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Effect of Jigsaw Cooperative Instructional Strategy on Students' Acquisition of Mathematics Process Skills

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ABSTRACT

The study investigated the effect of Jigsaw Cooperative Instructional Strategy on students' acquisition of Mathematics process skills in Senior Secondary Schools in Delta State, Nigeria. Four (4) research questions were raised, hypothesized and tested at 0.05 alpha level of significance. Quasi-experimental non-equivalent pretest, posttest, non- randomized control group design was used. The population of the study was 3716 students. The sample for study consisted of 114(0ne hundred and fourteen); the experimental group consists of 66(sixty six) students which comprised 28 boys and 38 girls while the control group comprised 48: 21male and 27 female. Data collected through Mathematics Achievement Test (MAT) were analyzed and interpreted using descriptive statistics: mean, standard deviation and inferential statistics: t-test and Analysis of Covariance (ANCOVA). The findings of the study revealed that the strategy recast acquisition of Mathematics process skills in Geometry among students. Therefore, based on the finding of the study, the following recommendations were made: Mathematics teachers should be encouraged to adopt the strategy to teach selected topics like Geometry to enhance students' active participation during lessons for better understanding and students should be given the opportunity to develop various skills through the use of strategy.

KEY WORDS: Jigsaw Cooperative Instructional Strategy, Acquisition, Mathematics Process Skills

Introduction

In pursuance of national goals and aspirations, the secondary school education system was endowed with several subjects among which is Mathematics. This was done with the government understanding; that the overall development, growth and transformation of most nations of the world were greatly guided, influenced and dependent on Mathematics education, its principles and applications. .Nigeria as a developing nation cannot under estimate the role of Mathematics if she truly wants to move forward as a nation. Mathematics is the bedrock of national development and a subject without no nation can move forward scientifically and technologically (Alutu & Eraikhuemen, 2004). Sumbabi and Bassey (2013) posited that Mathematics is an intellectually stimulating subject, a bed rock of science and technology and a link to the study of subjects like medicine, physics, chemistry and courses in engineering and earth sciences. And supporting this further, Onah, (2015) opined that without Mathematics, there is no science; without science, there is no modern technology, and without modern technology, there is no modern society. The views of Alutu and Eraikhuemen, Sumbabi and Bassey and Onah imply that there could be no real and meaningful development scientifically and technologically without a corresponding development in Mathematics education.

This exceptional and prominent position accorded the subject Mathematics among other school subjects is as a result of its role in the educational system and life in general. For instance, Mathematics gives the learner creative reasoning ability; Mathematical skills and models are readily used in industries, electronics, medicine and telecommunication and others fields. Again, most striking human discoveries of our time were made possible through the use and application of Mathematics ideas and principles. These show that Mathematics is very needful, not just only as a school subject to be taught and learnt in order for the individuals to become productive members of the society but its knowledge serves as a basis or requirement for the study or advancement of other fields of studies like Accountancy, Computer Science, Chemistry, Education, Engineering, Medicine and the Sciences. (Nation Policy of Education, 2013). This is the reason why many Mathematics educators and researchers, among others, have in recent times focused their research on finding better and improved ways of promoting the teaching and learning of Mathematics to increase achievements of students academically. Today in Nigeria, at least, credit pass grade in Mathematics is currently required by all tertiary institutions from all students for admission.

However, despite the importance of Mathematics to the society, there has been persistent poor performance in the subject. The May/June West African Examination Council (WAEC) results [2018, 2019, 20120, 2022] show that more than 50% of the candidates who took part in senior secondary certificate examination (SSCE) yearly got P7, P8 and even F9 grades, these results are indications that there are problems in the teaching and learning of Mathematics. The poor achievement obtained yearly at West African Examination Council (WAEC) results imply that students continually have learning difficulties in Mathematics. The evidences from these results suggest that Mathematics classrooms may not be providing students with adequate and enabling environment sufficient to enhance good achievement in school Mathematics.

