Prestige Journal of Counselling Psychology, Vol. 5, No. 2, September 2022 ISSN: 2651-5687 (Print)
A publication of the Association for the Promotion of Innovation in Education (APIE) ISSN: 2651-5709 (Online)

Effect of Cooperative Instructional Strategy on Students' Academic Achievement in Chemistry in Public Secondary Schools in Abak Local Government Area of Akwa Ibom State

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Abstract
The study adopted quasi-experimental research design to investigate the effect of cooperative instructional strategy on chemistry students' academic achievement in Abak Local Government Area. Three research questions and three hypotheses guided the study. The population of the study consisted of all the 4,812 senior secondary II chemistry students in the study area. The study sample comprised of 200 SS2 chemistry students in both urban and rural schools in the study area selected using simple random sampling technique. One researchers-developed instrument titled Chemical Bonding Achievement Test (CBAT) was designed and used to measure the students' pre-test and post-test achievement in the concept investigated. It has a reliability index of 0.76 established using test-retest method. The data generated from the study was analysed using mean, standard deviation and analysis of covariance (ANCOVA). Results showed that students taught chemistry using cooperative instructional strategy performed significantly better than those taught using expository instructional strategy; and that gender and school location had no statistically significant influence on students' academic achievement. Based on the results, it was recommended that teachers should strive to use blended instructional strategy in teaching chemistry as this will help to concretize learning and enhance the academic achievement of students.
Keywords: cooperative, instructional, strategy, academic, achievement

Introduction
Chemistry is a relevant and experimental science subject that demands proactive teaching method with effective students' involvement using hands-on, minds-on experiences to generate knowledge, develop scientific skills, attitude and social values that would equip them to solve problems and contribute to national development. The role of chemistry in raising the level of productive workforce and standard of living of any nation cannot be overemphasized. According to Daniel (2021), there is hardly any form of human endeavour going on in science without the application of chemistry.

Igboegwu (2011) stated that the functional role of chemistry to science, and technology is so multifaceted and multifarious that no area of science, technology and business enterprises escapes its application. Considering this critical role of chemistry, it is needful to lay a solid foundation in students to enhance their academic performance, proficiency and in solving mankind's numerous problems. However, it is a well-documented fact in science education literature that the teaching and learning of chemistry has been faced with challenges which prevent optimum achievement of the objectives of chemistry education in national development (Jegede, 2010; Chukwuka, 2014; Okorie & Ezeh, 2016; Gongden, 2016; Umanah, 2017).

In order to address the low academic achievement in chemistry at Senior Secondary Certificate Examination (SSCE) in Nigeria, there is a need for chemistry teachers to use appropriate teaching and learning approaches that are learner-centred rather than teacher-centred. The learner-centred teaching and learning approaches actively engage the learner in the learning process for effective mastering of the subject and the development of skills and positive attitude towards the subject (Agu & Samuel, 2018). It emphasizes students' active involvement and gives opportunities to communicate, interact, reason and develop self-confidence to solve academic problems.

Various innovative and interactive teaching strategies have been advocated by chemistry educators as being effective in teaching chemistry. Cooperative teaching strategy has been identified to promote creative, collaborative, leadership and decision-marking skills in learners for better academic achievement and the achievement of instructional objectives (Leman et al., 2013; Gull & Shehzad, 2015; Kulkarni, 2015).

Cooperative teaching strategy can be defined as a teaching strategy in which small teams, each composed of four to six students with different levels of ability, use a variety of learning activities to improve their understanding of the subject (Ibe, 2016). Each member of a team is responsible not only for learning what is taught but also for helping team mates learn, thus creating a sense of achievement, an atmosphere of cooperation and interaction. Students work through the assigned tasks until all group members successfully understand and complete it.

Cooperative teaching strategy is a shift in the educational paradigm from teacher-centred approach to more student-centred learning in small groups and it creates excellent opportunities for students to engage in problem solving with their group members (Waigango et al., 2014). This strategy has an interactive nature of learning which enables the learners to take more active role in the learning process, take responsibility for their work, be highly effective and develop cognitive skills. Furthermore, in cooperative learning strategy, the students tutor one another and are likely to acquire mastery of the materials than in common individual learning (Ajaja & Eravwoke, 2010; Adigun, 2016). Rather than putting the students against one another in competition for attention and grades, chemistry educators can select an appropriate cooperative teaching strategy that

effectively complements conventional teaching methods and addresses their students' needs.

