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Effects of Roundrobin and Jigsaw Cooperative Learning Strategies on Chemistry Students' Academic Achievement on Hydrocarbons in Senior Secondary Schools, Uyo, Akwa Ibom State - Nigeria

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Abstract

This study investigates the effects of Roundrobin and Jigsaw cooperative learning strategies on senior secondary school chemistry students' achievement on hydrocarbons considering the students' cognitive styles. Three research questions and three hypotheses guided the study. A quasi-experimental, non-randomized pre-test, post-test design was used for the study. The population of the study consisted of all the 1100 SS2 Chemistry students in all 14 public secondary schools in Uyo Local Government Area of Akwa Ibom State. The study sample comprised 108 SS2 Chemistry students from two secondary schools. Multi-stage sampling technique was used for sampling. First, criterion sampling technique was used in selecting two secondary schools that the chemistry students were not taught the concept of hydrocarbon and then simple random sampling technique was used for selecting the intact classes from the arms of SS2 in the selected schools. Two instruments: Achievement Test on Hydrocarbons (ATH), designed to measure the students' pre-test and post-test achievements in the concept investigated with a reliability index of .86 obtained using Pearson Product Moment Correlation; and adopted Sigels' Cognitive Styles Test (SCST) were used in gathering data for the study. The data obtained were analysed using mean, standard deviation and Analysis of Covariance (ANCOVA). The results showed that students taught using Jigsaw cooperative learning strategy performed significantly better than those taught using Roundrobin learning strategy. Again, neither the students' cognitive styles nor treatment by cognitive styles had statistically significant influence on the students' achievement. Consequently, it was recommended among others that curriculum planners should incorporate Jigsaw cooperative learning strategy for the teaching and learning of hydrocarbons and other chemistry concepts.

Keywords: Roundrobin, Jigsaw, hydrocarbon, cognitive styles, students' academic achievement

Introduction

Chemistry, as a branch of science and prerequisite subject for many fields of learning has been and will continue to be of tremendous importance to mankind. The application of its principles has helped in modern inventions and technological development. The functional role of chemistry as one of the science subjects in both national and global development cannot be overemphasized (Umanah & Udo, 2015). The study of chemistry helps in the acquisition of knowledge, skills and attitudes which enrich people's lives and allows them to be scientifically capable members of the society. Any nation therefore, that does not give attention to chemistry education at all levels, cannot be expected to make any reasonable progress in economic, social, political, scientific and technological development. A sound knowledge of chemistry is therefore, of great importance to many pupils, community and the society at large. Considering this critical role of chemistry, it is needful to lay a solid foundation in students to enhance their academic achievement, proficiency and in solving mankind's numerous problems (Giginna & Nweze, 2014). Furthermore, Nigeria and the world over are talking about sustainable development, for which Chemistry cannot be set aside, nor separated from the plans to achieve sustainable development. In order for the people to participate meaningfully, there is need to equip them with necessary lifelong or process skills such as communication, collaboration or team skills, tolerance, decision-making skills, information searching and utilization skills, thinking skills and leadership skills (Nwafor, 2012).

Chemistry is an experimental science subject that demands proactive teaching method with effective students' involvement using hands-on, minds-on and heads-on experiences to generate knowledge, develop scientific skills, adopt positive attitude and desired social values that would equip them to solve problems and contribute to national development (Udofia, 2016). Unfortunately, the teaching and learning of chemistry has been fraught with challenges which prevent many students from performing well in external examinations such as West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO).

According to West African Senior School Certificate Examination (WASSCE) Chief Examiner's Report (2019-2021) low academic achievement in chemistry has been attributed to factors such as students' poor communication skills, poor study habits, abstract nature of chemistry, poorly equipped laboratory, inability of students to perform enough chemistry practical before their examination and lack of experienced chemistry teachers. In the opinion of Umanah (2017); Bamiro (2015) and Igboanugo and Njoku (2015) a key determinant of students' achievement in chemistry is the quality of instructional strategies employed by chemistry teachers. Achimugu (2013) asserted that for learning to be meaningful and effective in chemistry classrooms, the teacher should be able to select appropriate teaching strategy that would stimulate the interest of the learners and get them actively engaged in the learning process. The teaching approach that a teacher adopts is one factor that may affect students' achievement and therefore use of appropriate teaching approach is critical to the successful teaching and learning of chemistry. Teaching methods are the tools of the teacher in reaching the set goals and consequently better students' academic achievement. If the tools are faulty or inappropriate, instructional goals cannot be achieved and students' academic achievement will be poor.