But Geometry seems to top the list of areas and topics in Mathematics predominately mentioned among others where candidates continually have difficulties (Eraikhuemen, Odafe & Omoifo, 2018). And majority of candidates who sit for the examinations completely avoid questions in Geometry and even the few that attempt questions in

Geometry do poorly in it; this is an indication that there is a problem in the teaching and learning of Geometry in Mathematics amidst others. Hence, the focus of this study was on some aspects of Geometry: chord property, circle Theorems, trigonometry and bearing. There seem to be difficult contents for many students and even teachers themselves to fully comprehend. Confirming this, Ali, Bhagawati and Sarmah (2014) opined that the teaching of Geometry is problematic because it requires knowledgeable and competent teachers. And as a follow up to the problem of teaching and learning of Geometry and other topics in Mathematics to enhance better achievement; the Chief Examiner for many years continually suggested among others that teachers should be encouraged to use method of teaching that are practicable and teachers as well as candidates are to put in more effort in the teaching and learning of Geometry. These suggestions are indications that the methods of teaching Mathematics lessons and its associated approaches seem to be faulty. But Geometry is a vibrant and exciting part of Mathematics and a key to understanding our world through concrete experiences with geometric figures and relationship (Sumbabi & Bassey, 2013).

The present Mathematics Curriculum was designed to enable the learners actively cultivate the understanding and application of Mathematics skills and concepts necessary to thrive in the ever changing technological world. More so, help learners develop the essential elements of problem solving, communication, reasoning, and connection among others. These Mathematics skills and essential elements are the process skills for learning and understanding ideas and concepts in Mathematics and were simply regarded as Mathematics Process Skills (MPS) in the study. The MPS include the following: Problem solving, Communicating, Reasoning and proving, Reflecting, Connecting, Representing and Computational strategies. These MPS are intertwined like the Jigsaw puzzle, depending on each. And the topics taught include: Chord property, Circle theorems, Trigonometry and Bearing (NERDC, 2007)..

Literature, and in fact practicing Mathematics teachers' views have shown that the most widely used method is the teacher centered lecture method of "talk and chalk"; this has always been the traditional method of teaching the subject in our secondary schools. In this method teacher works some examples on the board and students copy such worked examples into their exercise book; this is usually followed by students being given some work to solve based on the worked examples either in class or as take home assignment. Under this teaching method teachers "tell" students about Mathematics ideas and this result in poor communication of the topic of the day to the students. This method only leads to rote memorization and majority of students finds it difficult to understand mathematical concepts that way. (Omoifo, 2012).

The lecture method seems to be ineffective and deficient of what it takes to make good teaching and learning of all topics in Mathematics in our secondary schools; for the teaching and learning of Mathematics can only be result driven when students are willing to learn and teachers are well disposed to using appropriate methods and resources in teaching their students. This orientation of "result driven" coupled with the willingness of students to learn and teacher well disposed to using appropriate methods and resources in teaching their students seems to be lacking in the teaching strategy embedded in the lecture method.

On this note therefore, it been necessary to look at the secondary school Mathematics programe to see what had been done to remedy the situation of poor achievement already existing in the nation's Mathematics

teaching and learning at this stage. Therefore, the search for alternative strategies which can lead to better performance and help achieve the national goals and objectives from existing literature is in great necessity. From literature, the researcher found some qualities in Jigsaw Cooperative Instructional Strategy (JCIS) that can help in solving students' problem in Mathematics and Geometry in particular. JCIS is used to develop the skills and expertise needed to participate effectively in group activities which also focuses on listening, speaking, co-operation, reflection, and problem solving skills in the students (Hakkarainen, 2012).

However, one may ask "could JCIS be an appropriate strategy to remedy the problem of teaching and learning of Mathematics in our public secondary schools? This strategy has been found efficient in bringing positive change in some school subjects like Basic Science, Agricultural Science, Biology, Chemistry and Physics, rather than Mathematics (Al-Qaisi, 2015). Nevertheless, exploiting the vantages of the JCIS could serve as an antidote to the prevailing problem in Mathematics in the country.

The JCIS is a cooperative learning strategy with a class of learners divided into groups and having a specific task allocated to the various groups. Each learner is assigned a given task in the initial formed groups and furthermore, those with the same task are brought together to form what is known as the expert groups. In the expert groups, all groups members with the same task come together to discuss their task and take their decision. JCIS in the teaching of Mathematics would be a shift in focus from the mathematical content to the mathematical learning environments. JCIS is learner-centred involving hands-on mathematical activities. The learner is free to explore the environment and gather useful knowledge by him/her self with little or no aid rather than the teacher been seen as a reservoir which will dish out its content to the learner.