There are varieties and interesting cooperative teaching strategies from which a teacher can select for the teaching and learning of chemistry that will enable students to have active control over their own learning and enhance academic achievement. Such cooperative teaching strategies include Jigsaw, Think-Pair-Share, Round Robin, Numbered Head Together, Coop-Coop, Pantomime-A-Tale, Teams-Games Tournament and Students Teams Achievement Division to mention a few.

In Jigsaw cooperative teaching strategy, students are placed in teams, assigned portions of the material to learn, meet with students from other groups assigned the same portion and then returned to their groups to teach the material they have learned. Think-pair-share cooperative teaching strategy is three-step technique in which students think of an answer to a posed question or problem silently, shares their answer with a partner and then that pair shares with other pairs. In Round Robin Cooperative Teaching Strategy, students are divided into small groups of four to six students per group with one person appointed as the recorder. Each member of the group takes turn in presenting the material orally (Umanah, 2017).

Researchers report that cooperative teaching strategy fosters higher academic achievement in science and chemistry in particular (Nnorom, 2015; Agu & Samuel, 2018; Ihejiamaizu et al., 2020). However, it seems the use of cooperative teaching strategy in teaching chemistry in Nigerian secondary schools has not attracted much attention as chemistry classroom activities are still dominated by teacher-centred methods. Hence, there should be a paradigm shift from a teacher-centred learning environment to a student-centred learning environment through the use of cooperative teaching strategies. This had therefore made it necessary to investigate the effectiveness of cooperative teaching strategies (Jigsaw, Think-Pair-Share and Round Robin) on senior secondary school chemistry students' achievement on the concept of chemical bonding in Abak Local Government Area of Akwa Ibom State. The findings of this study would be beneficial to science teachers, Curriculum planners, Ministry of Education and Education Researchers.

This study is anchored on Vygotsky theory of cognitive development (1978). Vygotsky theory of cognitive development is based on a child's ability to learn socially relevant tools and culturally based signs. According to Vygotsky (1978), children learn through interaction with others. He believed that children initially experience knowledge and skills through interaction with other children and adults. Children internalized the knowledge and skills experienced during these interactions and eventually use the knowledge and skills to guide and direct their own behaviour.

Research questions

1. Is there any difference in academic achievement of SSII chemistry students taught using cooperative instructional strategy and those taught using expository instructional strategy?
2. What difference exists in the academic achievement of male and female students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy?
3. What difference exists in the academic achievement of urban and rural students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy?

Hypotheses

Ho1: There is no significant difference in the academic achievement of students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy.

Ho2: There is no significant difference in the academic achievement of male and female students taught chemistry using cooperative instructional strategy and expository instructional strategy.

Ho3: There is no significant difference in the academic achievement of urban and rural students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy.

Methodology

The study adopted the quasi-experimental design with pre-test, post-test non-randomized control group, where SS II chemistry students were exposed to multiple cooperative learning activities including Jigsaw, Think-Pair-Share and Round Robin in their intact classes. The pre-test provided a check on the non-random assignment of subjects to groups. Moreover, comparison on the basis of pre-test performance provided further process of equating the research group.

The population of the study consisted of all the 4,812 senior secondary II chemistry students in all the 10 public secondary schools in Abak Local Government Area of Akwa Ibom State in 2020/2021 school year. A sample size of 200 SS2 chemistry students was selected for the study (100 students from each of urban and rural schools in their intact classes of 50 students each). Simple random sampling technique through balloting was used in selecting two schools, one in urban and one in the rural setting. In each school, SSII chemistry students were grouped into experimental and control group of 50 students each.

All the 200 students were pre-tested with Chemical Bonding Achievement Test (CBAT). This instrument, with 25 items, was developed by the researchers for pre- and post-test. The items were developed on multiple choice options of A-D with only one correct option. Students were to choose the option that carried the correct answer; each correct option carries four marks. The instrument was face and content validated by three independent

assessors, two content experts in chemistry education and one Measurement and Evaluation expert, all in the Faculty of Education, University of Uyo. They moderated the items that led to the final instrument. Test-retest reliability strategy was adopted to generate data to establish validity. The data were coded and treated to Kuder Richardson Formula 21. The analysis yielded a reliability coefficient of .75.

The students in experimental group were exposed to multiple cooperative learning activities which included Jigsaw, Think-Pair-Share, and Round Robin on chemical bonding as a unit of instruction. On the other hand, students in the control groups were taught using the expository instructional strategy. The treatment was done with the help of their class teachers that were trained by the researchers. At the end of the treatment which lasted for four weeks, Chemical Bonding Achievement Test (CBAT) was administered to the students in both groups. The data obtained were analyzed using mean and standard deviation in answering the research questions while analysis of covariance (ANCOVA) was used in testing the null hypotheses.

