

Effect of Co-operative and Individualized Teaching Methods on Senior Secondary School Students' Achievement in Organic Chemistry.

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ABSTRACT

This study investigated the main and interaction effects of co-operative and individualized teaching methods on senior secondary school students' achievement in organic chemistry using gender and self-concept as moderating variables. This study employed 3x2x2 randomized pre-test, post-test quasi-experimental factorial design. The experimental groups were exposed to co-operative and individualized teaching methods and control group was exposed to traditional teaching methods. One hundred fifty-six (156) students were selected for the study.

Results revealed that there is significant main effect of treatment on students' achievement in chemistry ($F_{2, 143} = 299.781, P < 0.05$). This shows that the treatment is effective in enhancing student achievement in organic chemistry. However, the interaction effect of treatment, gender and self-concept on students' achievement in organic chemistry is not significant ($F_{1, 143} = 0.095, p > 0.05$).

Both co-operative and individualized methods significantly improved students' achievement in organic chemistry. However, co-operative method is significantly better than individualized method. Also, the efficacy of the both teaching strategies has nothing to do with student gender and self-concept. The strategies will work for both male and female students alike, regardless of their self-concept level. Teachers of chemistry should expose the students to cooperative learning method to encourage social interaction, active engagement and self-motivation among learners.

(Keywords: cooperative teaching method, individualized teaching method, organic chemistry instruction, hydrocarbon, self-concept, gender)

INTRODUCTION

It is now being recognized that there are better ways to learn than through the traditional methods of instruction (Wood & Gentile, 2003). Universities and other institutions are beginning to show an increased awareness of the importance of the ways students learn. Many of the standard methods of conveying knowledge have been shown to be relatively ineffective on the students' ability to master and then retain important concepts. Learning through some methods of teaching is passive rather than active. The traditional methods (lecture, laboratory, recitation methods) do not tend to foster critical and creative thinking, and collaborative problem-solving.

Students' scores in science subjects are usually below expectation (Olatoye, 2008, Alebiosu, 1989). It has become necessary to seek strategies that will employ approaches that ensure and enhance better academic performance of the students in the science subjects. In education today, there are interesting cooperative learning methods that enable students to have an active control over their own learning and also enhance academic achievement (Olatoye, 2009, Alebiosu, 1989, Okebukola, 1985). Cooperative learning is a teaching strategy in which small teams, each with students of different levels of ability use a variety of learning activities to improve their understanding of a subject.

Each member of a team is expected not only to learn what is taught but also to help teammates learn, thus creating an atmosphere of achievement. Research reveals that students completing cooperative learning groups task tend to have higher academic test scores, higher self-esteem and greater comprehension of the content and skills they are studying (Johnson & Johnson 1989). In a cooperative learning classroom, students' work together to attain group goals that cannot be obtained by working alone. In this classroom structure, students discuss the subject matter, help one another learn, and provide encouragement for members of the group (Johnson, Johnson & Holubec, 1986).

According to Johnson and Johnson (1989) cooperative learning experiences promote more positive attitudes toward the instructional experience than competitive or individualistic methodologies. One of the major theoretical perspectives related to cooperative learning is the motivational theory. Motivational theory that relates to cooperative learning focuses on rewards and goals structures. One of the elements of cooperative learning is positive interdependence, where students perceive that their success or failure lies within their working together as a group (Johnson, Johnson & Holubec, 1986). From a motivational perspective, cooperative goal structure creates a situation in which the only way group members can attain their personal goals is if the group is successful (Slavin, 1990). Therefore, in order to attain their personal goals, students are likely to encourage members within the group to do whatever will help the group to succeed.

Several studies have examined the effect of cooperative learning methods on student academic achievement. For example, Ojo (1992) compared cooperative, competitive and individualistic strategies in science classes and found that students who were exposed to cooperative methods learned and retained significantly more information than students taught by the other two methods. Alebiosu (1989) found similar results in a study involving high school chemistry classes taught by cooperative and individualistic methods. Also, Yusuf (2005) reported significantly better achievement in students exposed to cooperative learning method in a study carried out among Junior Secondary School students.

Individualized instruction is a method of instruction in which content, instructional materials, instructional media, and pace of learning are based upon the abilities and interests of each individual learner. Individualized instruction is not the same as a one-to-one student-teacher ratio or one-to-one tutoring, as it may seem, because economically, it is difficult, if not impossible to have a teacher for each student. Therefore, throughout the history of education, the notion of lecturing has not been challenged as a time-effective method of teaching, though alternative pedagogical models have been proposed. For example Educational Research Associates (2001) has concluded that placing greater reliance upon well-designed instructional materials – whether audio, video, multimedia, Computer-Assisted Instruction (CAI), or simply a good textbook – can hardly be less efficient than the lecture method, but yield a huge net benefit by freeing teachers to focus upon the needs and problems of individual students.

In this way, individualized instruction is like direct instruction, which also places greater reliance upon carefully prepared instructional materials and explicitly prepared instructional sequences. But where direct instruction is very rigidly structured for use with children in primary school, individualized instruction is recommended only for students of at least junior high school age, and presumes that they have greater self-discipline to be able to study more independently. Thus, individualized instruction has points of contact with the constructivism movement in education, started by the Swiss biologist, Jean Piaget, which states that the student should build his or her learning and knowledge. Individualized Instruction, however, presumes that most students of secondary school age still lack the basic knowledge and skills to direct most of their own curriculum, which must be at least partially directed by schools and teachers.

