk and chalk method) for teaching Mathematics in primary and secondary schools should not be encouraged in Nigeria. The method does not equip learners with necessary skills, belief, motivation, interest, and knowledge to approach mathematical problems and learning tasks in an effective and efficient way, and should be deemphasized in Mathematics classrooms (Ale, 2006; Andile & Moses, 2006) [4]. This has led to a shift to more learner-centred approaches such as peer collaborative instructional strategy.

Peer collaborative instructional strategy include both peer tutoring and co-operative learning. It has the potential to improve students' achievement and arouse their interest in learning Mathematics in secondary schools (Pajares, 2004)

[17]. The reason is the fact that what one person cannot achieve can be achieved by two or more persons putting their ideas together. The strategy stimulates the challenges of discovery and peers are actively involved as they discuss, ask questions, exchange ideas, differ opinions, make arguments and arrive at a conclusion by solving a task. It is an instructional programme in which students work in small groups to help one another in order to master academic content. Okonkwo (2014) [12] described peer collaborative instructional strategy as a type of instruction which involves instructors and a group of students working together to maximize learning. The strategy was proposed by educationists in 1990 in America (Gaith, 2006). Deductively, Peer collaborative instructional strategy is a process by which peers learn through joint effort and communication among themselves. This strategy can be practised among the students in a class, in small groups, in pairs of students at different places. The students are to be guided by a teacher as a facilitator.

Furthermore, study conducted by Etukodo (2002) [6] revealed that there was no significant gender difference in the performance of secondary school students in mathematics. Madu (2004) [10] maintained that female students underachieve in sciences and Mathematics than their male counterparts. James (2001) [9] emphasized that female students perform better than their male counterparts with the use of inquiry method. However, there is no conclusive research on genders, hence, gender is an important variable in this study.

Having seen the difficulties reported in Numerical Processes (Modular Arithmetic), it is necessary to carry out a research to improve students' achievement in the core area. Modular Arithmetic is a concept under Numerical Processes. It is the operation which gives a remainder when an integer is divided. It can be used in solving real life problems with cyclic variables. Therefore, this study investigated whether the use of peer collaborative instructional strategy would improve the students' achievement and arouse their interest in Numerical Processes at the Senior Secondary School level (SSI).

Statement of Problem

It has been observed that students display apathy for the study of Mathematics. Teachers dominate the teaching and learning in Mathematics classrooms. Over the years, the performance of students in Nigerian Secondary Schools have been very poor (WAEC Chief Examiner's Annual Report2018). Peer collaborative instructional strategy has been suggested to reduce passivity and boredom. The problem of this study stated in question form is: What is the effect of peer collaborative instructional strategy on Senior Secondary School Students' achievement and interest in Numerical Processes?

Purpose of the Study

The main purpose of the study was to determine the effect of peer collaborative instructional strategy on students' achievement and interest in Numerical Processes at Senior Secondary School level (SSI).

Specifically, the study sought to determine the following:

1. The effect of peer collaborative instructional strategy on students' achievement in Numerical Processes
2. The effect of peer collaborative instructional strategy on students' interest in Numerical Processes
3. The influence of gender on achievement of students taught with the peer collaborative instructional strategy in Numerical Processes.
4. The influence of gender on interest of students taught with peer collaborative instructional strategy in Numerical Processes

Research Questions

The following research questions were posed to guide the study

1. What is the effect of peer collaborative instructional strategy on the achievement of students in Numerical Processes?
2. What is the effect of peer collaborative instructional strategy on the interest of students In Numerical Processes?
3. What is the influence of gender on the achievement of students taught Numerical Processes with peer collaborative instructional strategy?
4. What is the influence of gender on the interest of students taught Numerical Processes with peer collaborative instructional strategy?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught Numerical Processes with the peer collaborative instructional strategy and those taught with the traditional method.
2. There is no significant difference in the mean interest ratings of students taught Numerical processes with the peer collaborative instructional strategy and those taught with the traditional method.
3. There is no significant difference between the mean achievement scores of male and female students taught Numerical Processes with the peer collaborative instructional strategy and those taught with the traditional method.
4. There is no significant difference between the mean interest ratings of the male and female students taught with the peer collaborative instructional strategy and those taught with the traditional method.
5. There is no significant interaction effect between the use of the peer collaborative instructional strategy and gender on students' achievement in Numerical Processes at Senior Secondary School level (SSI).
6. There is no significant interaction effect of the use of the peer collaborative instructional strategy and gender on students' interest in Numerical processes at Senior Secondary School level (SSI)

