INFLUENCE OF FORMAL COOPERATIVE LEARNING AND INDIVIDUALIZED LEARNING STRATEGIES ON SECONDARY SCHOOL CHEMISTRY STUDENTS' INTEREST AND ACADEMIC PERFORMANCE IN KATSINA STATE, NIGERIA

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Abstract
This study examined the influence of formal cooperative learning strategy and individualized learning strategy on secondary school chemistry students' interest and academic performance in Katsina state, Nigeria. Six objectives guided the study, supported by six research questions and six null hypotheses. A quasi-experimental design was adopted, involving 220 students selected from three purposively sampled co-educational public secondary schools in ZEQA Daura. Intact classes were used as experimental and control groups. Data were collected using validated instruments: the Organic Chemistry Students Interest Questionnaire (OCSIQ, $\alpha = 0.71$) and Organic Chemistry Students Performance Test (OCSPT, $\alpha = 0.84$). Reliability was determined using Pearson's Product Moment Correlation and Spearman Rank Order, accordingly. Mean and standard deviation were used to answer research questions, while independent-sample t-tests and ANOVA tested hypotheses at $p < 0.05$. Findings revealed significant differences in students' interest and academic performance, favoring the experimental groups. Students taught using formal cooperative learning strategy and individualized learning strategy performed better than those taught using the lecture method, with formal cooperative learning strategy showing superior results. The study concluded that adopting formal cooperative learning strategy and individualized learning strategy enhances students' engagement and achievement in chemistry and recommends integrating these strategies into classroom instruction.

Keywords: Formal Cooperative Learning, Individualized Learning, Chemistry, Interest, and Academic Performance.

Introduction
Improving students' academic performance and sustaining their interest in science subjects have remained central concerns in science education research globally (Donnelly & Jenkins, 2011; Jegede, 2017). Rapid scientific and technological advancements have increased the demand for scientifically literate citizens capable of critical thinking, problem-solving, and informed decision-making. Chemistry, as a core science subject at the secondary school level, plays a pivotal role in preparing students for science-related careers and national technological development. However, research evidence continues to show persistent challenges in students'

achievement and engagement in chemistry, particularly at the senior secondary school level (Ojukwu, 2016).

In Nigeria, chemistry is a compulsory subject in the secondary school science curriculum and serves as a prerequisite for admission into many science-, technology-, engineering-, and health-related programs. Despite its importance, students' performance in chemistry in public examinations such as the West African Senior School Certificate Examination (WASSCE) and the National Examinations Council (NECO) examinations has remained consistently poor. WAEC Chief Examiners' Reports have repeatedly highlighted candidates' weak conceptual understanding, inability to apply chemical principles, and difficulties with abstract topics such as organic chemistry and chemical calculations (WAEC, 2022). These trends raise concerns about the effectiveness of prevailing instructional practices in chemistry classrooms.

The continued dominance of teacher-centered instructional approaches, particularly the lecture method, has been identified as a major contributor to students' poor performance in chemistry (Olatoye, 2008; Adegoke, 2018). Although the lecture method allows for broad syllabus coverage, it often limits students' active participation, critical thinking, and conceptual understanding. Chemistry concepts are largely abstract and symbolic in nature, thus requiring instructional strategies that promote interaction, collaboration, and meaningful engagement with learning tasks (Kolb, 2019). Consequently, science education researchers have increasingly advocated for learner-centered instructional strategies, including cooperative learning and individualized learning. Formal cooperative learning emphasizes structured group interaction in which students work collaboratively toward shared academic goals while maintaining individual accountability (Johnson, Johnson, & Holubec, 1986). Studies have shown that cooperative learning improves students' academic achievement, enhances motivation, promotes positive attitudes toward science, and supports social interaction among learners (Kagan, 1994; Olatoye, Aderogba, & Aanu, 2021). Individualized learning, on the other hand, is based on the recognition of individual differences in learning pace, ability, and interest. This strategy allows learners to progress through learning tasks according to their personal learning needs, thereby fostering autonomy, initis soc, and self-directed learning (Anih, 2007; Igwe, 2017). Individualized learning has been reported to reduce learning anxiety and enhance mastery of difficult chemistry concepts, particularly for slow learners, while allowing gifted learners to advance at a faster pace.