In Nigeria, it is pertinent to observe that classes in our present day public secondary schools are large. Thus, students of different sex and cognitive ability levels constitute such classes (Mankilik & Umaru, 2011). Therefore, learning should be such that will promote students in their various cognitive abilities; for the cognitive ability levels range from high, average and low among male and female in the classroom setting. These variations sometimes affect the way students learning and understand; but in all, students need active learning that can promote high achievement regardless of their sex and cognitive ability to help them acquire the Mathematics process skills for future use.

Acquisition of Mathematical skills is the real essence of teaching and learning Mathematics at the secondary school educational system. Acquisition, according to Oxford Advanced Learner's Dictionary (2015) is the act of getting something, especially knowledge, a skill. Mathematics process skill acquisition is the ability to learn or acquire skills; usually, skill acquisition involves the development of new practices of ways of doing things better. In the classroom, all students should be exposed to these fundamentals early enough since these would be needed throughout life. Therefore the researchers' reviewed related literature on the effects of Jigsaw Cooperative Instructional Strategy compared with the traditional lecture method on students' achievement in secondary schools to aid acquisition of the MPS so as to boost students' achievement in the subject. In particular, empirical studies had shown that JCIS helped in improving students' performance among which are Timayi (2016) who examined the effect of Jigsaw IV Cooperative Learning Strategy (J4CIS) on interest and academic performance of secondary school students in Geometry in Kaduna State, Nigeria. A total

sample of 144 students comprising 72 each from two different schools were used. The results obtained shows that there was significance difference in performance in favour of students exposed to J4CIS, compared to the conventional lecture method. Al-Qaisi (2015) aimed to identify the effect of Jigsaw cooperative Instructional strategy compared to the traditional way in the achievement of physics and scientific processes for the students of the first middle grade in Fatima Zahra school for girls of Al-Anbar General Directorate of Education. The study sample consisted of 62 female students: students for section A and 31 students for section B in addition to those who failed the course and who were statistically excluded to ensure equivalence due to their additional experiences. The study showed that using JCIS in teaching physics led to the superiority of the experimental group on the control group in achievement and scientific operations. Also, Capar and Tarim (2015) reported that Cooperative Learning was a more successful method than traditional method with regard to both achievement and attitude, in the study of efficacy of cooperative learning method on Mathematics achievement and attitude.

Furthermore, Gull and Shehzad (2015) on the use of Cooperative Learning in Mathematics, aimed at university the effects of Cooperative Learning on students' academic achievement. The researcher used the quasi experiment design, with pretest - posttest to compare the mean test scores. The results indicated that there was a significant difference between scores of the experimental group before and after intervention. In the same vein, Farzaneh and Nejadansari (2014) conducted a study on students' attitudes towards Cooperative Learning for teaching comprehension. The outcome showed that the participants generally indicated enthusiasm towards supporting the implementation of Cooperative strategies in teaching and learning. In addition, Orprayoon (2014) examined the effects of Cooperative Learning on learning achievement and group working behaviour of junior students in modern French literature course. The analysis of Pretest and Posttest scores showed Cooperative Learning method raised significantly the students' learning achievement at 0.01 statistical levels.

Similarly, Takallou and Veisi (2013) studied cooperative learning and noted a significant effect on students' reading comprehension as both the high and low achievers in the experimental group expressed positive attitudes towards cooperative learning. Closely related was the research carried out by (Oludipe, Ojediran & Odueake, 2013) who investigated the effectiveness of Cooperative Learning strategy on Nigerian junior secondary students' attitude towards learning basic science. The data analysis indicated that among other there were significant main effects of treatment on students' attitude towards Basic Science. Slavin (2013) conducted a study on effects of cooperative learning and embedded multimedia on Mathematics learning in key stage 2 final report. The results indicated that there was positive effect of cooperative learning in Mathematics in other countries.

