COMPARATIVE EFFECT OF INDIVIDUALISED AND COOPERATIVE LEARNING STRATEGIES ON SECONDARY SCHOOL STUDENTS ACHIEVEMENT IN MATHEMATICS

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Abstract
The study investigated comparative effect of individualised and cooperative learning strategies on secondary school students' achievement in Mathematics. It covered the topics of venn diagram, union set, interception set, empty set, mean, media all are under set theorem and measure of central tendency. Two research questions and two hypotheses were used to guide the study and relevant literature were also reviewed. The study adopted quasi-experimental design and the study was carried out in Awka Education Zone in Anambra State. The population of the study comprised of 8,583 SS II Mathematics students from 65 co-education secondary schools in Awka Education Zone. Out of the 65 co-educational secondary schools in Awka Education Zone, six schools were drawn. The sample consisted of 270 SS2 students (100 males and 170 females). The sample was obtained using multi-stage sampling procedure. Fifty Mathematics Achievement Test (MAT) structured from WAEC past question papers was used as instruments for collecting data for achievement. The instrument was subjected to face and content validation. MAT reliability was established using Kudar Richardson 20 (KR-20) which yielded reliability coefficient of 0.81. Mean and Standard Deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The study revealed that individualised learning strategies are more effective than cooperative learning strategies for student achievement in Mathematics. Male students showed more achievement with both strategies than their females counterparts. Recommendations was that government should support teacher training in individualized strategies and promotion of cooperative methods in the education curriculum to enhance achievement in Mathematics. From the recommendations, conclusions and educational implications were made.
Keywords: Mathematics Achievement, Individualised Learning Strategies (ILS) and Cooperative Learning Strategy (CLS).

Introduction

Mathematics is fundamental to science, providing the language and tools for quantifying observations, modeling phenomena, and validating theories. Without Mathematics, scientific principles cannot be accurately formulated, analyzed, or understood, undermining the entire

scientific method. It is evident in the world today that if there is no Mathematics there will be no science, if there is no science there will be no technology, and when there is no technology, there will be no modern society. Transitively therefore, if there is no Mathematics, there will be no modern technology and society (Ezeliora et al., 2021).

More so, a strong background in Mathematics is crucial for many career and job opportunities in today's increasing technological society. It is a wheel in which science, technology and economy move. It's importance at any level of education to make it compulsory at pre-primary, primary, secondary and tertiary level of education (FRN, 2018). Among the training Mathematics provides are the ability to develop powers of logical thinking, accuracy with figures and spatial awareness.

Furthermore, Mathematics is integral to contemporary development, influencing various sectors, including science, technology, and economics. Despite its importance, student achievement in Mathematics has been alarmingly poor, according to researchers such as Ezeliora et. al. (2021) and Lokman et. al. (2020). Udu (2020) emphasizes that the poor achievement in the subject is as a results weaknesses in some vital concepts of the subject especially from Senior Secondary Certificate Examination (SSCE), particularly the West African Examinations Council (WAEC) examinations from 2017 to 2023.

For instance in year 2017 report revealed deficiencies in key areas, including logarithmic expressions, circle theorems, measures of central tendency, and problem-solving in geometry. Particularly troublesome was the struggle to translate word problems into mathematical statements or solve practical problems involving cyclic quadrilaterals and financial mathematics. In subsequent years, similar weaknesses continued to emerge. For example, the 2018 report noted difficulties with trigonometric expressions, probability problems, and the application of

logarithmic laws. By 2019, specific areas of concern included circle measurements, trigonometry, and geometry-related problems, demonstrating a persistent pattern in student underachievement.

From 2020 to 2023, WAEC reports recurrent themes in students' weaknesses, such as challenges related to sector and segment calculations, the use of Venn diagrams, and measures of central tendency. These consistent struggles highlight broader underlying issues in the Mathematics curriculum and instructional methods in schools. Some researchers outlined factors that contribute to students' difficulties that could lead to weaknesses in their achievement in secondary school subjects to include insufficient foundational knowledge, ineffective teaching strategies, lack of practice, and anxiety during examinations (Obikezie et al., 2023a; Obikezie et al 2023b). More so, Soni (2020) suggests that these weaknesses stem from inappropriate instructional methods, environmental factors, and a lack of resources, which inhibit effective teaching and learning.