Gender differences in science achievement have also continued to attract research attention. Gender, defined as socially constructed roles and expectations associated with males and females, has been linked to differences in academic performance and participation in science-related disciplines (Okeke, 2008; Erinosho, 2017). While some studies reported no significant gender differences in chemistry achievement (Tamir, 1990; Olatoye, 2018), others found disparities favoring either male or female students (Dhindsa & Chung, 1999; Bosede, 2020). These mixed findings suggest that instructional strategies may interact with gender to influence students' learning outcomes.

Statement of the Problem

In Katsina state, Nigeria, substantial investments have been made in science education facilities and teacher development. Despite these efforts, students' performance in chemistry in external examinations remains unsatisfactory (WAEC, 2022). This indicates that improving learning outcomes may depend not only on the availability of resources but also on the adoption of effective instructional strategies. There is therefore a need for empirical evidence on the effectiveness of learner-centered approaches such as formal cooperative learning and individualized learning strategies within the local educational context.

Against this backdrop, this study examines the influence of formal cooperative learning and individualized learning strategies on secondary school students' interest and academic performance in chemistry in Katsina state, Nigeria. The findings of this study are expected to contribute to instructional decision-making, curriculum improvement, and policy formulation aimed at enhancing chemistry education at the secondary school level.

Objectives of the Study

The objectives of this study are to:

1. examine the effect of formal cooperative learning on students' interest in organic chemistry in secondary schools in Katsina state.
2. examine the effect of individualized learning on students' interest in organic chemistry in secondary schools in Katsina state.
3. determine the effect of formal cooperative learning on students' performance in organic chemistry in secondary schools in Katsina state.
4. determine the effect of individualized learning on students' performance in organic chemistry in secondary schools in Katsina state.
5. compare the organic chemistry performance of students taught using formal cooperative learning with those taught using individualized learning in secondary schools in Katsina state.
6. examine the influence of gender on students' interest and performance in organic chemistry when taught using formal cooperative learning and individualized learning strategies in secondary schools in Katsina state.

Research Questions

The following research questions were raised to guide the study:

1. What is the effect of formal cooperative learning on students' interest in organic chemistry in secondary schools in Katsina state?
2. What is the effect of individualized learning on students' interest in organic chemistry in secondary schools in Katsina state?
3. What is the effect of formal cooperative learning on students' performance in organic chemistry in secondary schools in Katsina state?
4. What is the effect of individualized learning on students' performance in organic chemistry in secondary schools in Katsina state?
5. To what extent does students' performance in organic chemistry differ between those taught using formal cooperative learning and those taught using individualized learning in secondary schools in Katsina state?
6. Does gender influence students' interest and performance in organic chemistry when taught using formal cooperative learning and individualized learning strategies in secondary schools in Katsina state?

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

H_{01}: Formal cooperative learning has no significant effect on students' interest in organic chemistry in secondary schools in Katsina state.

H_{02}: Individualized learning has no significant effect on students' interest in organic chemistry in secondary schools in Katsina state.

H_{03}: Formal cooperative learning has no significant effect on students' performance in organic chemistry in secondary schools in Katsina state.

H_{04}: Individualized learning has no significant effect on students' performance in organic chemistry in secondary schools in Katsina state.

H_{05}: There is no significant difference in the performance of students taught using formal cooperative learning and those taught using individualized learning in organic chemistry in secondary schools in Katsina state.

H_{06}: Gender does not significantly influence students' interest and performance in organic chemistry when taught using formal cooperative learning and individualized learning strategies in secondary schools in Katsina state.

Methodology

The study adopted a quasi-experimental pretest–posttest non-equivalent control group design. This design was considered appropriate because intact classes were used and random assignment of students to groups was not feasible. The independent variables were formal cooperative learning strategy and individualized learning strategy, while the dependent variables were students' academic performance and interest in chemistry. Gender was treated as a moderating variable. The population covered four thousand, three hundred and seventy five (4,375), male and female SS II, Biology students during the 2024/2025 academic session in ZEQA Daura, Katsina state, Nigeria. A total of 220 SS II students were selected using a multistage sampling technique. Four public secondary schools in Daura ZEQA were purposively chosen based on qualified chemistry teachers and functional laboratories. Intact classes from these schools were then randomly assigned to either the formal cooperative learning or individualized learning groups, ensuring representation of both genders. This approach maintained class integrity in the quasi-experimental design while providing a representative sample to reliably assess the effects of the instructional strategies on students' interest and academic performance in Chemistry. Data were collected using validated instruments: the Organic Chemistry Students Interest Questionnaire (OCSIQ, $\alpha = 0.71$) and Organic Chemistry Students Performance Test (OCSPT, $\alpha = 0.84$). Reliability was determined using Pearson's Product Moment Correlation and Spearman Rank Order, accordingly. Mean and standard devis son were used to answer research questions, while independent-sample t-tests and ANOVA tested hypotheses at $p < 0.05$.