In addition, using Mathematics as a parameter, Zakaria, Solfitri, Daud and Abidin (2013) studied the effect cooperative learning on secondary school students' Mathematics achievement. The study involved 61 form three students divided into two groups; one consisted of 30 students in the control group while 31 students were in the treatment group. The results revealed that there was a significant difference of mean in Mathematics students' achievement between the Cooperative Group and the Traditional Group. Also, the content analysis data showed that students in the Cooperative Group were able to increase their understanding and develop their self- confidence. In addition, Mbacho (2013) carried out a study on the

effects of Jigsaw Cooperative Learning Strategy on students' achievement in secondary school Mathematics in Laikipia East District, Kenya; using a sample size of 160 students. After data analysis, result shows that learners taught using JCIS performed better than those taught using Conventional learning method. On the other hand, Mohammadjani and Tonkaboni (2012) undertook a comparative study between the effect of cooperative learning teaching method and lecture teaching method on students' learning and satisfaction levels. The study used the fourth grade elementary school students which consisted of 120 students (60 females and 60 male). The results showed that the cooperative learning teaching method has a higher effect on students learning than the lecture teaching method. Also, female students had higher satisfaction in learning levels in cooperative learning teaching method than their male counterparts. And still in Mathematics discipline, Lavasani and Khandan, (2011) examined the effect of Cooperative Learning on Mathematics anxiety and help seeking behaviour. The researchers reported that Cooperative Learning method in comparison with the Traditional Group decreased Mathematics anxiety in students significantly and avoidance component ($p>0.05$) but increased their help seeking behaviour. The study utilized 40 students from two schools randomly selected and termed them as experiment and control groups.

Statement of the Problem

Evidences from reviewed literature revealed that effective teaching of Mathematics had been hindered by a lot of factors among which are attitude of students to learn, lack of sufficient Mathematics teachers, poor background of students in Mathematics, lack of Mathematics laboratory, inadequate instructional materials and teachers use of ineffective methods and strategies in teaching various topics. These opinions were reiterated by Fatade, Mogari and Abayomi (2013) who stated that much of failure in school Mathematics is associated with a tradition of teaching that is inappropriate to the way most students learn. They explained this further more by saying that the traditional method of teaching Mathematics has been found to be very defective and full of many inadequacies that do not allow students to actively construct their own Mathematics knowledge. Hence, the problem of poor achievement in Mathematics still persists despite all efforts by the government of Nigeria to solve the problem of the teaching and learning of Mathematics in the country.

Therefore, the need for better strategies that can improve students' performance in Mathematics should be of uttermost concern to all stakeholders. Thus, teachers need to shift from the traditional lecture method to a learner-centered strategy. The researchers had found some qualities in Jigsaw cooperative instructional strategy that could help to remedy the problem of teaching and learning Geometry in our public secondary schools. This strategy have been found efficient in bringing positive change in some school subjects like Basic Science, Agricultural Science, Biology, Chemistry and Physics, rather than Mathematics (Al-Qaisi, 2015). Hence, exploiting the vantages of the Jigsaw cooperative instructional strategy could serve as antidotes to our problem in Mathematics: teaching and learning of Geometry.

Research Questions

The following questions were raised to guide the study:

1. What is the difference in the mean acquisition of Mathematics process skills scores of students taught Geometry through Jigsaw Cooperative Instructional Strategy and lecture method?

2. What is the difference in the mean acquisition of Mathematics Process Skills scores of male and female students taught geometry through JCIS?

3. What is the difference in the acquisition of Mathematics Process Skills mean scores between high and low ability students taught geometry through JCIS?

4. What is the interaction effect of Instructional strategies, Ability level and Sex on Mathematics students' acquisition of Mathematics Process Skills?

Hypotheses

All four (4) research questions were hypothesised thus:

1. There is no significant difference in the mean acquisition of Mathematics Process Skills scores of students taught Geometry through JCIS and those taught with lecture method.
2. There is no significant difference in the mean acquisition of Mathematics Process Skills scores of male and female students taught Geometry through JCIS.
3. There is no significant difference in the acquisition of Mathematics Process Skills mean scores between high and low ability students taught Geometry through JCIS.
4. There is no significant interaction effect of Instructional strategies, Ability level and sex on students on acquisition of Mathematics Process Skills?

