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Effects of Jigsaw cooperative instructional strategy on senior school one students' achievement in quadratic equation in Nigeria

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Abstract
The aim of this study was to investigate the effect of the jigsaw cooperative instructional strategy on senior school one students' achievement in quadratic equations in Jos North Local Government Area, Plateau State. The study employed a quasi-experimental design, specifically a pre-test post-test non-equivalent control group design. The population consisted of all SS1 students in government-approved co-educational secondary schools in the area. A sample of 92 students from two public co-educational senior secondary schools was selected using a purposive sampling technique. A 20-item multiple-choice Mathematics Achievement Test (MAT) was used for data collection. The instrument was validated by experts in Mathematics education, and its reliability was established using Cronbach's alpha coefficient ($\alpha = 0.84$). Descriptive statistics (mean and standard deviation) were used to analyze the research questions, while inferential statistics (Analysis of Covariance, ANCOVA) were used to test the hypotheses at a 0.05 level of significance. Results showed that students taught using the jigsaw cooperative instructional strategy achieved higher post-test scores than those taught using conventional instruction. Additionally, male and female students in the experimental group performed equally well. The study recommends the adoption of the jigsaw cooperative instructional strategy in Mathematics education to improve students' achievement. The study's findings have implications for educators, policymakers, and researchers seeking to improve Mathematics education in Nigeria.

Keywords: *Jigsaw cooperative learning, Mathematics achievement, Quadratic equations*

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INTRODUCTION

Mathematics is the science that deals with the logic of shapes, quantity and arrangement. Gowers (2019) defines Mathematics as the abstract study of patterns that occur in the real world or that are created in the mind. It is the building block for everything in our daily lives, including mobile devices, computers, software, architecture (ancient and modern), art, money, engineering, medicine, business, meteorology, astronomy and even sports. Mathematics is the language of the universe, capable of expressing the truth that underlies our everyday existence (fry, 2018).

The inclusion of Mathematics as a core subject in the secondary school curriculum is due to the key roles it plays in the achievement of the objectives of secondary school education, such as promoting science and technology, provision of trained manpower in the applied science, technology and commerce, and the acquisition of appropriate skills, abilities and competence both mental and physical, as equipment for the individual to live on and contribute to the development of his society (Federal Republic of Nigeria, 2014). Despite Mathematics being the queen of sciences without which no nation can hope to achieve any measure of scientific and technological growth, the academic performance of students in Mathematics among the public secondary schools in Nigeria has consistently been low over a period of time Ohanyelu (2021). These achievements have been not so stable over the years and despite the fact that it is not as poor as it used to be, there is need for more work to be done to see that students do exceedingly well in Mathematics. Many factors affect students' achievement in Mathematics, some of which are students' attitude to Mathematics, teachers' attitude to teaching, gender factor, parental influence and teaching method. It is believed that adopting an instructional teaching strategy that directly impacts the students through active engagements in the teaching-learning process will greatly improve the students' achievement in Mathematics. One of such is the Jigsaw Cooperative Instructional Strategy (JCIS).

According to Aaronson (2015), JCIS enables each student of a 'Home' group to specialize in one aspect of learning. Students meet with members from other group who are assigned the same aspect and after mastering the materials, return to the group members to share what they have been able to do in their groups

in turns. Aaronson suggested 10-step strategy to implementing the JCIS. First; teachers create small heterogeneous groups with students representing multiple ability levels. Then, the teacher appoints a group leader to be in charge of the group‘s tasks. Next, the teacher assigns the group several tasks, depending on the number of students in each group. Each student is in charge of completing a separate task. The teacher allots a certain amount of time for students to complete their tasks or become familiar with material. Then, students from different groups who have the same tasks work together temporarily to become experts on their topic and fill in any gaps in their information. Original group members come back together and each member presents his/her own information and provides an opportunity for rest of group to ask questions. While students are teaching each other about the topic, the teacher moves around the room monitoring progress and answering any questions that students have about the topics.