Presentation of results

Three research questions were raised for the study and the research questions are answered as shown below:

Research question 1: Is there any difference in academic achievement of SSII chemistry students taught using cooperative instructional strategy and those taught using expository instructional strategy?

Table 1: Mean and standard deviation of the difference in academic achievement of students taught using cooperative instructional strategy and those taught using expository instructional strategy

Instructional strategies	n	Pre-test $\bar{x}$	SD	Post-test $\bar{x}$	SD	Mean difference
Cooperative	100	16.20	8.52	74.24	10.04	58.04
Expository	100	10.50	2.62	38.21	12.40	27.71

The analysis shows a mean difference of 58.04 for the experimental group, over 27.71 of expository group. This means that the use of cooperative instructional strategy in chemistry enhances students' achievement than those taught using expository instructional strategy.

Ho1: There is no significant difference in the academic achievement of students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy.

Table 2: Result of ANCOVA analysis of the difference in academic achievement of students taught Chemistry using cooperative instructional strategy and those taught using expository instructional strategy

Source	Type III sum of square	Df	Mean square	F-cal	Sig.	Decision at p<.05
Corrected model	17679.905[a]	2	5893.302	52.891	.00	s
Intercept	14286.877	1	14286.877	128.222	.00	s
Pretest	7616.754	1	7616.754	68.359	.00	s
Instructional strategies	2921.835	1	1460.917	13.112	.00	s
Error	22507.358	187	111.423			
Total	587272.000	200				
Corrected Total	40187.262	189				

a. R squared = .440 (Adjusted R Squared = .432)

In table 2, the calculated F-ratio for the effect of instructional strategies at df 1,189 is 13.112, while its corresponding calculated level of significance is .00 alpha. This level of significance is less than .05 in which the decision is based, indicating that there was a significant difference in the academic achievement of students in the concepts taught using cooperative instructional strategy and expository instructional strategy. With this observation, null hypothesis one was rejected. This means that there is a significant difference among the mean scores of students on chemical bonding in chemistry based on the instructional strategies used.

Research question 2: What difference exists in the academic achievement of male and female students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy?

Table 3: Mean and standard deviation of the difference in academic achievement of male and female students taught Chemistry using cooperative instructional strategy and expository instructional strategy

Instructional strategies	Gender	N	Pre test		Post test		Mean difference
			$\bar{x}$	SD	$\bar{x}$	SD	
Cooperative	Male	52	14.20	7.82	72.80	9.80	58.60
	Female	48	12.80	6.48	69.21	10.20	56.41
Expository	Male	54	16.20	7.41	28.21	12.60	12.01
	Female	46	14.70	8.21	18.62	10.42	3.92

In table 3, the result shows that male students taught using cooperative instructional strategies had the best post-test pre-test mean difference (58.60) followed by the female students taught using cooperative instructional strategy (56.4), followed by the male students taught using expository instructional strategies (12.01) and the female students taught using the expository instructional strategy (3.92) in a decreasing order. This means that the use of cooperative instructional strategy enhanced the academic achievement of

male and female students, but the male students achieved better than their female counterparts.

Ho2: There is no significant difference in the academic achievement of male and female students taught chemistry using cooperative instructional strategy and expository instructional strategy.

Table 4: Result of ANCOVA analysis of the difference in the academic achievement of male and female students taught Chemistry using cooperative instructional strategy and expository instructional strategy

Source	**Type III sum of square**	**Df**	**Mean square**	**F-cal**	**Sig.**	**Decision at p<.05**
Corrected model	18578.681[a]	6	3096.447	28.51	.00	s
Intercept	14163.811	1	14163.811	130.43	.00	s
Pretest	7259.552	1	7259.552	66.85	.00	s
Instructional strategies	2891.504	1	1445.752	13.31	.00	s
Gender	19.337	1	.99.337	.18	.67	ns
Instructional strategies* Gender	801.782	2	400.891	3.69		
Error	21608.582	187	108.586			
Total	587272.000	200				
Corrected Total	40187.262	189				

a.R squared = .462 (Adjusted R squared = .446)

In table 4, the calculated F-ratio for the main effect of instructional strategies at 1,189 is 13.31, while its corresponding calculated level of significance is .000. This level of significance is less than .05 in which the decision is based, indicating that there was a significant difference between the academic achievement of students in the concept taught given the instructional methods used. However, the F-cal value for the main effect of gender given the instructional strategies at df 1,189 was .18 while its significant level is .67. This significant level is greater than .05 alpha in which the decision is based, indicating that the influence of gender on the students' achievement was not statistically significant. With this observation, null hypothesis two was upheld.