Methodology

This study adopted the quasi-experimental research design, using the non–randomized equivalent pretest, posttest, control group design. Intact classes were used and the experimental group was exposed to JCIS, while the control group was taught using Lecture Method. The population for the study consists of three thousand seven hundred and sixteen (3716) Senior Secondary Schools two (SS II) Mathematics students in eighteen (18) co-educational public senior secondary schools in Warri South Local Government Areas of Delta State. But only seventeen (17) senior secondary schools two (SS II) Mathematics students were used.

The sample size for this study consists of 114 senior secondary school two (SS II) Mathematics students, made of 48 boys and 66 girls. The experimental group consists of 66 students which comprises of 28 boys and 38 girls while the control group consists of 48 which comprises of 21 boys and 27 girls. Two senior secondary schools were randomly selected through purposive sampling technique for the study. An intact class each was used in each school. Pretest was given before treatment began for a period of four (4) weeks. At the end of the period spent for treatment, a Posttest was carried out to assess students' achievement. The experimental group received treatment conducted using Jigsaw Cooperative Instructional Strategy for four (4) weeks while the conventional Lecture Method was used for the control group. In each week, there were four (4) periods (two double periods) lasting 40 minutes per period at the regular school time table for the teaching selected topics in Geometry with Mathematics process skills as the objectives at the end of each lesson. The independent variables of the study are the Jigsaw Cooperative Instructional Strategy and Conventional Lecture Method while the dependent variable was students' acquisition of Mathematics Process Skills as measured by the students' MAT scores.

The instrument used for data collection in the study was the MAT developed by the researchers. The MAT items were constructed based on four topics in Geometry as contained in the senior secondary education Mathematics curriculum for SS II. It consisted of 30 multiple choice objective test items with five response options (A to D) from which the students were asked to choose the right answer, to test their acquisition of Mathematics process skills using a table of specification thus: Problem solving seven (7) items, Communicating four (4) items, Reasoning and proving five (5) items, Reflecting four (4) items, Connecting four (4) items, Representing three (3) items, and Computational strategies three (3).

In order to ensure validity of the instrument two Mathematics curriculum experts and one experienced senior secondary school Mathematics teacher were used. They scrutinized the items for clarity of expression, plausibility, suitability and appropriateness to the level of the students. Their corrections were effected in the final copy of the instrument.

The reliability of the MAT was determined using Kuder- Richardson formula 21 Statistics. One intact class of fifty seven (57) students in a public senior secondary school two (SS II) in Warri South, Delta State who were not part of main study were used. The scores obtained were used to determine the coefficient of internal consistency; the reliability of the instrument was found to be 0.78; this was high enough for the instrument to be used for the study.

The data collected from students' Pretest and Posttest scores using Mathematics Achievement Test were analyzed and interpreted using descriptive statistics: mean and standard deviation to answer the research questions 1 to 4 while inferential statistics was used to test the hypotheses 1 to 4 for significant differences; The Independent Samples Test (t-test) was used to test $H0_2$ and $H0_3$ while Analysis of Covariance (ANCOVA) were used to test $H0_1$ and $H0_4$. All four hypotheses were tested at 0.05 alpha level of significance.

Results: The data analysis for research questions and hypotheses were carried out using mean, standard deviation, t-test and Analysis of Covariance.

HO_1: There is no significant difference in the acquisition of MPS between students taught Geometry through JCIS and those taught with Lecture Method.

Table 1: Summary of Descriptive Statistics of Acquisition of Mathematics Process Skills.

GROUP	N	Pretest Mean	SD	Posttest Mean	SD	Mean gain
Experimental	66	7.79	3.242	11.05	3.523	3.26
Control	48	6.44	2.305	6.38	2.420	- 0.06

The data in Table 1 show students in the experimental group (JCIS) got a mean score of 7.79 and a standard deviation of 3.242 in pretest, a mean score of 11.05 and a standard deviation 3.523 at posttest, making a pretest-posttest mean gain of 3.26. While the students in the control group (Lecture method) got a mean score of 6.44 and a standard deviation of 2.305 in pretest, a mean score of 6.38 and a standard deviation 2.420 at posttest, making a pretest-posttest mean gain of – 0.06. The JCIS group performed better than their Lecture group counterparts. To conclude on whether or not the observed pretest and posttest mean differences are significant or not, ANCOVA statistics was utilized as in Table 2.