Jigsaw can be segmented into separate components. Each group member becomes an expert on a different concept or procedure and teaches it to the group (Panitz 2014). Just like Jigsaw puzzle each piece (student’s part) is essential for the understanding of the final product. Therefore, each student is essential for the understanding of the whole concept being taught. The advantage of Jigsaw learning strategy is that students perform the challenging and engaging tasks in their experts’ group with enthusiasm since they know they are the only ones with that piece of information when they move to their respective group students who tutor each other must develop a clear idea of the concept they are presenting and orally communicate to their partner (Neer, 2017). This is indicative that JCIS has the potential of turning around the tide in the dwindling achievement of students in Mathematics. It is against this backdrop that the study is designed to examine the effect of jigsaw cooperative instructional strategy on senior school one students’ academic achievement in quadratic equation in Jos North LGA, Plateau State.

Aim And Purpose Of The Study

The aim of the study is to investigate the “effect of jigsaw cooperative instructional strategy on senior school one students’ achievement in quadratic equation in Jos North LGA, Plateau State”. Specifically, the objectives of the study are:

1. To find out the pretest achievement scores of SS1 students in the experimental and control group.
2. To find out the posttest achievement scores of SS1 students in the experimental and control group.
3. To determine the posttest achievement scores of SS1 students in the experimental group based on gender.

Research Questions

The study sought to answer the following research questions:

1. What is the difference between the pretest achievement mean scores in the experimental and the control group?
2. What is the difference between the posttest achievement scores in the experimental and the control group?
3. What is the difference between the posttest achievement mean scores of male and female students of the experimental group?

Hypotheses

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

HO1: There is no significant difference between the pretest achievement mean scores of SSI students in the experimental and control group.

HO2: There is no significant difference between the posttest achievement mean scores of SS1 students in the experimental group and control group.

HO3: There is no significant difference between the posttest achievement mean scores of SS1 male and female students in the experimental group.

METHOD

The study adopted a pre-test post-test quasi-experimental design. Specifically, the non-equivalent experimental control group designs. This design was chosen because it may not be possible for the researcher to randomly select the participants and also assign them to groups without disrupting their academic programs. The population for this study comprised of all SS I students in the government approved coeducational secondary schools in Jos North Local Government Area of Plateau State for the 2023/2024 session. There were about 1570 SS I students in public secondary schools of the study area. This population is made up of 740 males and 830 females. The sample for the study comprised of two public co-educational senior secondary schools in Jos North Local Government Area of Plateau state.

The sample of the study consisted of 92 SS I students from intact classes of two schools selected using purposive sampling technique. The sampling technique was adopted in order to select schools that have centres for WAEC and NECO and have been conducting these external examinations for at least five years. Thus, the sample sizes for the experimental and control groups were the number of students in the sampled classes. That is the intact classes. The experimental group is made up of 27 males and 23 females, while the control group is made up of 20 males and 22 females respectively. These made up a total of 50 and 42 students in the experimental and control groups respectively.

A 20-item multiple choice instrument called Mathematics Achievement Test (MAT) with content in quadratic equation was used for data collection. The instrument was used for pretest. However, the same items were re-organized for posttest. Each item had four options A, B, C and D.

The content validity of the MAT was established by matching the test items with the subject matter outlined in the Nigerian Mathematics O-level teaching syllabus, the appropriateness of the options provided for each item was checked by experts. The experts were drawn from the Department of Science and Technology Education (Mathematics Education) and Research, Measurement and Evaluation, Department of Educational Foundation, University of Jos.

The Instrument (MAT) was trial-tested to establish the internal consistency using the Cronbach Alpha method. The MAT' instrument was administered in two co-educational senior secondary schools which were not considered for the study in Jos North that met the criteria but were used only for pilot study not the main study. The scores were then analyzed using Cronbach Alpha to establish the reliability coefficient of the instrument, which was 0.84. MAT was administered as pretest in the first week of the study. In the second and third weeks, treat was administered and at the fourth week, posttest was conducted. Thus, the study lasted for four weeks.

The total score for MAT was 100 marks. Thus, each item was assigned a score of 5 marks. The correct answer was scored 5 while the wrong answer was scored 0. Descriptive Statistics (mean and standard deviation) was used in answering the research questions while an inferential statistic of ANCOVA of independent samples was used in testing the research hypotheses at 0.05 level of significance.