According to National Policy on Education (NPE, 2013), the Federal Government of Nigeria formulated goals that reflected among others; the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies to empower the individual to live in and contribute positively to the development of the society. In consequence, the quality of instruction at all levels has to be oriented toward inculcating social values. In addition, the need to use activity-oriented and learner-centred methods of teaching is emphasized in the National Policy on Education (NPE, 2013). It states that educational activities shall be learner-centred for maximum self-development and self-fulfilment and the education system shall be structured to develop the practice of self learning. This calls for the use of innovative and interactive learning strategies in which the learners play the most active part in the learning process and also interact with each other to construct their own knowledge.

Despite the prime position chemistry occupies in Nigeria educational system and efforts made by chemistry educators to improve students' academic achievement, it is observed that students academic achievement in chemistry has consistently been below expectation and unimpressive (WAEC Chief Examiners Reports, 2019 - 2021). Furthermore, it is disheartening to note that the inculcation of social values in the course of instruction has not been effectively achieved probably because of the teaching approach adopted by chemistry teachers. It has therefore become necessary to seek for innovative instructional strategies that could enhance better academic achievement of students in chemistry as well as inculcation of the desired social values in the course of instruction to enable them cope with any intellectual or cultural challenges which the rapidly changing environment may demand in future.

Various innovative and interactive teaching strategies have been advocated by chemistry educators as being effective in teaching chemistry as well as improve students' academic achievement. One of the innovative and interactive instructional strategies that promote imaginative, critical, creative, communication, collaborative, leadership and decision-making skills in the learners for better academic achievement is cooperative learning strategy (Umanah, 2017).

Cooperative learning strategy is defined as a learning strategy in which small teams, each composed of 4 to 6 students with different levels of ability, use a variety of learning activities to improve their understanding of a subject matter. In addition to learning what is taught, each member of a team is responsible not only for learning what is taught but also for helping teammates learn, thereby creating an atmosphere of cooperation, interaction and achievement (Abuhamda, 2020). In cooperative learning strategy, the teacher is the facilitator of learning and students have more opportunities to actively participate in their learning, question and challenge each other, share and discuss their ideas, and internalize their learning. As the students tutor one another, they are likely to acquire mastery of the material than in the common individual learning (Waiganjo, Wambugu, Ngesa & Cheplogoi, 2014). According to Johnson and Johnson (2009) in Umanah

(2017), the way students perceive one another and interact with one another is a neglected aspect of instruction.

Cooperative learning strategy promotes students' academic performance, increase students' retention, higher-level thinking skills, oral communication skills, social skills, critical thinking skills, problem solving skills, students' self- esteem, self-confidence and positive race relations than the conventional lecture method (Kulkarni, 2015; Sani, 2015; Sengul & Katranci, 2014; Christian & Pepple, 2012). There are five key elements that make cooperative learning strategy more beneficial than other methods of learning. These are**:** positive interdependence, face-to-face promotive interaction, individual and group accountability, interpersonal and small group social skills and group processing**.** There are varieties and interesting cooperative learning strategies but this study investigates the effectiveness of Roundrobin and Jigsaw cooperative learning strategies on senior secondary school chemistry students' academic achievement on the concept of hydrocarbon in chemistry considering their cognitive styles.

Roundrobin Cooperative Learning Strategy

Roundrobin cooperative learning strategy is a learning strategy in which the class is divided into small groups (4 to 6 members) with one person appointed as the recorder (Kulkarni, 2015; Adigun, 2016). It is an oral technique in which the teacher announces the topic to be shared with the team. A question is posed with multiple answers and students are given time to think about the answers. After the 'think time', members of the team share responses with one another using Roundrobin cooperative learning strategy. The recorder writes down the answers of the group members. The person sitting to the right of the recorder starts and each person in the group in order gives an answer until time is out. The students discuss and agree on the best answer for their group. When everyone has finished, the teacher calls on the students of each team to give their answer to the question. Finally, the teacher gives feedback and necessary corrections to the teams (Adigun, 2016; Kulkarni, 2015). According to Adigun (2016), Roundrobin cooperative learning strategy is beneficial to the students in that it helps facilitate communication among peers in learning from each other how to teach.

