Journal of Studies in Science and Mathematics Education
ISSN: 2630-662x
Published: 06.08.2026
Volume (issue): 6(1)
Page: 83–91

The Impact of Jigsaw IV Teaching Strategy on Polytechnic Students' Performance and Attitude towards Trigonometry in Kebbi State, Nigeria

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Abstract

This study investigates the impact of Jigsaw IV teaching strategy on polytechnic students' performance and attitude towards trigonometry in Kebbi state, Nigeria. Two research objectives, corresponding research questions and hypotheses guided this study. A pretest-posttest quasi-experimental design was employed involving 169 students as the population of the study where 56 National Diploma II (ND II) students of Waziri Umaru Federal Polytechnic Birnin Kebbi were drawn as the sample of the study using hat-draw sampling technique. The experimental group received treatment using Jigsaw IV strategy, while the control group used conventional method for a period of six-weeks. Data was collected using pre-test post-test on Trigonometry Performance Test (TPT = 0.789) and Trigonometry Attitude Assessment Scale (TAAS = 0.818) which were all validated by experts and were also found reliable based on the reliability test score. Students exposed to the Jigsaw IV teaching technique showed significant improvements in both performance and attitude, according to independent sampling t-tests. The results demonstrate that the inclusive and cooperative nature of the Jigsaw IV teaching approach fosters learning environment that increases students' self-esteem and motivation. According to the findings of the study, polytechnic institutions should make an effort to set up systems to track how well the Jigsaw IV teaching method is being applied over time.

Keywords: jigsaw IV, teaching strategy, polytechnic students, performance, attitude, trigonometry

1 Introduction

The conventional teacher-centered approach to teaching is increasingly giving way to a student-centered approach in recent years. Studies involving cooperative learning have emerged as an internationally important area among researchers. Sani et al., (2026) pointed out that cooperative learning strategy is a student-centered approach different from the more frequently used traditional approach which is centered on teachers. Although for a cooperative learning to be successful, there are disagreements over the ideal group size which suggest students to be split into in-person groups which include Jigsaw grouping, learning together, teams-games-tournaments, as well as research group (Abdurrahman et al., 2023; Muhammad et al., 2022). Based on its use, the Jigsaw learning approach deviates from the conventional framework. It builds students' ability for lifelong learning and exposes them to the reasoning behind scientific study.

Elliot Aronson developed the Jigsaw strategy for cooperative learning in 1971, and Robert Slavin improved its evaluation procedures in 1986 (Seyhan, 2021). In order to help students from diverse cultural backgrounds reduce the intensity of ethnic tensions and close learning gaps in the then-segregated schools in Austin, Texas, Aronson created a teaching strategy known as Jigsaw because it resembles the game Jigsaw puzzle (Fajonyomi et al., 2023). The term "Jigsaw" describes how students are split up into specialist groups to focus on certain tasks. Afterward, they return to the home group and take turns imparting what they have learned, much like a jigsaw puzzle (Jeong, 2021). The Jigsaw approach, according to Sani (2025), aims to: provide an alternative to reading and lectures as a way to introduce new material; enhance the sense of mutuality and interdependence among the members; hold students accountable for obtaining, practicing, and processing their own and others' learning; and provide an example of high-performing teamwork. Jigsaw teaching strategy facilitates constructivist learning by enabling students to actively participate in both their own and their peer learning which promotes constructivist learning and helps students gain greater understanding and proficiency in trigonometry, mathematics, and other subjects.

With this approach, students take complete charge of their learning while the instructor oversees to guarantee excellent learning, teamwork, and collaboration among group members as they collaborate to promote both their own and others' learning. According to Sani (2025), the Jigsaw strategy comprises the following basic steps: "each student in a "home" group receives a subtopic to become an expert on; subtopic experts from each "home" group meet in an "expert" group to learn and master their subtopics; experts return to their home group to teach their subtopic to the other members; and each student undergoes individual assessments on all subtopics". According to Sani (2025), the Jigsaw strategy fosters good educational results, helps students develop their social skills, increases their self-esteem, confidence, and enthusiasm in studying, and empowers students to take responsibility for their peers education. The Jigsaw approach aims to enhance students' feeling of cooperation, critical thinking, and problem-solving abilities while showcasing successful teamwork. According to Akudo et al., (2021) and Ocampo (2022), the Jigsaw teaching strategy encourages students' attitudes toward the educational experience more than traditional competitive teaching strategies; however, students who received instruction using the Jigsaw strategy were less likely to miss class than other students. This is consistent with constructivist theories, which highlight the significance of students actively creating their knowledge and comprehension through previous experiences and concepts while being guided by teachers. In the context of mathematics education, students must develop their own understanding of every mathematical concept, according to constructivism, which emphasizes that students form their own interpretations of the evidence and submit them for review. As a result, the primary duty of teaching is not merely explaining, lecturing, or trying to convey mathematical knowledge, but rather creating situations for students that will encourage students to make the essential mental structures (Jamilu et al., 2022). The findings of the study is expected to assist students to improve their self-confidence as they are trained to work in group and support one another. School administrators may gain deeper insights into their role as instructional implementors and supervisors of the teaching and learning process.