Another critical factor that could influencing student achievement in Mathematics is learning style. As noted by Xing (2023), each student has a unique way of processing and retaining information, which is crucial for effective learning. Identifying and accommodating these individual learning styles whether visual, auditory, or kinesthetic can significantly enhance students' understanding of mathematical concepts. Moser and Kimberly (2023) elaborate on various individualised learning styles, including, individualised learning, hands-on activities and cooperative learning, emphasizing that recognizing these differences is essential in Mathematics instruction. This study focused on two effective instructional strategies: individualised learning and cooperative learning.

Individualised learning (IL) tailors education to address each student's specific needs and preferences. Ibrahim and Zulkipli (2022) characterize Individualised learning as a philosophical

approach involving ten strategic steps, including creating learner profiles, setting clear goals, and offering personalized assessment options. This strategy accounts for cognitive maturity and customizes content delivery based on each learner's abilities and interests.

Udu (2019) reinforces this notion, asserting that individualised learning entails adjusting instructional materials, media, and the pace of learning according to individual strengths and weaknesses. It fosters a constructivist approach, allowing students to build their understanding over time, ultimately leading to improved academic outcomes. Soni (2020) discusses various methods of individualised learning, such as programmed instruction and independent study, all of which have been found effective in enhancing student achievement.

Cooperative learning (CL) on the other hand, promotes collaborative efforts among students of diverse abilities. This strategy encourages teamwork to tackle common educational tasks. Udu (2019) emphasizes that cooperative learning cultivates a supportive environment where students can leverage each other's strengths, enhancing overall comprehension and mastery of mathematical concepts. Lin et. al. (2024) refer to this strategy as an umbrella term encompassing various educational methods that involve joint intellectual effort among students and teachers.

The essence of cooperative learning lies in fostering interdependence not only does it improve understanding of the material, but it also develops essential skills like communication, teamwork, and problem-solving. Atemnkeng and Chu (2022) emphasize that creating an active learning environment can result in higher academic achievements, as students learn to control their educational experiences collaboratively. According to Nnachi et. al. (2021), Edekor and Agbornu (2020) reported in their different studies that cooperative learning strategy is superior to other learning strategy like individualised learning strategy in fostering high achievement in Biology and in Mathematics in junior high school at hohoe municipality. While Dawal (2021) reported

that Individualized Instructional Strategy (IIS) is superior to the conventional method and other teaching methods in facilitating the achievement of students in Basic Science and Technology.

Furthermore, Nela et. al. (2018) observed that teachers most often choose to use three levels of individualisation approach because they believe it enhances students' achievement than cooperative approach in southern Asia. Meanwhile, Uboh and Inyang (2022) revealed that the effectiveness of individualised learning over cooperative learning strategy on students` achievement in the concept of motion in Physics as significant while Melkamu, et. al. (2024) demonstrated a significant difference between students instructed through cooperative learning and students instructed using individualised-based teaching in terms of their Chemistry achievement in favour of cooperative learning strategy but Ferhat and Mehmet (2016) observed no significant differences between the groups in terms of the pretest and posttest in two learning strategies not minding the students' gender type.

Gender disparities in student achievement often reflect societal influences, biases, and learning environments. Dawal (2021) opined that addressing these factors through targeted support can enhance equity in educational outcomes. No wonder Dawal (2021) further asserted base on the authors observation that the mean scores for females in achievement are higher than that of the males for the group taught with individualised and cooperative learning strategy when taught Basic Science and Technology during covid-19 era. While Anidi et. al. (2022) reported no significant difference in the achievement of male and female pupils taught reading with cooperative learning and other competitive learning strategy like individualised learning strategy. Meanwhile, Melkamu, et. al. (2024) who observed that gender differences did not exist in Chemistry achievement when students were taught using competitive learning strategies like individualised and cooperative learning strategy.

From the literature reviewed, the issue of gender in comparative effect of individualised and cooperative learning style is still inconclusive and contradictory. Also most of the literature reviewed where done in science subjects even the once in Mathematics where done in junior secondary. All the empirical studies reviewed where done outside the present scope of this present study. Finally, the issues of repeated occurring weaknesses in major concepts of Mathematics among secondary school students has been a thing of concern among stake holders. On these motivated the researchers to carry out this study on comparative effect of individualised and cooperative learning strategies on secondary school students' achievement in Mathematics concepts of Venn diagram, union set, interception set, empty set, mean, and media all are under set theorem and measure of central tendency in Awka Education zone of Anambra State.

Purpose of the Study

The main purpose of this study was to determine the comparative effect of individualised and cooperative learning strategies on secondary school students' achievement in Mathematics.

Specifically, the study ascertained the:

1. Mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy.
2. Mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy.

Research Questions

The following research questions guided the study:

1. What is the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy?
2. What is the mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy?