Table 2: One-Way Analysis of Covariance (ANCOVA) of Mathematics Students' Acquisition of Mathematics Process Skills

Dependent Variable: PosttestExpCon

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	704.439[a]	2	352.220	39.738	.000
Intercept	648.162	1	648.162	73.127	.000
PretestExpCon	98.264	1	98.264	11.086	.001
Method	472.101	1	472.101	53.263	.000
Error	983.850	111	8.864		
Total	11085.000	114			
Corrected Total	1688.289	113			

Table 2 shows the ANCOVA analysis of Mathematics students' acquisition of MPS in experimental and control groups at pretest and posttest. The results indicate that $F_{(2, 114)} = 53.263$, $p = .000$ which is significant at 0.05 alpha level of significance. Therefore, the null hypothesis of no significant difference is not retained.

HO_2: There is no significant difference in the acquisition of MPS between male and female students taught Geometry in the Experimental Group.

Table 3: Summary of Descriptive Statistics of Male and Female Mathematics Students' Acquisition of MPS in the Experimental Group.

Sex	N	Pretest Mean	SD	Posttest Mean	SD	Mean gain
Male	28	8.75	3.748	11.54	3.805	2.29
Female	38	7.00	2.630	10.45	2.993	3.45

The data in Table 3 show that the male got a mean score of 8.75 and a standard deviation of 3.748 in pretest, a mean score of 11.54 and a standard deviation 3.805 at posttest, making a pretest-posttest mean gain of 2.29. While the female students got 7.00 and a standard deviation of 2.630 in pretest, a mean score of 10.45 and a standard deviation 2.993 at posttest, making a pretest-posttest mean gain of 3.45 the female in experimental group performed better than male counterparts with mean gain (2.29) at Posttest. To determine if the difference in the main gain is significant, t-test for independent samples was used as presented in table 4.

Table 4: Summary of Independent Samples t-test of Male and Female Mathematics Students' Acquisition of MPS in the Experimental Group.

Sex	N	Mean	SD	t	Sig(2 tail)
Male	28	11.54	3.805		
				1.301	.198
Female	38	10. 45	2.993		

Table 4 shows result of calculated t-value of 1.301 and $p = 0.198 > 0.05$ alpha level of significance. The null hypothesis of no significance is retained. This implies that there was no significant difference in the acquisition of Mathematics process skills in Geometry taught using Jigsaw cooperative instructional strategy based on sex.

HO_3: There is no significant difference in the acquisition of MPS between high and low ability students taught geometry through Jigsaw cooperative and control instructional Strategy at Posttest.

Table 5: Summary of Descriptive Statistics of High and Low Mathematics Students' Acquisition of MPS in the Experimental group.

Ability level	N	Pretest Mean	SD	Posttest gain Mean	SD	Mean
High	29	10.79	2.194	12.38	3.479	1.59
Low	37	5.43	1.501	10.00	3.232	4.57

Table 5 shows that High Ability level got a mean score of 10.79 and a standard deviation of 2.194 in pretest, a mean score of 12.38 and a standard deviation 3.479 at posttest, making a pretest-posttest mean gain of 1.59. While Low Ability level got a mean score of 5.43 and a standard deviation of 1.501 in pretest, a mean score of 10.00 and a standard deviation 3.232 at posttest, making a pretest-posttest mean gain of 4.57. The Low Ability level students with mean gain of 4.57 in the experimental group performed better than High Ability level with mean gain of 1.59. To determine if the difference in the main gain is significant, t-test for independent samples was used as presented in table 6.

Table 6: Summary of Independent Samples t-test of High Ability level and Low Ability level of Mathematics Students' Acquisition of MPS in the Experimental Group.

Ability level	N	Mean	SD	t	Sig(2 tail)
High	29	12.38	3.479	2.871	.006
Low	37	10. 00	3.232		

Table 6 shows result of calculated t-value of 2.871 and $p = 0.006 > 0.05$ alpha level. The null hypothesis of no significance is retained. This implies that there was no significance difference in the posttest mean score of students' acquisition of MPS in experimental groups based on ability level.

HO_4: There is no significant interaction effect of Instructional strategies, Ability level and sex of Mathematics students on acquisition of MPS at posttest.