Many people believe that mathematical concepts are hard to understand, hard to learn, and nearly impossible to visualize. The condition is getting worse due to students' negative attitude towards mathematics and learning mathematics (Purwanti & Hatmantho, 2019). Many researchers believe that attitude has a major role in determining whether a student does better or worse in mathematics (Ngussa & Mbuti, 2017; Ocampo, 2022). Over time, attitudes may evolve, and once a positive attitude is established, it can enhance students' academic performance. On the other hand, a negative attitude hinders effective learning and consequently affects student's academic achievement. Furthermore, poor academic performance in mathematics teaching and learning is also attributed to the use of ineffective teaching strategies. According to Jamilu et al. (2022) and Suleiman and Hammed (2019), ineffective teaching strategies may be the cause of students' mathematics failure rather than their incapacity to learn. According to earlier research conducted in Nigeria, the Jigsaw IV method improves students' performance in trigonometry (Muhammad, Dahiru & Abdullahi, 2024), coordinate geometry (Akudo & Olaoye, 2021), and geometry (Timayi et al., 2015).

1.1 Research Objectives

The objectives of the study are to:

i. Investigate the effect of Jigsaw IV teaching strategy on polytechnic students' performance in trigonometry in Kebbi State.
ii. Determine the influence of Jigsaw IV teaching strategy on polytechnic students' attitude towards trigonometry in Kebbi State.

1.2 Research Questions

The following research questions were raised for answering:

i. How does the use of Jigsaw IV teaching strategy improve polytechnic students' performance in trigonometry in Kebbi state?
ii. How does the use of Jigsaw IV teaching strategy affect polytechnic students' attitude towards trigonometry in Kebbi state?

2 Literature Review/Theoretical Framework

Over the years educators have been searching for ways to move away from the traditional teacher-centered approach to cooperative teaching strategies as effective alternatives, especially in mathematics class rooms where students often struggle with abstract concepts. One cooperative strategy that has gained international recognition is the Jigsaw teaching strategy, first introduced by Elliot Aronson in 1971 and later redefined by Robert Slavin in 1986, Aronson designed it to foster collaboration, accountability and active participation in diverse class rooms. Later refinements by Slavin added more structure and evaluation procedures, making Jigsaw adaptable to different educational contexts to how the method could be evaluated and applied in classroom settings (Jeong, 2021; Seyhen, 2021). The Jigsaw teaching strategy requires students to become experts on specific subtopics, which they then teach their peers, thereby creating puzzle-like structure of shared knowledge. The early types of Jigsaw teaching strategies Jigsaw I, II, III) emphasize group formation and peer teaching, while Jigsaw IV adds quizzes, reteaching of difficult concepts and structured assessments. Other types, such as Reverse Jigsaw and Subject Jigsaw, shift the focus to group reporting or modular exchange of knowledge (Sani, 2025). These modifications demonstrate the flexibility of the Jigsaw framework in accommodating different classroom contexts and learning objectives. Research evidence consistently shows that Jigsaw strategies enhance both performance and attitude across disciplines. Studies have found that Jigsaw IV improves student's outcomes in Mathematics (Obafemi et al., 2023), geometry (Akudo and Olaoye, 2021; Jamilu et al., 2022), and plane-shapes (Sani, 2025).

For Jigsaw to succeed, teachers must carefully select and organize content, form diverse group, and monitor progress to ensure productive collaboration (Dhull and Verma, 2019). Meanwhile, students take ownership of their learning by becoming experts in subtopics assigned to them, making students responsible for developing, rehearsing and processing own and others subtopics (Doymus, 2022). Effective application of Jigsaw strategy requires attention to environmental and organizational factor. Sani (2025) outlines key conditions for successful implementation, including suitable physical settings that allow face-to-face group interaction, appropriate class sizes, careful subtopic selection, and diverse group composition. Clear guidelines, role assignments (such as leader, recorder, or presenter), and time management are also critical to maintaining the cooperative structure. When these elements are managed properly, Jigsaw activities not only improve academic outcomes but also enhance student's confidence and enthusiasm for learning.