Jigsaw Cooperative Learning Strategy

Jigsaw cooperative learning strategy is a learning strategy in which students in a class are grouped into the 'home groups` and the `expert groups`, each group made up of 4-6 members. The lesson contents or task is broken into sections to be worked upon by various groups. Each student from every `home group` is assigned a portion of the material. Then the `home groups` members will disengage from the group and join other teams to form `expert groups`; while in the `expert groups` the students study intensively their particular material to ensure that they understand it well and prepare it for peer tutoring. Later, each student returns to his/her respective home group, he or she teaches his assigned material to the rest of his or her group and learns the other sub-topics from his/her peers in the group. After the completion of the assigned learning task the whole class is tested, each student working independently (Amedu, Otuka & Uzoechi, 2015; Mari & Gumel, 2015).

Cognitive Style

A typical classroom consists of students with different learning abilities and dimensions of individual differences in the cognitive processing styles that they adopt in making meanings, problem-solving and decision-making when exposed to learning activities. Individual factors differentiate individuals from one another. It is therefore critical to consider what individual student brings to the learning situation. Research findings have indicated several consistent major dimensions of individual differences. Of these dimensions, cognitive style is a major one (Ashiru & Sadiq, 2016; Musya, 2015).

Cognitive style is a psychological construct which describes an individual mode of information perception, organization and representation. Asikhia (2019) and Atsuwe and Mtoh (2019) refer to cognitive styles as relatively stable ways in which a learner approaches a learning task, acquire and process information, as well as including the consistent ways in which an individual memorizes and retrieves information. According to Asuzu (1984) in Bassey, Umoren and Udida (2012), three cognitive styles have been well established through findings in relation to science learning and teaching. These are: Analytic, relational and inferential cognitive styles.

Analytical Cognitive Style

This style is also called field independent or descriptive cognitive style. According to Koh and Milne (2012), individuals in analytic mode associate stimuli on the basis of their overt physical attributes like part of whole. Onwu and Asuzu (1989) cited in Umanah (2017) look at analytic style as the tendency to associate objects or events on the basis of common characteristics, which are directly discernible (e.g. chair and a table are similar because both have four legs).

Relational Cognitive Style

An individual with relational style of perceiving is less analytic, field dependent, associating objects or events on the basis of features establishing a relational link between them (Evans, Richardson & Waring, 2013). For example, a man lives in a house, husband and wife live together, the box of matches is used to light the pipe, or knife and bread are similar because the knife cuts the bread.

Inferential Cognitive Style

Individuals with inferential tendency are imaginative in approach, associating events or objects on the basis of inferred features. According to Za'rour and Panaouri Kilariotis (1997) in

Umanah (2017) individuals with inferential cognitive style conceptualize by combining stimuli on the basis of what they infer rather than obvious similarities (e.g. a wrist watch and ruler are measuring instruments).

Idika (2017) and Bassey, Umoren and Udida (2012) conducted a study on the influence of cognitive styles on academic performance of students in chemistry and found that there was a significant difference in academic performance due to their cognitive styles. Students with analytic cognitive styles performed significantly higher than students with relational and inferential cognitive styles. It is therefore crucial for chemistry teachers to understand and identify students' cognitive styles so as to plan activities and use appropriate teaching strategies that can maximize the learners' abilities in learning for higher academic achievement.

Hydrocarbon is a major section in the Senior Secondary School chemistry curriculum that has been identified as an area of chemistry where both teachers and students experience difficulties in learning (Obunwo, Dike & Amadi, 2014). Students perceive the concept of hydrocarbons in organic chemistry as abstract and difficult probably because of the teaching methods adopted by chemistry teachers in teaching the concept of hydrocarbon. Some have difficulties because most chemistry teachers rarely involve students actively in their lessons. Yet the knowledge of hydrocarbons is essential for modern industrial economy and in our daily lives. Hydrocarbons are organic compounds containing carbon and hydrogen as the only elements. They occur naturally in natural gas, coal and crude oil. Hydrocarbons are the most widely used organic compounds known and are quite literally the driving force for civilization. They are used for natural gas, petrol, diesel, generating electricity, ripening of fruits, manufacturing of plastics, alcohols, clothes among other things (Renneboog, 2017). Several professionals such as chemical engineers, food technologists, veterinarians, pharmacologists and chemists also apply an understanding of hydrocarbon. However, the May/June (2019) WASSCE Chief Examiner's Report states that candidates could not answer questions on the concept of hydrocarbons in organic chemistry because they lack adequate knowledge of the concept. Consequent upon the observed poor performance of senior secondary school chemistry students, it behoves on chemistry teachers to adopt innovative teaching approaches that enhance active participation of students and better performance in the subject.