Table 7: Summary of Descriptive Statistics of interaction effect of Instructional strategies, Ability level and sex of SS II Mathematics students' acquisition of MPS at Posttest.

Strategy	Sex	Ability level	Number	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
JCIS	Male	High	15	11.53	2.748	12.73	3.615	1.20
		Low	12	5.50	1.446	10.00	3.790	4.50
	Female	High	14	10.00	0.961	11.93	3.339	1.93
		Low	25	5.40	1.555	9.88	2.818	4.48
Lecture Method	Male	High	3	10.33	1.528	7.67	.577	-2.66
		Low	18	5.44	2.007	6.61	2.570	1.17
	Female	High	4	10.25	1.500	7.50	1.291	-2.75
		Low	23	6.04	1.430	6.04	2.705	0.00

Table 7 presents the descriptive statistics of interaction effect of Instructional strategies, Sex and Ability level of students on acquisition of MPS. The result showed that Male high ability level students in the Jigsaw cooperative got a mean score of 11.53 and a standard deviation of 2.748 in pretest, a mean score of 12.73 and a standard deviation 3.615 at posttest; making a mean gain of 1.20. The male, low ability level students in the Jigsaw cooperative got a mean score of 5.50 and a standard deviation of 1.446 in pretest, a mean score of 10.00 and a standard deviation 3.790 at posttest; making a mean gain of 4.50. The Female high ability level students in the Jigsaw cooperative got a mean score of 10.00 and a standard deviation of 0.961 in pretest, a mean score of 11.93 and a standard deviation 3.339 at posttest; making a mean gain of 1.93. And the Female low ability level students in the Jigsaw cooperative got a mean score of 5.45 and a standard deviation of 1.555 in pretest, a mean score of 9.88 and a standard deviation 2.818 at posttest; making a mean gain of 4.48. The Male high ability level students in the Lecture method got a mean score of 10.33 and a standard deviation of 1.528 in pretest, a mean score of 7.67 and a standard deviation .577 at posttest; making a mean gain of - 2.66. The Male low ability level students in the Lecture method got a mean score of 5.44 and a standard deviation of 2.007 in pretest, a mean score of 6.61 and a standard deviation 2.570 at posttest; making a mean gain of 1.17. The Female high ability level students in the Lecture method got a mean score of 10.25 and a standard deviation of 1.500 in pretest, a mean score of 7.50 and a standard deviation 1.291 at posttest; making a mean gain of – 2.75. And the Female low ability level students in the Lecture method got a mean score of 6.04 and a standard deviation of 1.430 in pretest, a mean score of 6.04 and a standard deviation 2.705 at posttest; making a mean gain of 0.00. JCIS group Male Low ability level did better than High ability level. Also, the Female Low ability level equally did better than High ability level at Posttest. For the Control group, Male Low ability level outperformed the High ability level. Also, the Female Low ability level did better than the High ability level at Posttest. ANCOVA was used to conclude observed mean differences of the experimental and control groups as presented in table 8.

Table 8: Summary of Analysis of Covariance (ANCOVA) of interaction effect of Instructional strategies, sex and Ability level of students on the acquisition of MPS.

Dependent Variable: PosttestExpCon

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1154.914[a]	8	144.364	28.419	.000
Intercept	595.850	1	595.850	117.299	.000
PretestExpCon	58.317	1	58.317	11.480	.001
Method	16.884	1	16.884	3.324	.071
Sex	.773	1	.773	.152	.697
Abilitylevel	337.212	1	337.212	66.383	.000
Method * Sex	9.777	1	9.777	1.925	.168
Method * Abilitylevel	5.771	1	5.771	1.136	.289
Sex * Abilitylevel	5.717	1	5.717	1.126	.291
Meth*Sex*Abilitylevel	4.343	1	4.343	.855	.357
Error	533.375	105	5.080		
Total	11085.000	114			
Corrected Total	1688.289	113			

a. R Squared = .684 (Adjusted R Squared = .660)

Table 8 presents the ANCOVA of an $F_{(1, 114)} = .855$ and $p = 0.357 > 0.05$ alpha level of significance. Therefore null hypothesis of no significance difference is retained. There is no significant interaction effect of Instructional strategies, sex and Ability level on students' acquisition of MPS.