The Jigsaw teaching strategy embodies constructivist principles, encouraging learners to build knowledge through collaboration with peers. Jigsaw IV teaching strategy facilitates constructivist learning by allowing students to take an active role in their own learning, and the learning of their peers thereby developing deeper understanding and skills in trigonometry, mathematics and various other disciplines. Constructivist principles emphasizes that students form their own interpretation of evidences and submit them for review, within the context of mathematics education, students have to build their own understanding of every concept of mathematics, so that the main responsibility of teaching is not just explaining, lecturing, or attempting to convey mathematical knowledge, but creating situations for students that will promote students making the essential mental structures (Lessani et al., 2016). This is in line with constructivists ideas, that emphasizes the importance of individuals actively constructing their knowledge and understanding through past experiences and ideas under teacher's guidance. Its adaptability across different contexts underscores its relevance as a pedagogical tool for addressing challenges in teaching and learning, such as negative attitude and poor performance of students especially in mathematics.

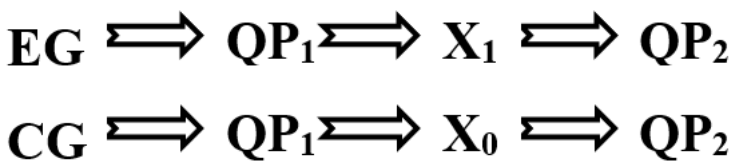
3 Materials and Methods

3.1 Methodology

The purpose of this study was to examine how the Jigsaw IV teaching strategy affected the performance and attitude of polytechnic students in trigonometry. For this, a pretest posttest quasi-experimental research design was considered appropriate consisting of two groups (experimental and control). Pre-test (QP_1) was administered to both groups in order to test their level of homogeneity. Both groups were subjected to six (6) weeks treatment (experimental group received trigonometry instruction using the Jigsaw IV teaching method (X_1), whereas the control group received trigonometry instruction using the conventional teaching method (X_0)). A post-test (QP_2) was given to both groups after the intervention process to determine the effectiveness of the treatment. Figure 1 below shows the diagrammatic representation of the study design:

Figure **1:**

Diagrammatic representation of the research design



3.2 Population, Sample and Sampling Technique

The population of the study consists of all the National Diploma II (ND II) students of Waziri Umaru Federal Polytechnic Birnin Kebbi offering the course of trigonometry. There are one hundred and sixty-nine (169) ND II students enrolled in trigonometry classes. The selection of ND II students is justified by the fact that they seem to possess the necessary skills to meet the study requirements. Two ND II classes makes up the study sample which were selected using a simple hat-draw sampling technique. According to Sani (2017), "a sample size of 30 per group is adequate for educational studies, particularly experimental designs, as it supports statistical robustness and is feasible within classroom settings". Thus, the study encompassed a total of 112 ND II students, with 56 students from the Department of Architectural Technology making up the experimental group and 56 ND II students from the Department of Mechanical Engineering making up the control group. The rationale behind the selection of Architectural Technology and Mechanical Engineering students for this study is to ensure minimal or zero interaction between the students in the experimental and control groups. Architectural studios also feature moveable desks that may be used for small-scale in-person group discussion.

3.3 Instrumentation

For this study, three research instruments were used to help gather the necessary data. These comprised a pretest and posttest in order to investigate the level of homogeneity and examine polytechnic students' performance by the end of the treatment; as well as a questionnaire aimed at measuring their attitude toward trigonometry. At least three experts validated the instruments, and the following are the research instruments used:

i. Pre-Trigonometry Performance Test (PTPT) and Trigonometry Performance Test (TPT) were administered to students during both the pre-test and post-test phases, the tests consist of 30 items each in 4 multiple choices on trigonometry covering trigonometric ratios, sum and difference formulas, bearing, heights and distances, angle of elevation and depression, half-angle formulas, the unit circle, and trigonometric identities. The selection of this subheadings was justified as they form the foundation for understanding the study of trigonometry and its applications in education, science and engineering. The items were extracted from Trigonometry and Analytical Geometry past questions of 2014 to 2023, intended to measure student's ability in the area of knowledge, understanding and application of trigonometry.