RESULTS AND DISCUSSION

RESULTS

Research Question One

What is the difference between the pretest achievement mean scores of the experimental and the control group?

Table 1. Mean and standard deviation of the pretest achievement mean scores of the experimental and the control group

Group	N	$\bar{X}$	SD
Experimental	50	37.30	10.213
Control	42	35.60	1.365
Mean Difference		1.70	

Table 1 shows the pretest achievement mean scores for the experimental and control groups. The experimental group had a mean score of 37.30 and a standard deviation of 10.213. In contrast, the control group had a mean score of 35.60 and a much smaller standard deviation of 1.365. The mean difference between the groups is 1.70, suggesting that the experimental group performed slightly better on average. However, the higher variability in the experimental group's scores indicates less consistency compared to the control group. Despite this small mean difference, both groups appear relatively similar in initial performance, providing a good basis for comparison in posttest analysis.

Research Question two

What is the difference between the posttest achievement scores of the experimental and the control group?

Table 2. Mean and standard deviation of the posttest achievement scores of the experimental and the control group

Group	N	$\bar{X}$	SD
Experimental	50	72.00	11.384
Control	42	70.12	9.658
Mean Difference		**1.88**	

Table 2 presents the posttest achievement mean scores for the experimental and control groups. The experimental group had a mean score of 72.00 with a standard deviation of 11.384. The control group had a mean score of 70.12 and a standard deviation of 9.658. The mean difference between the two groups is 1.88, suggesting that the experimental group performed marginally better than the control group in the posttest. Despite the small difference in mean scores, the data shows that both groups had comparable outcomes, though the experimental group exhibited slightly more spread in individual performance.

Research Question Three
What is the difference between the posttest achievement mean scores of male and female students of the experimental group?

Table 3. Mean and standard deviation of the posttest achievement mean scores of male and female students of the experimental group

Group	N	$\bar{X}$	SD
Male	47	71.28	11.251
Female	45	71.00	10.034
Mean Difference		**0.28**	

Table 3 presents the posttest achievement mean scores of male and female students within the experimental group. The male students had a mean score of 71.28 and a standard deviation of 11.251. The female students had a slightly lower mean score of 71.00 with a standard deviation of 10.034. The mean difference between male and female students is 0.28. This shows similar achievement in the achievement of male and female students.

Hypothesis One:
Ho_1: There is no significant difference between the pretest achievement mean scores of SSI students in the experimental and control group.

Table 4. Analysis of variance (ANCOVA) on pre-test mean achievement scores of students in the experimental and control group

Pre-test achievement scores of students in experimental and control groups					
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	.323	1	.323	.002	.966
Within Groups	17129.787	98	174.794		
Total	**17130.110**	**99**			

Table 4 present the summary of analysis of variance (ANCOVA) of the significant effect of jigsaw cooperative instructional strategy on the pre-test achievement scores of students in quadratic equation. The analysis of variance p-value was 0.966. The null hypothesis was therefore accepted since the p-value is greater than the 0.05 level of significance ($p=0.966 > 0.05$). it was therefore concluded that there is no significant difference between the mean achievement scores of control and experimental group.

Hypothesis Two:
Ho_2: There is no significant difference between the post-test achievement mean scores of SS1 students in the experimental group and control group.

Table 5. Analysis of variance (ANCOVA) on post-test mean achievement scores of students in the experimental and control group

Post-test achievement scores of students in experimental and control groups					
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	14592.640	1	14592.640	65.451	.000
Within Groups	21894.600	98	222.955		
Total	36442.240	99			

Table 5 present the summary of analysis of variance (ANCOVA) of the significant effect of jigsaw cooperative instructional strategy on the post-test achievement scores of students in quadratic equation. The analysis of variance p-value was 0.000. The null hypothesis was therefore rejected since the p-value is less

than the 0.05 level of significance (p=0.000 < 0.05). it was therefore concluded that there is significant difference between the post-test mean achievement scores of students' in experimental and control group.

Hypothesis Three:
Ho_3: There is no significant difference between the posttest achievement mean scores of SS1 male and female students in the experimental group.