Discussion of Results

This study investigated the effect of JCIS on the acquisition of MPS on Senior Secondary School Mathematics Students in Delta State. The conventional lecture method had been the method of Mathematics instructions from many studies and from many classroom teachers' experiences.

The finding of this study, from hypothesis one (HO_1) presented in tables 1 and 2 revealed that students from the experimental group exposed to JCIS performed significantly better than those from the control group exposed to the lecture instruction method. However, there was significant difference in the acquisition of MPS between students taught Geometry through JCIS and those with lecture method in favour of the experimental group. By the implication of this result, Mathematics teachers should adopt Jigsaw Cooperative Instructional Strategy in the classrooms which is students' centred activity based innovatory strategy instead the traditional lecture method. It is not enough to just come to the class to teach; the teacher must be conscious of the method to use to deliver the lesson of the day; for the teaching method a teacher uses is of great influence on the performance of the students positively or negatively.

The finding of results from hypothesis two (HO_2) presented in tables 3 and 4 showed male students in the Experimental group did better than their female counterparts. Also, for the Control group, the males did better than the females at posttest. Nevertheless, There was no significant difference in the acquisition of MPS between Male and Female students taught Geometry. This means sex does not have any influence in the study carried out; the instructional strategies used for treatment are not sex biased. The result confirms the finding of Adigun (2015) who reported that, male students outperformed the female counterpart and negates the works of Okoye, (2012) that females perform better than males. More so, Jigsaw cooperative instructional strategy as shown by the result of this study can promote high achievement of both boys and girls than that of the Lecture method and as such should be encouraged.

The finding of results from hypothesis three (HO_3) presented in tables 5 and 6 showed High and Low Ability levels of students in the experimental group exposed to the JCIS and that of control group exposed to the LM. The result revealed a p-value greater than the alpha level of significance; therefore null hypothesis of no significance difference is not rejected. There was no significance between the high and low ability levels. The treatment given the experimental group enabled both High and Low abilities to learn regardless of their ability levels

And lastly, the finding from hypothesis four (HO_4) presented in tables 7 and 8 on the interaction effect of Instructional strategies, Sex and Ability level of SS II students on acquisition of MPS. The finding revealed no significant interaction effect of Instructional Strategy, Sex and Ability level on students' on acquisition of MPS**.** Therefore, the null hypothesis of no significance difference is not rejected. This is an indication that the effect of Instructional strategies on students achievement based on Sex and Ability level of students are the same hence no interaction effect between Instructional strategies, Sex and Ability level of students. .

Conclusion

The finding of the study revealed that there was significant effect of JCIS on the acquisition of MPS by Senior Secondary School II students when compared with the conventional lecture method. Therefore, based on the findings of the study, the instructional strategy adopted by the researchers improved greatly students'

performance in the acquisition the MPS since the students were more engaged in activities than is obtainable in the conventional traditional lecture method. It is not enough to just come to the class to teach; the teacher must be conscious of the method to use to deliver the lesson of the day; for the teacher method of teaching can influence achievement of the students either positively or negatively.

Recommendations

The following are recommended, based on the major finding of the study:

1. Mathematics teachers should be encouraged to adopt JCIS to teach selected topics like Geometry to enhance students' active participation for better understanding content.
2. Students should be given opportunities to develop skills through the use of JCIS. This is a student' centred activity based learning that will expose them to self-discoveries that will enhance their productivity.
3. Professional development for Mathematics teachers on Jigsaw cooperative instructional strategies in form workshops, seminars, conferences and other in-service training on Geometry in the secondary schools should be done by the government.
4. Government should build larger classroom that can accommodate JCIS practices.

Contribution to knowledge

The significance of this research cannot be overstated. It expands the repertoire of instructional strategies available to Mathematics educators, offering additional tools to enhance the effectiveness of teaching and learning. By bolstering students' acquisition capabilities, the study aims to elevate academic achievements. It constitutes a valuable addition to the body of literature on Mathematics education in secondary schools, aligning with global efforts to enhance students' performance. Moreover, the research highlights the potential of Jigsaw cooperative instructional strategy (JCIS) in fostering critical thinking and nurturing creative ideas in students.

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