ii. Trigonometry Attitude Assessment Scale (TAAS) was utilized to gather information on polytechnic student's attitude towards trigonometry, adapted and modified from Martha-Tapia (1996) Attitude Scale to suite the present study and consisted of 30 items, with ten items each for confidence, value and enjoyment, in the form of four-point Likert scale (1= strongly disagree; 4 = strongly agree), administered to both groups before and after the treatment to determine attitudinal change towards trigonometry.

iii. The independent t-tests were utilized to examine the differences in mean scores between groups for academic performance and students' attitude towards trigonometry. The reliability test for this study was determined among 30 ND II students purposively selected for pilot study. The correlation coefficient values of 0.74 and 0.78 were recorded for TPT and TAAS at 5% level of significance respectively. This clearly indicates that these items were reliable to measure the intended construct. Data analysis was carried out using Statistical Package for Social Science (SPSS) Software version 21.

3.4 Research Procedure and Implementation

This study was carried out during the Bazara Semester of the 2024–2025 Academic Session at Waziri Umaru Federal Polytechnic Birnin Kebbi (WUFPBK), from 1st September to 10th October 2025. In order to assess students' knowledge and attitudes on trigonometry, the PTPT and TAAS were given to both the experimental and control groups at the beginning of the study. After six (6) weeks of intervention using the Jigsaw IV teaching strategy for the experimental group and the conventional method for the control group, the TPT and TAAS were administered once again to measure students' performance and attitudes regarding trigonometry.

Table **2:**

Framework for implementing Jigsaw IV teaching strategy

Phase One	Phase Two	Phase Three	Phase Four
Creation of groups	Learning session	Teaching session	Assessment
Determination of subtopic	Experts come up with a comprehensive material to master and also rehearse how to teach the material.	Experts take turns teaching areas of expertise and learning all the materials being taught by other respective home groups members.	Students undergo quizzes on subtopics in the experts' group and another in the homegroup covering all of the materials

4 Results

Research Question One (RQ1): How does the use of Jigsaw IV teaching strategy improve polytechnic students' performance in trigonometry in Kebbi State, Nigeria?

Table **3**

Mean and standard deviation for performance of students in experimental and control groups

Groups	N	Mean	S. D	M D
Experimental (Jigsaw)	56	78.40	8.70	16.30
Control (Traditional)	56	62.10	9.30	

The result in Table 3 above shows a substantial performance gap between the two groups. The experimental group being the group taught using Jigsaw IV teaching strategy scored 78.40 and 8.70 mean and standard deviation respectively while that of the control group pulls 62.10 and 9.30 respectively, with the mean difference of 16.30 respectively. This result revealed that students in the experimental group scored higher than their peers in the control group.

Research Question Two (RQ2): How does the use of jigsaw iv teaching strategy affect polytechnic students' attitude towards trigonometry in Kebbi state, Nigeria?

Table **4**

Mean and standard deviation for attitude of students in the experimental group

Groups	N	Mean	S. D	M D
Experimental (Jigsaw)	56	82.60	7.90	14.20
Control (Traditional)	56	68.40	8.50	

The result in Table 4 above shows a strong improvement in students' attitude towards trigonometry when taught using Jigsaw IV teaching strategy. As the Jigsaw group scored 82.60 mean score and 7.90 Standard deviation while the Traditional group scored 68.40 mean scores and 8.50 standard deviation, with the mean difference of 14.20 respectively.

$H0_1$: There is no significant difference in trigonometry performance between students taught using the Jigsaw IV strategy and those taught using traditional methods.

Table **5**

Summary of independent sample t-test for experimental and control groups

Groups	N	df	Mean	S. D	t-value	p-value
Experimental	56	110	78.40	8.70	9.59	< 0.0001
Control	56		62.10	9.30		

Table 5 above shows the t-test of the mean scores of experimental and control groups. The table indicate significant difference in performance between the two groups since p is less than 0.05, therefore, the hypothesis is rejected. This implies that the Jigsaw IV teaching strategy had a significant positive effect on student's performance in trigonometry compared to traditional teaching methods.

$H0_2$: There is no significant difference in students' attitude towards trigonometry between students taught using the Jigsaw IV strategy and those taught using traditional methods.