Results

Research Question One: What is the effect of formal cooperative learning on students' interest in organic chemistry in secondary schools in Katsina state?

Table 1: Differences in the mean interest score of experimental group i and control group.

Groups	N	Mean	Std. Dev.	Mean difference
Experimental Group I	70	98.81	9.65	
				32.69
Control Group	75	66.12	6.68	

Table 1 above shows the mean interest scores of the experimental group 1 and control group. It could be seen that the mean interest scores of experimental group 1 (M =98.81, SD = 9.65) differ from that of control group (M = 66.12, SD = 6.68) by 32.69. This indicates that students in experimental group I developed more interest than their counterparts in the control group.

Research Question Two: What is the effect of individualized learning on students' interest in organic chemistry in secondary schools in Katsina state?

Table 2: Differences in the mean interest score of experimental group 2 and control group.

Groups	N	Mean	Std. Dev.	Mean difference
Experimental Group 2	75	86.41	10.64	
Control Group	75	66.12	6.68	20.29

Table 2 above shows the mean interest scores of the experimental group II and control group. It could be seen that the mean interest scores of experimental group II (M =86.41, SD =10.64) differ from that of control group (M = 66.12, SD = 6.68) by 32.69. This indicates that students in experimental group II developed more interest than their counterparts in the control group.

Research Question Three: What is the effect of formal cooperative learning on students' performance in organic chemistry in secondary schools in Katsina state?

Table 3: Differences in the mean performance score of experimental group 1 and control group.

Groups	N	Mean	Std. Dev.	Mean difference
Experimental Group I	70	26.13	1.21	
Control Group	75	20.53	1.86	5.60

Table 3 above shows the mean performance scores of experimental group I and control group. It could be seen that the mean performance scores of experimental group 1 (M =26.13, SD = 1.21) differ from that of control group (M = 20.53, SD = 1.86) by 5.60. This indicates that students in experimental group I performed better than their counterparts in the control group.

Research Question Four: What is the effect of individualized learning on students' performance in organic chemistry in secondary schools in Katsina state?

Table 4: Differences in the mean performance score of experimental group ii and control group.

Groups	N	Mean	Std. Dev.	Mean difference
Experimental Group II	75	22.69	1.65	
Control Group	75	20.53	1.86	2.16

Table 4 above shows the mean performance scores of experimental group II and control group. It could be seen that the mean performance scores of experimental group 1I (M =22.69, SD = 1.65) differ from that of control group (M = 20.53, SD = 1.86) by 2.16. This indicates that students in experimental group II performed better than their counterparts in the control group.

Research Question Five: To what extent does students' performance in organic chemistry differ between those taught using formal cooperative learning and those taught using individualized learning in secondary schools in Katsina state?

Table 5: Differences in the mean performance score of experimental group i and experimental group II.

Groups	N	Mean	Std. Dev.	Mean difference
Experimental Group I	70	26.13	1.21	
				3.43
Experimental group II	75	22.69	1.65	

Table 5 above shows the mean performance scores of experimental group I and II. It could be seen that the mean performance scores of experimental group 1 (M =26.13, SD = 1.21) differ from that of experimental group II (M = 22.69, SD = 1.65) by 3.43. This indicates that students in experimental group I performed better than their counterparts in experimental group II.

Research Question Six: Does gender influence students' interest and performance in organic chemistry when taught using formal cooperative learning and individualized learning strategies in secondary schools in Katsina state?

Table 6: Differences in the mean performance score of male and female students in experimental group I & II.