Hypotheses

The following null hypotheses were tested at .05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy.
2. There is no significant difference in the mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy.

Method

The study adopted a quasi – experimental design specifically; a non-equivalent control group design. The area of study is Anambra State Nigeria. The population of the study comprised of 8,583 students (4,145 females and 4,438 males) from all the senior secondary two (SS2) Mathematics students in the sixty five (65) State owned co-educational secondary schools in Awka Education Zone of Anambra State that enrolled for the 2022/2023 academic session (PPSC, 2023). Co-educational schools are of interest to the study because it is easier to ensure a balanced representation of gender intact groups. The sample consisted of 270 SS2 students (100 males and 170 females). The study sample was dawned through a multi-stage sampling procedure. Initially, stratified random sampling identified one co-educational secondary school from each of four local

governments in the Awka Education Zone, and two schools from Awka South, which has the highest number of schools and qualified Mathematics teachers. Co-educational schools were chosen to ensure balanced gender representation. Schools selected had qualified Mathematics teachers with at least ten years of experience who had prepared students for the Senior Secondary School Certificate Examination for at least five years. Three schools formed the experimental group taught with individualized learning strategies (50 male, 100 female), while three schools used cooperative learning strategies (50 male, 70 female). Each school provided one intact class for the experiment.

Instrument

The study used one measuring instruments for data collection named Mathematics Achievement Test (MAT). The MAT consisted of 50 objective questions structured from WAEC past questions related to the topics used for the study. The MAT have two sections A and B. Section A elicited response from participants on their personal data with particular reference to gender while section B contained fifty (50) WAEC standard objective option A-D options. Both MAT was validated three experts, one a professor in specialty in Mathematics education in the Department of Science Education Nnamdi Azikiwe University Awka, a professor on measurement and evaluation in the Department of Educational Foundations Chukwuemeka Odumegwu Ojukwu University, Igbariam and a senior secondary school Mathematics teacher with 20 years of experience. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).

Results

Research Question 1

What is the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy?

Table 1: Mean and Standard Deviation Achievement Scores of Students Taught Mathematics using Individualised Learning Strategy (ILS) and Those Taught Using Cooperative Learning Strategy (CLS)

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
ILS	150	15.41	2.30	26.91	8.69	11.50
CLS	120	14.55	2.18	24.96	6.91	10.41

The results in Table 1 shows that the pre-test and posttest mean achievement scores of students taught Mathematics using individualized learning strategy (ILS) were 15.41 and 26.91 respectively while the standard deviations were 2.30 and 8.69. On the other hand, pre-test and posttest mean achievement scores of students taught Mathematics using cooperative learning strategy were 14.55 and 24.96 respectively while the standard deviation were 2.18 and 6.91. The standard deviation scores for the posttest for both groups were higher than the standard deviations for the pretest. This suggests more variability in the posttest scores of the students than the pre test scores. More of the scores near the mean in the posttest than in the pretest. Since the pretest mean is smaller than the posttest mean in both learning strategies used in the study, both learning strategies improved students' academic achievement in the Mathematics concepts used. More so, since individaulised learning strategy has a higher posttest mean than cooperative learning posttest mean, this indicated that students taught with individualized learning strategy improved in academic achievement than those taught with cooperative learning strategy. Also since posttest

mean for individailsed learning strategy is higher than the posttest mean of cooperative learning strategy, individailsed learning strategy is more effective than cooperative learning strategy.

The mean gain score of students taught with individualized learning strategy is 11.50 while that of cooperative learning strategy is 10.41. This represents a mean difference of 1.09 in favour of students taught Mathematics with individualised learning strategy which implies that students taught with individualised learning strategy achieved better in Mathematics concepts taught than those taught using cooperative learning strategy.

Research Question 2

What is the mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy?

Table 2: Mean and Standard Deviation Achievement Scores of Male and Female Students Using Individualise Learning Strategy (ILS) and those taught with Cooperative Learning Strategy (CLS)

			Pretest		Posttest		
Groups	Gender	N	Mean	SD	Mean	SD	Mean Gain
ILS	Male	50	15.38	2.16	30.78	11.37	15.40
	Female	100	15.42	2.38	24.98	6.19	9.56
CLS	Male	50	14.44	2.19	25.40	8.36	10.96
	Female	70	14.63	2.19	24.64	5.70	10.01