Scope of the Study

The study is limited to Senior Secondary School One (SSI) students in Ankpa LGA of Kogi State. It was designed to find the effect of the peer collaborative instructional strategy on students' achievement and interest in Numerical Processes. The content scope include: Modular Arithmetic – Cyclic Events, Addition, Subtraction, Multiplication and Division in Different Modulo and Application of Modular Arithmetic to real life situation. The choice of SSI is the fact that the concept is to be taught in that class as specified in

the curriculum by the Nigerian Education Research and Development Council (NERDC).

Methodology

The design of the study is quasi- experimental research design. Specifically, non-equivalent pretest -posttest control group design since intact classes were used. The use of intact classes was to avoid threat of selection bias among the students and to avoid re- arranging and re – grouping which could disrupt the normal lessons. The pretest was used to partial out initial differences in the two groups and to control selection bias, a threat to internal validity. The population of this study consists of all SS1 students in Ankpa LGA of Kogi State, Nigeria. The LGA has 24 Senior Secondary Schools. These schools have a population of 1200 SSI students with boys numbering 650 and girls 550 (Planning Research and Statistics – PRS, Ankpa Education Zone, 2019) [12]. The choice of SSI is based on the fact that the topics chosen for treatment were selected from the core-curriculum of the Federal Ministry of Education for SSI.

Simple random sampling technique was used for sample selection. Out of 24 schools, two (2) schools were randomly selected, each was assigned to the experimental (48) and control group (44) to reduce interaction effect. The sample constituted 90 students in two intact classes from the selected schools. The researcher constructed two instruments for data collection. These are Modular Arithmetic Achievement Test (MAAT) and Modular Arithmetic Interest Scale (MAIS). The MAAT consists 20 multiple choice test items each with four options. The MAIS also consists 20 statements which express students' feeling towards Modular Arithmetic. MAIS uses a four-point scale namely: Strongly Agree = 4, Agree = 3, Disagree = 2, and Strongly Disagree = 1. The items in MAAT and MAIS were subjected to content and face validation by experts in Mathematics Education and Measurement and Evaluation. Their comments were used for modification of items in the MAAT and MAIS drafted for use after the validation of the two instruments. The instruments were trial tested using two classes from two schools in the LGA that did not participate in the research. The reliability of MAAT was established using Kuder-Richardson Formula – 20 (KR-20) method because the items were dichotomously scored. The KR-20 internal consistency of the MAAT yielded the reliability coefficient of 0.79. The Cronbach Alpha statistic was used to establish the reliability coefficient of MAIS, yielding a coefficient of 0.87. The researcher sought for the co-operation of the Principal and Mathematics teachers of the school the experiment was carried out. The regular teachers were coached on the lesson notes prepared for the experimental class and were allowed to teach to take care of hawthorn effect. The teachers in the control group were allowed to teach in a normal form using talk and chalk method. The duration on the normal school time table (40 minutes) was used each day for the experiment and tests for both the treatment and the control groups were conducted. The raw scores of students from MAAT and ratings from MAIS were used for data analysis. Research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA). Pretest achievement scores and interest ratings were used as covariates to the students' posttest scores and ratings.

Results

The results of this study are presented according to the research questions and hypothesis.

Research Question One

What is the effect of peer collaborative instructional strategy on students' achievement in Numerical Processes?