Groups	N	Mean	Std. Dev.	Mean difference
Male EG I	37	25.89	1.26	0.00
Female EG I	33	26.39	1.12	0.50
Male EG II	42	22.76	1.85	3.13 & 3.63
Female EG II	33	22.60	1.38	3.26, 3.79 & 0.16

Table 6 above shows the mean performance scores of male and female students in the experimental groups. The table indicated that the mean performance scores of male students in experimental group I (M = 25.89, SD = 1.26) differ from that of the female students in the same group (M = 26.39, SD = 1.12) by 0.50. However, male students in experimental group II (M = 22.76, SD = 1.85) differ from that of the female students in the same group (M = 22.60, SD = 1.38) by 0.16.

Hypotheses

H_{O1}: Formal cooperative learning has no significant effect on students' interest in organic chemistry in secondary schools in Katsina state.

Table 7: t-test Analysis of Interest Score between Experimental group I and Control Group

Groups	N	Mean	Std. Dev.	Df	t value	P value	Remark
Experimental Group I	70	98.81	9.65	143	-23.85	0.00	Significant
Control Group	75	66.12	6.68				

Table 7 shows that there was significant difference between the mean interest score of students in experimental group I and control group (t= -23.85, df = 143 and P-value = 0.00), Since the (P-value < alpha value the hypothesis is therefore rejected. Consequently, there is significance difference in the mean interest score of chemistry students taught using cooperative learning and those taught using lecture method in senior secondary school.

H_{O2}: Individualized learning has no significant effect on students' interest in organic chemistry in secondary schools in Katsina state.

Table 8: t-test analysis of interest score between experimental group II and control group

Groups	N	Mean	Std. Dev.	Df	t value	P value	Remark
Experimental Group II	75	86.41	10.64	148	-13.99	0.00	Significant
Control Group	75	66.12	6.68				

Table 8, shows that there was significant difference between the mean interest score of students in experimental group II and control group (t= -13.99, df = 148 and P-value = 0.00), Since the (P-value < alpha value the hypothesis is therefore rejected. Consequently, there is significance difference in the mean interest score of chemistry students taught using individualized learning and those taught using lecture method in senior secondary school.

H_{O3}: Formal cooperative learning has no significant effect on students' performance in organic chemistry in secondary schools in Katsina state.

Table 9: t-test analysis of mean academic performance score between experimental group i and control group

Groups	N	Mean	Std. Dev.	Df	t value	P value	Remark
Experimental Group I	70	26.13	1.21	143	-21.23	0.00	Significant
Control Group	75	20.53	1.86				

Table 9 shows that there was significant difference between the mean performance score of students in experimental group I and control group (t= -21.23, df = 143 and P-value = 0.00), Since the P-value < alpha value the hypothesis is therefore rejected. Consequently, there is significance difference in the mean academic performance score of chemistry students taught using cooperative learning and those taught using lecture method in senior secondary school.

H_{O4}: Individualized learning has no significant effect on students' performance in organic chemistry in secondary schools in Katsina state.

Table 10: t-test analysis of mean academic performance score between experimental group ii and control group

Groups	N	Mean	Std. Dev.	Df	t value	P value	Remark
Experimental Group II	75	22.69	1.65	148	-7.53	0.00	Significant
Control Group	75	20.53	1.86				

Table 10, shows that there was significant difference between the mean performance score of students in experimental group II and control group (t= -7.53, df = 148 and P-value = 0.00), Since the P-value < alpha value the hypothesis is therefore rejected. Consequently, there is significance difference in the mean Academic Performance score of chemistry students taught using individualized learning and those taught with lecture method in senior secondary school.

H_{O5}: There is no significant difference in the performance of students taught using formal cooperative learning and those taught using individualized learning in organic chemistry in secondary schools in Katsina state.

Table 11: t-test analysis of mean academic performance score between experimental group I and experimental group II

Groups	N	Mean	Std. Dev.	Df	t value	P value	Remark
Experimental Group I	70	26.13	1.21	143	14.18	0.00	Significant
Experimental group II	75	22.69	1.65				

Table 11, shows that there was significant difference between the mean performance score of students in experimental group I and experimental group II (t= 14.18, df = 143 and P-value = 0.00), Since the P-value < alpha value the hypothesis is therefore rejected. Consequently, there is significance difference in the mean academic performance score of chemistry students taught using formal cooperative learning and those taught with individualized learning strategies in senior secondary school.