Table 2 shows mean and standard deviation achievement scores of male and female students taught Mathematics using individalised and cooperative leaning strategies. From the result the pretest and posttest mean achievement score of male students taught Mathematics using individualised learning strategy were 15.38 and 30.78 while the standard deviations were 2.16 and 11.37 with mean gain scores of 15.40. Also, the pretest and posttest mean achievement score of female students taught Mathematics using individualised learning strategy were 15.42 and 24.98

while the standard deviations were 2.38 and 6.19 with mean gain scores of 9.56. The standard deviation scores for the pretest for the male and female students were lower than the standard deviations for the post test. This suggests more variability in posttest scores than the pretest scores. More of the scores are near the mean in the posttest than in the pretest. Since posttest mean score for male is higher than the posttest mean score of the female, the male students achieved higher than their female counterpart in use of individualised learning strategy. However, the mean gain difference between male and female students is 5.84 in favour of male students. This implies that male students achieved better than their female counterpart in the use of individualised learning strategy in the Mathematics concepts taught.

More so, the result shown that the pretest and posttest mean achievement score of male students taught Mathematics using cooperative learning strategy were 14.44 and 25.40 while the standard deviations were 2.19 and 8.36 with mean gain scores of 10.96. Also, the pretest and posttest mean achievement score of female students taught Mathematics using cooperative learning strategy were 14.63 and 24.64 while the standard deviations were 2.19 and 5.70 with mean gain scores of 10.01. The standard deviation scores for the pretest for male and female students were lower than the standard deviations for posttest. This suggests more variability in posttest scores than the pretest scores. More of the scores are near the mean in the posttest than in the pretest. Since posttest mean score for male is higher than the posttest mean score of the female, the male students achieved higher than their female counterpart in use of cooperative learning strategy. However, the mean gain difference between male and female students is 0.95 in favour of male students. This implies that male students achieved better than their female counterpart in the use of cooperative learning strategy in the Mathematics concepts taught.

Summarily in Table 2 when the two learning strategies are compared as moderated by gender. Male students in individualised learning strategy (ILS) achieved better than their counterparts with posttest mean of 30.78 followed by male students in cooperative learning strategy (CLS) with posttest mean of 25.40 while female students in individualised learning strategy (ILS) followed with posttest mean of 24.98 and finally female students in cooperative learning strategy (CLS) group with posttest mean of 24.64.

Hypothesis 1

There is no significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy.

Table 3: Analysis of Covariance (ANCOVA) of Students' Mean Achievement Scores Between Two Learning Strategies ILS and CLS in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Decision
Corrected Model	407.582[a]	[1]	407.582	6.507		
Intercept	1959.819	1	1959.819	31.286		
Leaning Strategies	407.582	1	407.582	6.507	0.011	S
Error	16787.885	268	62.641			
Total	200340.000	270				
Corrected Total	17195.467	269				

a. R Squared = .024 (Adjusted R Squared = .020)
b. Computed using alpha = 0 .05

The result in Table 10 show that there is significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy, F(1,407.582) =6.507, p=.011. Since the obtained p-value is less than the stipulated .05 level of significance, the null hypothesis which stated that there is no significant difference in the mean achievement scores of students taught Mathematics using

individualized learning strategy and those taught using cooperative learning strategy is rejected. This implies that the mean achievement score of students taught Mathematical concept using individual and cooperative learning strategy has a significant difference in mean achievement scores in respect to this study. This implies that there is a significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy in favour of those taught with individualised learning strategy.

Hypothesis 2

There is no significant difference in the mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy.

Table 4: The ANCOVA Results of Male and Female Students' Achievement Scores when Taught with Two Leaning Strategies of ILS and CLS in Mathematics.

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Decision
Corrected Model	1404.772[a]	1	1404.772[a]	23.842	0.000	
Intercept	19831.097	1	19831.097	336.574		
Leaning Strategies	1404.772	1	1404.772	23.842	0.000	S
Error	15790.695	268	58.921			
Total	200340.000	270				
Corrected Total	17195.467	269				

a. R Squared = .082 (Adjusted R Squared = .078)
b. Computed using alpha = 0.05

The result in Table 4 show that there is a significant difference in the mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy, F(1,1404.772) =23.842, p=.000. Since the obtained p-value is less than the stipulated .05 level of significance, the null hypothesis which

stated that there is no significant difference in the mean achievement scores of male and female students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy is rejected. This implies that the mean achievement score of male and female students taught Mathematics concepts using individual and cooperative learning strategy has a significant difference in mean achievement scores in respect to the study. That implies that there is a significant difference in the mean achievement scores of male and female students taught Mathematics using individualized and cooperative learning strategy in favour of the male students.