Table 1: Means and Standard Deviation of Pretest and Posttest Achievement Scores

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental	46	6.24	1.51	9.50	0.61
Control	44	5.87	1.20	6.59	1.54

The results in Table 1, the experimental group which represents those taught with peer collaborative instructional strategy, obtained a mean achievement score of 9.50 and a standard deviation of 0.61 while the control group representing those taught with traditional method had a mean achievement of 6.59 and standard deviation of 1.54. The difference in the means indicated that the experimental group achieve higher than the control group.

Research Question Two

What is the effect of peer collaborative instructional strategy on students' interest in Numerical processes?

Table 2: The Means and Standard Deviations of Pre –Interest and Post-Interest Ratings

Group	N	Pre-Interest		Post-Interest	
		Mean	SD	Mean	SD
Experimental	46	27.04	1.94	33.60	2.20
Control	44	24.84	3.98	26.01	3.74

From the data Table 2, the experimental group which represents those taught with peer collaborative instructional strategy obtained a mean score of 33.60 and standard deviation of 2.20, while the control group representing those taught with the traditional method had a mean interest rating of 26.01 and standard deviation of 3.74. This outcome shows a difference in the Post-Interest scores in favour of the experimental group, an indication that peer collaborative instructional strategy improves students' interest in Numerical Process.

Research Question Three

What is the influence of gender on the achievement of students taught Numerical Processes with peer collaborative instructional strategy?

Table 3: The Means and Standard Deviations of Pretest and Posttest Achievement Scores of Male and Female Students

Group	N	Pre-test		Post-test	
		Mean	S. D	Mean	S. D
Male	22	5.52	1.30	9.35	0.72
Female	24	6.88	1.40	9.64	0.45

Considering the results in Table 3, the male students obtained a mean achievement score of 9.35 and standard deviation of 0.72 while the female students obtained a mean posttest achievement score of 9.64 and standard deviation of

0.45. The post-test achievement scores indicate that female students score slightly higher than male students, when taught Numerical Processes using peer collaborative instructional strategy.

Research Question Four

What is the influence of gender on the interest of students taught Numerical Processes with the peer collaborative instructional strategy?

Table 4: The Means and Standard Deviations of Pre- Interest and Post- Interest ratings of Male and Female Students

Group	N	Pre-Interest		Post-Interest	
		Mean	SD	Mean	SD
Male	22	27.00	1.58	33.35	2.03
Female	24	27.09	2.23	33.82	2.34

From Table 4, it can be seen that the male students obtained a post-interest mean ratings of 33.35 and standard deviation of 2.03 while the female students obtained a post-interest mean ratings of 33.82 and standard deviation of 2.34. Again, female students' interest was slightly more improved than their male counterpart when taught Numerical Processes using peer collaborative instructional strategy.

Research Hypothesis One

There is no significant difference in the mean achievement scores of students taught Numerical Processes with the peer collaborative instructional strategy and those taught with the traditional method at Senior Secondary School level (SSI).

Table 5: Test of Between Subject Effects Dependent Variable Post-test.

Source	Type III Sum of Square	DF	Mean Square	F	Sig.
Corrected Model	998,7865	2	499.3945	187.3705	.000
Intercept	295.3435	1	295.3435	110.8115	.000
Pretest	255.0365	1	255.0115	95.6885	.000
Group	618.165	1	618.165	231.933	.000
Error	229.214	87	1332.5		
Total	2368.00	90			
Corrected Total	1228.000	89			

Table 5 shows that the main effect was significant at 0.05 level of significance, thus, the null hypothesis of no significance difference in the mean achievement scores of students taught Numerical Processes with peer collaborative instructional strategy and those taught the same concept with the traditional method was hence rejected (p-value of 0.000 is less than 0.05 level of significance).

Research Hypothesis Two

There is no significant difference in the mean interest ratings of students taught Numerical Processes with the peer collaborative instructional strategy and those taught with the traditional method at Senior Secondary school level (SSI).

Table 6: Test of Between Subjects Effects Dependent Variable Post Interest.