Research question 3: What difference exists in the academic achievement of urban and rural students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy?

Table 5: Mean and standard deviation of the difference in academic achievement of urban and rural students taught chemistry using cooperative teaching strategy and those taught using expository teaching strategy

Instructional strategies	School Location	N	Pre test $\bar{x}$	SD	Post test $\bar{x}$	SD	Mean difference
Cooperative	Urban	46	18.80	6.21	62.80	8.02	44.00
	Rural	54	16.72	9.81	50.21	10.24	33.49
Expository	Urban	48	16.82	12.31	21.42	12.84	5.04
	Rural	52	15.54	10.40	18.59	16.02	3.05

In table 5, the result shows that urban students taught using cooperative instructional strategy had best post-test pre-test mean difference (44.00) followed by rural students taught using cooperative instructional strategy (33.49), followed by urban students taught using expository instructional strategy (5.04) and rural students taught using expository instructional strategy (3.05) in decreasing order. This implies that cooperative instructional strategy improves the academic achievement of students in urban and rural schools and the impact is felt in urban than in rural schools.

Ho3: There is no significant difference in the academic achievement of urban and rural students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy.

Table 6: Result of ANCOVA of the difference in the academic performance of urban and rural students taught Chemistry using cooperative instructional strategy and those taught using expository instructional strategy

Source	Type III sum of square	Df	Mean square	F-cal	Sig.	Decision at p<.05
Corrected model	201061.682[a]	6	3510.280	36.52	.00	s
Intercept	16831.497	1	16831.497	175.13	.00	s
Pretest	2037.953	1	2037.953	21.20	.00	s
Treatment	3733.222	1	1867.611	19.43	.00	s
Location	320.449	1	320.449	3.33	.07	ns
Treatment* location	2972.067	2	1486.033	15.46	.00	s
Error	19125.580	196	96.108			
Total	587272.00	200				
Corrected Total	40187.262	199				

a.R squared = .524 (Adjusted R squared = .510)

In table 6, the F-cal value for the main effect of school location given the instructional strategies at df 1,199 was 3.33 while its significant level is .07. This significant level is greater than .05 alpha in which the decision is based, indicating that the influence of school location on the students' achievement was not statistically significant. With this observation, null hypothesis three was upheld.

Discussion of the findings

The result of data analysis revealed a significant difference in the academic achievement of students taught chemistry using cooperative instructional strategy and those taught using expository instructional strategy, which is in line with the findings of Leman et al. (2013); Kulkarni (2015); Gull and Shehzad (2015); Agu and Samuel (2018) and Ihejiamaza et al. (2020). The better enhancing effect of cooperative instructional strategy could be attributed to the consistent elaboration of learning concepts, sharing ideas and peer tutoring in small groups which made learning exciting, interactive and sustain the students' interest. These findings attest to the efficacy of Vygotsky theory of Cognitive Development which assumes that interaction among students around appropriate tasks increases their mastery of concepts.

On the influence of gender on students' academic achievement, the findings indicated that its influence was not statistically significant given instructional strategies used. This indicates that gender is not a strong determinant of students' academic achievement. The no significant influence of gender reported in this study agrees with Umanah (2017); Ihejiamaizu et al. (2020) and Daniel (2021); but contradicts Nnorom (2015) and Agu and Samuel (2018) who observed that male students performed significantly better than female students in science related tasks.

With respect to the influence of school location given the instructional strategies, the finding showed that its influence was not statistically significant. That is, school location is not a strong predictor of students' academic achievement. The no significant influence of school location reported in this study is in agreement with the findings of Umanah (2017) and Daniel (2021). Conversely, the findings disagrees with Chukwuka (2014) and Okorie and Ezeh (2016) who observed that students in rural schools achieved significantly better than their urban counterparts.

Conclusion

Based on the findings of the study, it was concluded that cooperative instructional strategies as an innovative instructional strategy could enhance students' achievement in chemistry irrespective of gender and school location. It generates continuous elaboration of learning concepts, sharing of ideas and peer tutoring. This can help to generate interest and cause students to take active part in their own learning thereby enhancing their academic performance.

Recommendation

Based on the findings, it was recommended that teachers should strive to use cooperative instructional strategy in teaching chemistry as this will help to concretize learning and enhance the academic performance of students.

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