Statement of the Problem

Students' academic achievement in chemistry in external examinations conducted by West African Examination Council (WAEC) and National Examination Council (NECO) has consistently been poor and unimpressive. Specifically, the May/June 2019 WAEC Chief Examiner's Report states that candidates could not answer questions on the concept of hydrocarbon in organic chemistry because they lack knowledge and understanding of the concept. Yet hydrocarbon is essential for the modern industrial economy and in our daily lives. This situation does not favour Nigeria's move towards scientific and technological development as this will remain a dream if the present poor state of students' achievement in chemistry is not addressed. Among the factors identified as contributing to this poor performance of students in chemistry in particular and science in general are ineffective and uninteresting teaching methods adopted by chemistry teachers in the field and students' variables such as cognitive styles. Due to this, chemistry educators, continue to research for effective and innovative strategies that favour high academic achievement in the subject. One of such innovative teaching strategies that can be used by chemistry educators in reducing poor academic achievement in chemistry is cooperative learning strategy. The question then is which of the cooperative learning strategies will prove more effective in facilitating students' academic achievement on the concept of hydrocarbon in chemistry considering their cognitive styles? This study therefore attempts to investigate the effectiveness of Roundrobin and Jigsaw cooperative learning strategies on senior secondary school chemistry students' academic achievement on the concept of hydrocarbon in chemistry considering their cognitive styles.

Research Questions

Specifically, the study sought plausible answers to the following questions:

1. What is the achievement mean scores of students when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies?
2. What is the achievement mean scores of students with Analytic, Relational, and Inferential cognitive styles when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies?
3. What is the interaction effect of treatment by cognitive styles on students' achievement on hydrocarbon in chemistry?

Research Hypotheses

The following research hypotheses were formulated to guide the study:

1. There is no significant difference between the achievement mean scores of students when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies.
2. There is no significant difference in achievement mean scores of students of different cognitive styles when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies.
3. There is no significant interaction effect of treatment by cognitive styles on students' achievement on hydrocarbon in chemistry.

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Methodology

A quasi-experimental, non-randomized pre-test, post-test non-equivalent comparative group design was used for the study. All 1100 SS2 chemistry students in 14 public secondary schools in the 2021/2022 academic session in Uyo Local Government Area of Akwa Ibom State made up the population. A sample size of 108 SS2 chemistry students from two selected schools was used for the study. Multi-stage sampling technique was used. First, a criterion sampling technique was used for selecting the schools that the students were not taught the concept of hydrocarbon at the time of the study, and then simple random sampling technique was used for selecting the intact classes from among the arms of SS2 in the selected schools. Pre-test was administered to students to serve as covariate to control for the initial differences among the subjects. Two instruments were used in gathering data for the study. Achievement Test on Hydrocarbon (ATH) with 50-item 4-option multiple choice designed to measure the students' pre-test and post-test achievement in the concept of hydrocarbon; and the Sigels' Cognitive Styles Test (SCST), an adopted 20-item 3-option test designed to measure the students' cognitive styles. Two lecturers in Science Education Department validated the instrument. The reliability index of the Achievement Test on Hydrocarbon (ATH) was determined using Pearson Product Moment Correlation that yielded .86. In scoring the ATH, each correct answer was scored 1mark while incorrect answer was scored zero. The total mark earned was 50 marks while the minimum mark was zero. For Sigels' Cognitive Styles Test (SCST), each set contains pictures of three items and students were to select two items that go together or are similar in any way and write down reason for grouping them together. Each correct answer was scored 2 marks while wrong answer was scored zero. Prepared instructional packages were used to teach students in the two experimental groups. The students in Experimental Group 1 were taught using the Roundrobin cooperative learning strategy; while those in Experimental Group 2 were taught using Jigsaw cooperative learning strategy. The duration for treatment was four weeks. At the end of the treatment, the reshuffled version of the ATH was administered to students in the two treatment groups as post-test and the test scripts from both the pre-test and post-test administrations were collected for marking and computation analysis. The data generated from pre-test and post-test were analysed using mean, standard deviation, and Analysis of Covariance (ANCOVA) statistics. Mean scores were used for answering the three research questions, while ANCOVA was used in testing the three hypotheses formulated at .05 level of significance.