Source	Type III Sum of Square	DF	Mean Square	F	Sig.
Corrected Model	5479.522	2	2739.761	82.521	.000
Intercept	2131.476	1	2131.1995	2131.1995	.000
Pre-Interest	437.0275	1	437.0275	437.0275	.000
Group	3618.106	1	3618.106	3618.106	.000
Error	2855.2665	87	16.6005	16.6005	
Total	316,947.5	90			
Corrected Total	8347885	89			

From table 6, the main effect is significant at 0.05 level of significance. Therefore, the null hypothesis is of no significant difference in the mean interest ratings of students taught Numerical Processes using peer collaborative instructional strategy and those taught the same Numerical Processes with the traditional method was hence rejected (p-value of 0.000 is less than 0.05 level of significance).

Research Hypothesis Three

There is no significant difference in the mean achievement scores of male and female students taught Numerical Processes with peer collaborative instructional strategy and those taught Numerical processes with the traditional method at Senior Secondary School level (SSI).

Table 7: Test of Between Subject Effects Dependent Variable Posttest

Source	Type III Sum of Square	DF	Mean Square	F	Sig.
Corrected Model	38,194	2	19.097	34,332	.000
Intercept	411.6115	1	411.6115	739.9855	.000
Pretest	1.0835	1	34.794	62.552	.000
Sex	22.806	1	1.0835	1.947.5	.026
Error	15403.5	87	.278		
Total	15403.5	90			
Corrected Total	61.000	89			

The results in Table 7 shows that p-value of 0.026 is less than 0.05 level of significance. This shows that there is no significant difference in the mean achievement scores of male and female students taught Numerical Processes using peer collaborative instructional strategy and those taught the concept with the traditional method at Senior Secondary School level (SSI). Therefore, the null hypothesis was rejected.

Research Hypothesis Four

There is no significant difference between the mean interest ratings of male and female students taught Numerical Processes using Peer collaborative instructional strategy and those taught the same Numerical Processes using the traditional method at Senior Secondary School level (SSI).

Table 8: Test of Between Subjects Effects Dependent Variables Post-interest.

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Corrected Model	21.867	2	10.9335	0.5625	0.163
Intercept	764.2915	1	764.2915	39.669	.000
Pretest	12.4225	1	12.4225	0.645	0.2645
Sex	8.809	1	8.809	0.457	0.171
Error	789.933	43	9.6335		
Total	192735.000	46			
Corrected Total	811.899	45			

The results in Table 8 shows that p-value of 0.171 is greater than 0.05 level of significance, and as such the null hypothesis cannot be rejected. This shows that there is no significant difference in the mean interest ratings of male and female students taught Numerical Processes using Peer collaborative instructional strategy and those taught with the traditional method at Senior Secondary School level (SSI).

Research Hypothesis Five

There is no interaction effect between the use of peer collaborative instructional strategy and gender on students' achievement in Numerical Processes at Senior Secondary School level (SSI).

Table 9: Test of Between Subjects Effects Dependent Variable Posttest

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Corrected Model	1060.52	4	265.155	184.6525	.000
Intercept	184.771	1	184.7725	93.8315	.000
Pretest	298.3805	1	298.3805	151.5255	.000
Group	591.224	1	591.224	300.239	.000
Sex	57.8845	1	57.8845	29.395	.000
Group & Sex	1.8545	1	1.8545	0.942	.086
Error	167.38	85	0.9845		
Total	23628.000	90			
Corrected Total	1228.00	89			

The results in Table 9 shows that p-value of 0.086 is greater than 0.05 level of significance, and as such the null hypothesis cannot be rejected. This shows that there is no significant interaction effect between the use of peer collaborative instructional strategy and gender on students' achievement in Numerical Processes at Senior Secondary School level (SSI).

Research Hypothesis Six

There is no significant interaction effect between the use of peer collaborative instructional strategy and gender on students' interest in Numerical Processes at Senior Secondary School level (SSI).

Table 10: Test of Between Subjects Dependent Variable Post – Interest.