Table **6**

Summary of independent sample t-test for students' attitude in experimental groups

Groups	N	df	Mean	S. D	t-value	p-value
Experimental	56	110	82.60	7.90	9.10	< 0.0001
Control	56		68.40	8.50		

From Table 6 above, the p-value is less than 0.05, indicating significant difference in students' attitude towards trigonometry between the two group. Therefore, the hypothesis is also rejected, which suggest that the Jigsaw IV teaching strategy has positive effect on students' attitude towards trigonometry.

5 Discussion

This primary objective of this study is to ascertain how the Jigsaw IV teaching strategy affects students' trigonometry performance and attitudes in Kebbi State, Nigeria. The results show a statistically significant improvement in both academic performance and attitude among students exposed to the Jigsaw IV teaching strategy when compared to students taught using conventional method. With a mean difference of 16.30, the polytechnic students who received instruction using the Jigsaw IV strategy scored higher on mean ($M = 78.40$, $SD = 8.70$) than those who received instruction using the conventional method ($M = 62.10$, $SD = 9.30$). The results of the independent t-test showed a high significant difference in favor of the experimental group, with a value of 9.59 ($df = 110$, $p < 0.0001$). This result is consistent with other research, such as that of Fajonyomi et al. (2023), who discovered that the Jigsaw IV instructional strategy significantly impacted students' academic performance in mathematics. In a similar vein, Jamilu et al. (2022) highlighted that students exposed to J4CLS outperformed those exposed to conventional teaching methods. Additionally, there was a considerable favorable attitude toward trigonometry in the experimental group ($M = 82.60$, $SD = 7.90$) as compared to the control group ($M = 68.40$, $SD = 8.50$), with a mean difference of 14.2. The statistical significance of this difference is confirmed by the t-test result ($t = 9.10$, $df = 110$, $p = < 0.0001$). This result is in line with research by Ocampo (2022), who found that students' performance and attitude toward mathematics are enhanced by the Jigsaw method. Consequently, Damoeroem and Markus (2021) highlighted that Jigsaw IV strategy enhanced students' attitudes about physics regardless of gender or score level.

6 Conclusion

Jigsaw teaching strategy has generally been shown to be effective in enhancing students' performance and interest in mathematics, regardless of their gender or socioeconomic background. Depending on the set of objectives they hope to achieve, mathematics teachers use any of the different but related Jigsaw strategies in their classes. This research provides an explanation of how to maximize any of the several but related jigsaw teaching strategies used in mathematics classrooms.

Additionally, the study focused on the jigsaw activity's instructor and student tasks. It is noteworthy that when a jigsaw activity's instructions are followed correctly, students' attention is enhanced as well as their social skills and competences. Furthermore, the study provides strong evidence that the Jigsaw IV activity structure encourages active participation, peer teaching, and accountability, greatly enhances polytechnic students' academic performance and attitude toward trigonometry. The cooperative and inclusive nature of the Jigsaw IV teaching strategy appears to promote a learning environment that boost student's confidence and motivation.

7 Recommendations

The results of this study have led to the following recommendations:

1. The Jigsaw IV teaching method should be included into mathematics and other technical subject curricula in the polytechnic sector by curriculum developers and educational policy makers.
2. Polytechnics should make an effort to set up systems to track how well the Jigsaw IV teaching method is being applied over time.
3. Long-term consequences of the Jigsaw IV strategy on information retention, problem-solving skills, and experiences of students should be included in future research.

8 Limitations

The use of intact classes from two different academic departments as the experimental and control groups make up the study limitation as the two departments together didn't make up 10% of the 46 departments in Waziri Umaru Federal Polytechnic Birnin Kebbi.

9 Ethical statements

Participation in the study is completely voluntary. A letter of request for permission to conduct the research at Waziri Umaru Federal Polytechnic Birnin Kebbi was forwarded to the office of the Registrar and after carefully analyzing the content of the request, the Management of the institution grant permission to conduct the study under close monitoring by the Heads of Departments concerned.

10 Conflict of Interest

There is no conflict of interest between the authors. All of what has been drafted was reviewed and agreed upon by the researchers. The authors declare neither financial nor non-financial conflict of interest.

11 Author Contributions

M. M. Sani: Introduction, Literature review, Materials and Methods, Data Collection

M. A. Sani: Abstract, Data Collection, Results, Discussion, Conclusion.

12 Funding

The researchers did not receive any funding or grant for this study.

13 Confidentiality

The participants personal information is not revealed to third party and in no circumstance any of such information will be revealed. The research records will be treated as confidential.

14 Reference

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