Results

Research Question 1: What is the achievement mean scores of students when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies?

Table 1: Mean and standard deviation of students' pre-test and post-test scores classified by treatment groups

Treatment Groups	Sample Size	Pre-test		Post-test		Mean Gain Score
		$\bar{X}$	SD	$\bar{X}$	SD	
RoundRobin	45	30.89	6.33	47.02	11.29	16.13
Jigsaw	63	43.94	15.00	62.06	15.65	18.12

The post-test, pre-test mean gain scores of 16.13and 18.12 for the students in the Round robin and Jigsaw cooperative learning strategies, respectively, indicate that those taught using Jigsaw had a better mean gain score. ANCOVA was used to analyze whether the observed mean differences were statistically significant as shown in Table 2.

Hypothesis 1: There is no significant difference between the achievements mean scores of students when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies.

Table 2: Analysis of Covariance (ANCOVA) of students' post-test scores classified by treatment groups with pre-test as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Pretest	7646.18	1	7646.18	61.13	.000	S
Treatment	720.61	1	720.61	5.76	.018	S
Error	13134.54	105	125.09	-	-	-
Total	362948.00	108	-	-	-	-
Corrected Total	26719.52	107	-	-	-	-

a. R Squared = .508 (Adjusted R Squared = .499)

In Table 2, the calculated F-ratio for the effect of instructional strategies at df 1, 107 is 5.76, while its corresponding calculated level of significance is .018 alpha. This level of significance is less than .05 in which the decision is based; indicating that there is a significant difference in the academic achievement of students in the concepts taught using Roundrobin and Jigsaw cooperative learning strategies. With this observation, null hypothesis 1 was significant. The better mean gain score of the students in the Jigsaw group indicates that those in the Jigsaw group outperformed those in the Roundrobin group.

Research Question 2: What is the achievement mean scores of students with Analytic, Relational, and Inferential cognitive styles when taught hydrocarbon in chemistry using Roundrobin, and Jigsaw cooperative learning strategies?

Table 3: Mean and standard deviation of students' pre-test and post-test scores classified by treatment groups and cognitive styles

Treatment Groups	Cognitive Styles	Sample Size	Pre-test		Post-test		Mean Gain Score
			$\bar{X}$	SD	$\bar{X}$	SD	
Round Robin	Analytic	11	31.64	7.94	44.36	6.62	12.72
	Relational	21	30.76	6.71	47.52	12.95	16.76
	Inferential	13	30.46	4.33	48.46	11.92	18.00
Jigsaw	Analytic	9	42.44	14.21	58.44	18.05	16.00
	Relational	25	42.40	14.96	59.52	15.98	17.12
	Inferential	29	45.72	15.57	65.38	14.44	19.66

The mean gain scores in Table 3 show that the students with inferential cognitive style taught using Jigsaw cooperative learning strategy had the best mean gain followed by those with inferential style in the Roundrobin cooperative learning group. The ANCOVA results in Table 4 were used to determine whether the observed mean differences by cognitive styles were statistically significant.

Null Hypothesis 2: There is no significant difference in achievement mean scores of students of different cognitive styles when taught hydrocarbon in chemistry using Roundrobin and Jigsaw cooperative learning strategies.

Table 4: Analysis of Covariance (ANCOVA) of students' post-test scores classified by treatment and cognitive style groups with pre-test as covariate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision at p<.05 alpha
Pretest	7335.28	1	7335.28	58.17	.000	S
Treatment	591.98	1	591.98	4.69	.033	S
CogniStyles	303.53	2	151.77	1.20	.304	NS
Error	12737.03	101	126.11	-	-	-
Total	362948.00	108	-	-	-	-
Corrected Total	26719.52	107	-	-	-	-

a. R Squared = .523 (Adjusted R Squared = .495)

The results in Table 4 show a calculated F-ratio of 1.20 with a significant level of .304 at df 2, 107 on students' cognitive styles in their achievement on hydrocarbon in chemistry. This level of significance is less than .05 in which the decision is based; indicating that students' cognitive styles on their achievement was not statistically significant. Hence, null hypothesis 2 was upheld.