Source	Type III Sum of Square	DF	Mean Square	F	Sig.
Corrected Model	6643.8815	4	1660.9705	83.495	.000
Intercept	143.35	1	7.206	7.206	.000
Pre-Interest	1464.593	1	73.6235	73.6235	.000
Group	2038.043	1	102.45	102.45	.000
Sex	645.837	1	32.4655	32.4655	.000
Group & Sex	820.88	1	41.2645	41.2645	.000
Error	1690.907	85			
Total	316929.500	90			
Corrected Total	834.7885	89			

From table 10, p-value of 0.00 is less than the 0.05 level of significance. This shows that there is a significant interaction effect between the use of peer collaborative instructional strategy and gender on students' interest in Numerical Processes at Senior Secondary School level (SSI). Therefore, the null hypothesis was rejected.

Discussion of Results

The main aim of this study was to investigate the Effect of Collaborative Instructional Strategy on Senior Secondary School Students' Achievement and Interest in Numerical Processes. Six hypotheses were formulated based on the research questions. The data were collected and analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

From Table 1, the result revealed that the use of peer collaborative instructional strategy in teaching produced a higher mean achievement score of 9.50 and standard deviation of 0.61 in Modular Arithmetic Achievement Test than the Traditional Method which yielded the mean score of 6.59 and standard deviation of 1.54. This may imply that students' achievement in Numerical Processes is related to the peer collaborative instructional strategy used since higher mean score and lower standard deviation depict students' higher achievement in Numerical processes. Therefore, the use of this strategy is more effective in enhancing students' achievement in Numerical Processes than the traditional (conventional) method. The success of the experimental group over the control group could be due to the fact that the peer collaborative instructional strategy is more practical, student- oriented and interesting than the traditional method, hence, having a significant difference in their performance.

Regarding students' interest, Table 2 revealed that the students taught with peer collaborative instructional strategy had a higher mean interest ratings (33.60) than those taught with the traditional method who had a lower mean interest ratings of (26.00). The reason may have been that students were so curious to adopt the peer collaborative instructional strategy in solving problems in Numerical Processes. Their high interest must have contributed to the high achievement score in Numerical Processes. Table 3 revealed that female students had a higher mean achievement score (9.64) when both were taught with peer collaborative instructional strategy. Table 4 revealed that female students had a higher mean interest score (33.82) than the male students who had (33.35) when they were taught using peer collaborative

instructional strategy.

These findings has revealed that

1. There is a significant difference in the achievement scores of students taught Numerical Processes using the peer collaborative instructional strategy and those taught with the conventional method (Table 5).
2. There is a significant difference in the mean interest ratings of students taught Numerical Processes using the peer collaborative instructional strategy and those taught with the traditional method (Table 6).
3. There is no significant difference in the mean achievement scores of male and female students taught Numerical Processes using the peer collaborative instructional strategy and those taught using the traditional method (Table 7).
4. There is no significant difference in the mean interest ratings of male and female students taught Numerical Processes using the peer collaborative instructional strategy and those taught with the traditional method (Table 8).
5. There is no significant interaction effect between the use of the peer collaborative instructional strategy, the traditional method and gender on students' achievement in Numerical processes(Table 9)
6. There is a significant interaction effect between the adoption of the peer collaborative instructional strategy, the traditional method and gender on students' interest in Numerical Processes.

Conclusion

From the findings and discussions of this study, the following conclusions are made:

1. Use of the peer collaborative instructional strategy was significantly better than the use of the traditional method in enhancing students' achievement and interest in Numerical Processes.
2. Use of the peer collaborative instructional strategy and the traditional method had no effect on the achievement and interest of male and female students.
3. The interaction effect between the use of the peer collaborative instructional strategy, the traditional method and gender had no significant effect on students' achievement but had a significant effect on their interest.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Mathematics teachers should embark on the use of Peer Collaborative Instructional Strategy for teaching and learning in Senior Secondary Schools.
2. The non-governmental organization, communities, individuals groups, schools, state and federal government should ensure that workshops and seminars are organized on how adopt the Peer Collaborative Instructional Strategy in Mathematics teaching and learning.
3. Policy makers are expected to use the information provided by this study as a basis for taking decision on the best instructional strategy like the peer collaboration to be adopted in Nigerian Senior Secondary Schools.

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