Ho_6: Gender does not significantly influence students' interest and performance in organic chemistry when taught using formal cooperative learning and individualized learning strategies in secondary schools in Katsina state.

Table 12: Summary of ANOVA on significant difference in performance scores of students in experimental group I and experimental group II.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between groups	432.118	3	144.039			
Within groups	298.944	2.120	27.08	67.936	0.00	Significant
Total	731.062	144				

Table 12, shows that there was significant difference between the mean performances scores of students in experimental group I and experimental group II based on Gender (F = 67.936, df = 3, 141 and MS=144.039, 2.120), Since the (P-value = 0.00 < alpha value = 0.05). However, post-hoc test was carried out to identify the location of the difference.

Table 13: Scheffe Post-hoc comparisons of performance of students by groups.

(I) grouping	(J) grouping	Mean Difference (I-J)	Std. Error	P-Value	Remark
Male EG I.	Female EG I	-0.50	0.35	0.559	Not significant
	Male EG II	3.13	0.33	0.00	Significant
	Female EG II	3.28	0.35	0.00	Significant
Female EG I	Male EG I	0.50	0.35	0.559	Not Significant
	Male EG II	3.63	0.34	0.00	Significant
	Female EG II	3.79	0.36	0.00	Significant
Male EG II	Male EG I	-3.13	0.33	0.00	Significant
	Female EG I	-3.63	0.34	0.00	Significant
	Female EG II	0.16	0.34	0.976	Not Significant
Female EG II	Male EG I	-3.28	0.35	0.00	Significant
	Female EG I	-3.79	0.36	0.00	Significant
	Male EG II	-0.16	0.34	0.976	Not Significant

Table 13, shows that the difference does not exist between the mean performance scores of female students taught chemistry concept using formal cooperative learning as well as individualised learning (P-value = > alpha value in each case). However, the difference lies between the mean performance scores of male students in EG I and EG II as well as between female students in EG I and EG II (P-value = < alpha value in each case). Therefore, the null hypothesis which states that there is no significance difference in the mean Academic Performance score of male and female chemistry students taught using formal cooperative learning and their counterparts taught using individualized learning in senior secondary school is rejected.

Discussion of Findings

The study revealed that formal cooperative learning (FCLS) and individualized learning strategies (ILS) significantly improved secondary school students' interest and academic performance in organic chemistry compared to the conventional lecture method. Students exposed to FCLS demonstrated higher interest and performance, supporting previous findings that cooperative learning enhances engagement, retention, and achievement in science subjects (Agwu-Udu, 2017; Nwaokolo, Adejoh, James, Okwara, & Kalu, 2019; Temisan & Kuburat, 2016; Adeyemi & Elphinah, 2016). Individualized learning strategy also positively influenced students' interest and performance, consistent with Gull and Shehzad (2015) and Nwaokolo et al. (2019), although cooperative learning generally produced slightly higher outcomes. Comparative analysis indicated that students in cooperative learning groups outperformed those in individualized learning groups, echoing results by Nwachukwu (2014) and Temisan and Kuburat (2016). Furthermore, gender did not significantly moderate the effects of either instructional strategy, suggesting that both formal cooperative learning strategy and individualized learning strategy are gender-inclusive. Overall, the findings underscore the effectiveness of learner-centered approaches in enhancing both motivation and achievement in organic chemistry, with cooperative learning showing a marginal advantage over individualized methods.

Conclusion

This study established that formal cooperative learning strategy and individualized learning strategy significantly enhance secondary school students' academic performance and interest in Chemistry compared to the conventional lecture method. The findings underscore the effectiveness of student-centered teaching approaches in promoting engagement, understanding, and achievement in Chemistry among secondary school students in Katsina state, Nigeria.

Recommendations

1. Teachers should adopt formal cooperative learning strategy and individualized learning strategy in Chemistry instruction to improve students' interest and academic outcomes.
2. Education authorities should organize regular training programs to equip teachers with skills for implementing these strategies effectively.
3. Schools should provide adequate instructional materials and laboratory resources to support cooperative and individualized learning.
4. Curriculum planners should integrate active learning approaches into Chemistry curricula to foster interactive and student-centered learning.
5. Future research should examine the long-term effects of formal cooperative learning strategy and individualized learning strategy on students' retention and performance in other science subjects.

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