Discussion of Findings

The discussion of findings was organized under the following**:**

1. Individualised versus cooperative learning strategies in Mathematics achievement
2. Male and female students in individualized versus cooperative learning strategies in Mathematics achievement

Individualised versus cooperative learning strategies in Mathematics achievement

The findings of the study showed that students taught Mathematics with individualised learning strategy achieved more than those taught Mathematics with cooperative learning strategy. The finding is not in conformity with researchers like Nnachi et. al. (2021), Edekor and Agbornu (2020) who observed that cooperative learning strategy is superior to other learning strategy like individualised learning strategy in fostering high achievement but the finding is in line with Dawal (2021) who reported that Individualized Instructional Strategy (IIS) is superior to the conventional method and other teaching methods in facilitating the achievement of students in Basic Science and Technology. More so, the finding of the study is in consonance with Nela et. al. (2018) who indicated that teachers most often choose to use three levels of individualization approach because

they believe it enhances students' achievement than cooperative approach. The outcome of this result where students taught Mathematics with individualised learning strategy achieved more than those taught Mathematics with cooperative learning strategy could be as a result that individualised learning strategy encourages students' participation and empowerment in their learning journey while accommodating diverse learning styles.

Furthermore, the study disclosed that there is a significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy in favour of those taught with individualised learning strategy. This supports Uboh and Inyang (2022) who revealed the effectiveness of individualized learning over cooperative learning strategy on students` achievement in the concept of motion in Physics as significant. But the finding is not in line with Melkamu, et. al. (2024) who demonstrated a significant difference between students instructed through cooperative learning and students instructed using individualised-based teaching in terms of their chemistry achievement in favour of cooperative learning strategy. This do not support Ferhat and Mehmet (2016) who observed no significant differences between the groups in terms of the pretest and posttest in two learning strategies. The significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy in favour of those taught with individualised learning strategy could be that individualised learning strategy goals are identified by the student, available tools can be tailored to individual needs by its use in learning a concept. By the virtue of this study, this study has joined the group of knowledge that averred a significant difference in the mean achievement scores of students taught Mathematics using individualized learning strategy and those taught using cooperative learning strategy in favour of those taught with individualised learning strategy.

Male and female students in individualized versus cooperative learning strategies in Mathematics achievement.

The findings of the study showed that male students achieved better than female students taught Mathematics with individualised and cooperative learning strategy. The finding is not supported by Dawal (2021) who observed that the mean scores for females in achievement are higher than that of the males for the group taught with individualised and cooperative learning strategy. The outcome of the study that male students achieved better than female students taught Mathematics with individualised and cooperative learning strategy could be influenced by factors such as confidence levels, mathematical socialization, and potentially varying attitudes towards competition and collaboration which male seems to possess more than their female counterpart in learning environment.

The finding also showed that there is a significant difference in the mean achievement scores of male and female students taught Mathematics using individualized and cooperative learning strategy in favour of the male students. This is not supported by Anidi et. al. (2022) who reported no significant difference in the achievement of male and female pupils taught reading with cooperative learning and other competitive learning strategy like individualised learning strategy. The result is also not in line with Melkamu, et. al. (2024) who observed that gender differences did not exist in Chemistry achievement when students were taught using competitive learning strategies like individualised and cooperative learning strategy. The significant difference in the mean achievement scores of male and female students taught Mathematics using individualized and cooperative learning strategy which favours the male students could be that male students have mathematical socialization, and potentially varying attitudes towards collaboration which is essential in the two learning strategies used in the study. By the virtue of

this finding, this study has joined the group of researchers who postulated a significant difference in the mean achievement scores of male and female students taught Mathematics using individualized and cooperative learning strategy in favour of male students.

Conclusion

Based on the findings of this study, the following conclusions were drawn:

The study compares individualised learning strategies to cooperative learning strategies in Mathematics, revealing notable findings on student achievement. Results indicate that individualised learning strategy is significantly more effective for student achievement than cooperative learning, favouring those taught through this method.

The findings also highlight gender-related outcomes: both learning strategies lead to higher achievement among male students compared to female students.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. The government should support teacher training in individualised learning strategies, which are more effective for Mathematics achievement than cooperative learning.
2. Policies should promote the integration of cooperative learning into the national curriculum and provide funding for training educators.
3. Teachers are encouraged to tailor individualized approaches to meet diverse student needs, fostering self-paced learning and engagement while also facilitating collaborative activities to enhance interaction.
4. Curriculum planners must design flexible curricula that support personalized and cooperative learning methods, emphasizing structured group work. Considering that individualized strategies yield better outcomes in students achievement, schools should prioritize their

implementation with adequate training for educators to improve student achievement in Mathematics.

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