Null Hypothesis 3: There is no significant interaction effect of treatment by cognitive styles on students' achievement on hydrocarbon chemistry.

Table 5: Analysis of Covariance (ANCOVA) of students' post-test scores classified by treatment and cognitive style groups with pre-test as covariate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision at p<.05 alpha
Pretest	7335.28	1	7335.28	58.17	.000	S
Treatment	591.98	1	591.98	4.69	.033	S
CogniStyles	303.53	2	151.77	1.20	.304	NS
Treatment *CogniStyles	39.63	2	19.82	.16	.855	NS
Error	12737.03	101	126.11	-	-	-
Total	362948.00	108	-	-	-	-
Corrected Total	26719.52	107	-	-	-	-

a. R Squared = .523 (Adjusted R Squared = .495)

In Table 6, the calculated F-ratio for the interaction effects of treatment by cognitive styles on students' achievement on hydrocarbon in chemistry is .16, while their corresponding calculated level of significance is .855. This level of significance is greater than .05 in which the decision is based; indicating that there was no significant interaction effects of treatment by cognitive styles on the students' achievement on hydrocarbon in chemistry. With this observation, null hypothesis was upheld.

Discussion of Findings

The findings with regard to the effect of Roundrobin and Jigsaw cooperative learning strategies on students' achievement on hydrocarbon in chemistry in Tables 1 and 2 showed that there was a statistically significant difference in the academic achievement of students. Students taught using Jigsaw cooperative learning strategy did significantly better than those taught using Round-robin learning strategy. The better enhancing effect of Jigsaw on students' achievements could be attributed to the fact that individual student's effort must have been enhanced when students were divided into home groups and expert groups in which members of expert groups study intensively the new concept or content to ensure that they understand it well and prepare it for peer tutoring in their home groups. Jigsaw cooperative learning enables each student to become an expert on a certain topic then move and interact with other class members studying the same topic to gain deeper understanding of the concept studied. The finding agrees with Areelu and Ladele (2018); Gregory (2013) and Leman, Yildizay, Aylin and Burcin (2013) that consistent elaboration of the learning concepts, sharing ideas, and peer tutoring in small groups which made learning exciting, attractive thereby sustaining the students' interest in the learning process consequently enhances students' achievement.

As regard students' cognitive styles given the instructional strategies used; the findings indicated that the influence of cognitive styles on students' achievement when taught hydrocarbon in chemistry using Jigsaw and Round-robin cooperative learning strategies was not statistically significant despite the observed differences in the mean gain scores of students in favour of those with inferential cognitive style. This implies that the effects of treatment were the same at levels of cognitive styles and all the students improved in their achievement irrespective of their cognitive styles. The finding is in disagreement with that of Idika (2017) and Bassey, Umoren and Udida (2012) who reported that there is significant difference in students' cognitive styles and achievement in chemistry. The no significant influence of cognitive styles observed in this study could be attributed to the instructional strategies used which greatly enhanced students' self-confidence, attitude and interest in the concepts taught.

With respect to treatment - cognitive styles - academic achievement interactions, the findings showed that there were no statistically significant interaction effects among these variables. The implication of this finding is that the effects of the treatments were the same at all levels of cognitive styles and academic achievement of students in Chemistry. In other words, the treatment given had the same effects on students' academic achievement notwithstanding their cognitive styles and the instructional strategies used.

Conclusion

Based on the findings of the study, it is hereby concluded that of the two cooperative learning strategies investigated, Jigsaw is the most effective in facilitating students' academic achievement in the concept of hydrocarbon in chemistry; that cognitive styles are not significant predictors of students' achievement and the effects of the treatments were the same at all levels of cognitive styles and the influence of the students' cognitive styles were the same at all levels of the treatment used.

Recommendations

Based on the findings and the conclusions reached, the following recommendations were made:

1. Students should be trained and encouraged by teachers to use Jigsaw and Roundrobin cooperative learning strategies in learning chemistry.

Chemistry teachers should make effective use of Jigsaw cooperative learning strategy in teaching the concept of hydrocarbon in chemistry.

2. Curriculum planners should ensure the incorporation of Jigsaw cooperative strategy in the teaching and learning of hydrocarbon and other chemistry concepts.

3. School administrators in conjunction with other professional bodies like STAN should endeavour to organise and sponsor regular workshops to train science teachers on the use of Jigsaw and Roundrobin cooperative learning strategies.

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