Table 6. Post-test achievement scores of male and female students in experimental and control groups

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	240.759	1	240.759	.652	.421
Within Groups	36201.481	98	369.403		
Total	**26442.240**	**99**			

Table 6 present the summary of analysis of variance (ANCOVA) of the significant effect of jigsaw cooperative instructional strategy on the achievement of male and female in quadratic equation. The analysis of variance p-value was 0.421. The null hypothesis was therefore accepted since the p-value was greater than the 0.05 level of significance (p=0.354 > 0.05). it was therefore concluded that there is no significant difference between the mean achievement scores of male and female students' achievement scores in experimental and control group.

DISCUSSION

The study investigated the effect of jigsaw cooperative instructional strategy on senior school one students' achievement in quadratic equation in Jos North Local Government Area Plateau State. The results of findings in Table 1 revealed that the students who were taught quadratic equation using jigsaw cooperate instructional strategy achieved higher than those taught using conventional method of teaching. The difference was found based on Table 4 to be significant This implies that jigsaw cooperate instructional strategy improve students' achievement in quadratic equation than conventional method. The finding of this study concurred with that of Ige and Akanbi (2022) who investigated the effect of cooperative learning strategies, including jigsaw, on students' achievement in Mathematics in Nigerian secondary schools.

Their findings showed no significant difference in pre-test scores between control and experimental groups, suggesting that jigsaw may not have an immediate impact on students' performance in certain topics like quadratic equations. They concluded that other factors, such as students' background knowledge and individual learning pace, could account for these results.

The results of findings in Table 2 revealed that that the experimental group performed marginally better than the control group in the posttest. The difference based on Table 5 was found to be significant. The finding concurred with that of Olorunfemi and Adeyemi (2023) study, which explored the impact of cooperative learning strategies, including the jigsaw method, on secondary school students' post-test achievement in Mathematics. Their results revealed a significant improvement in the experimental group's achievement scores compared to the control group, concluding that the collaborative nature of the jigsaw strategy facilitated better comprehension and problem-solving abilities in quadratic equations. On the other hand, the finding disagreed with that of Balogun and Aluko (2022) who found that while cooperative learning strategies like jigsaw positively impacted student engagement, there was no significant difference in the post-test scores of the experimental and control groups in their study on quadratic equations. They suggested that the complexity of quadratic equations might require a more direct instructional approach to achieve significant improvement in achievement scores.

The results of findings in Table 3 revealed that the mean difference between male and female students was minimal, at just 0.28, showing that both genders performed almost equally in the posttest, with very little difference in achievement. This slight difference based on Table 6 was found to be not significant. The finding of this study concurred with that of Adekunle and Ibrahim (2023) conducted research on the effect of cooperative learning strategies, including the jigsaw method, on the achievement of male and female students in Mathematics. Their results showed no significant difference in the performance of male and female students in the experimental and control groups. They concluded that the jigsaw strategy provided an equal opportunity for both genders to participate and benefit from peer learning in mathematical concepts, including quadratic equations. On the other hand Ajayi and Nwabueze (2022) explored the effect of the jigsaw cooperative learning strategy on male and female students' achievement in Mathematics. Their findings revealed a significant difference in the achievement of male and female students, with male students outperforming females in the

experimental group. They suggested that social dynamics in group learning settings could influence how male and female students engage with mathematical tasks.

CONCLUSION

The study investigated the effect of the jigsaw cooperative instructional strategy on senior school one students' achievement in quadratic equations. The results showed that the jigsaw strategy improved students' achievement in quadratic equations significantly. The study also found that, there is no significant difference in male and female students performance in quadratic equation after exposure to the jigsaw strategy. Based on the findings of this study, the following recommendations were made:

1. Students should be encouraged to work in cooperative groups to improve their understanding and achievement in Mathematics.
2. Teachers should adopt the jigsaw cooperative instructional strategy to improve students' achievement in Mathematics.
3. Parents should encourage their children to work in cooperative groups and provide support for their children's Mathematics education.
4. School administrators should provide resources and support for teachers to adopt innovative instructional strategies like the jigsaw cooperative instructional strategy.
5. Curriculum planners should incorporate cooperative learning strategies into the Mathematics curriculum to improve students' achievement.
6. Authors in Mathematics should develop instructional materials that incorporate cooperative learning strategies to improve students' achievement in Mathematics.

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