Sanhez and Roda (2006) defined self-concept as the set of knowledge and attributes, that a person has about himself or herself; the perception an individual assigns to herself/himself, the characteristics or attributes that a person uses to describes himself or herself. In experimental studies, there is normally social interaction among the students themselves and between the students and their teacher. It is therefore important to consider a moderating variable like self-concept which may influence student interaction and possibly achievement in the class.

Self-concept is a strong predictor of student academic achievement (Olatoye, 2008; Lang, 2006). Also, self-concept can be developed or constructed by individuals through interaction within the environment and reflecting on that interaction (Huitt, 2004). Thus self-concept is a variable that can be enhanced in students through conscious efforts of the teacher and counselor. Including a moderating variable like this in the study will enable teachers and experts in the field know if the treatment is sensitive to self-concept or not and enhance precautionary measures they should take in adopting the teaching strategies. Olatoye (2008) asserted that any student characteristics that can change because of training and exposure to counseling can be very important in enhancing students' academic achievement.

Several studies have also examined the influence of gender on students' academic achievement. For example, Olatoye and Adekoya, (2009; 2010) found no gender difference in academic achievement of students exposed to different teaching strategies in science. Okebukola (1985) found no gender difference in academic achievement in cooperative and competitive learning groups. However, Oyediji (1991) reported the significant influence of gender on academic achievement with boys having better scores than girls in the study. However, this study is particularly interested in determining the effect of cooperative and individualized learning methods on students' academic achievement in chemistry using gender and self-concept as moderating variables.

The issue of teaching methods and their effect on secondary school science students' achievement has been a very important issue in the recent times. The importance of science and technology in the growth development of any nation cannot be overemphasized. It is apparent that science and technology cannot thrive without using appropriate instructional methods. Future development of any nation in the fields of science depends on how well the science subjects are taught. This study therefore investigated the main and interaction effects of co-operative and individualized teaching methods on senior secondary school students' achievement in organic chemistry using gender and self-concept as moderating variables.

HYPOTHESES

1. There is no significant main effect of treatment (co-operative, individualized and control/lecture) on students' achievement in organic chemistry.
2. There is no significant main effect of gender on students' achievement in organic chemistry.
3. There is no significant main effect of self-concept on students' achievement in organic chemistry.
4. There is no significant interaction effect of treatment and gender on students' achievement in organic chemistry.
5. There is no significant interaction effect of treatment and self-concept on students' achievement in organic chemistry.
6. There is no significant interaction effect of gender and self-concept on students' achievement in organic chemistry.
7. There is no significant interaction effect of treatment, gender and self-concept on students' achievement in organic chemistry.

METHODOLOGY

Research Design

This study employed 3x2x2 randomized pre-test, post-test quasi-experimental factorial design. The experimental groups were exposed to co-operative and individualized teaching methods and control group was exposed to traditional teaching methods.

The same multiple-choice objective test items were administered to the students in the three groups as pre- and post-tests. Before administering the pre-test, a self-concept questionnaire was administered and scored to identify students' of low and high self-concept that were present in each group. In other words, the students' were randomized into three groups based on gender and self-concept before administering the pre-test.

The pre-test was conducted before the treatment. Cooperative technique was used in the first group, individualized was employed in the second group while the traditional method of teaching was employed in the third group which also serves as control.

At the end of the treatment for six weeks, a post-test was conducted in all the groups. In other words, post-test was administered after the treatment under investigation had been administered.

Target Population

The target population for this study comprised all the public Senior Secondary School Students in Ogun State, who are offering chemistry.

Sample and Sampling Technique

In selecting schools to participate in this study, purposive sampling technique was used to select the chemistry students in the senior secondary schools of choice in Ogun State. The Researcher knowing fully well that these schools chosen are co-educational, randomly picked 26 boys and 26

girls from the population of SSS 2 chemistry students in each school for the experimental and control groups. For each school, a total of 52 students were selected. For the three schools (each school representing a group), a total of 156 students were selected for the study. It should be noted that the self-concept questionnaire had been administered and students had been classified into high and low self-concept groups before the judgmental selection based on gender was made. The respondents were randomized into groups as shown in table 2 based on their gender and self-concept. This randomization was done before pre-test was administered.

Instruments

In this study the test items used covered what the students had been taught in chemistry. The items were developed using a test blue-print indicating the topics and number of test items along three process categories of objective: remembering, understanding and thinking. The instruments used are:

- i. Chemistry Achievement Test (CAT)
- ii. Teaching Manual.
- iii. Self-concept Questionnaire (SCQ)

Table 1: Randomized Pre-Test-Post-Test Factorial Design

Group	Pretest	Treatment	Posttest
1 st Experimental Group	O _{1Co-op}	X _{Co-op}	O _{2 Co-op}
2 nd Experimental Group	O _{1 Ind}	X _{Ind}	O _{2 Ind}
Control Group	O ₁₁		O ₂₁

Where: O_{1 Co-op} represents the pre-test scores for co-operative group (1st experimental group)
 O_{2 Co-op} represents the post-test scores for co-operative group (1st experimental group)
 X_{Co-op} represents treatment for co-operative group (1st experimental group)
 O_{1 Ind} represents pre-test scores for individualized group method (2nd experimental group)
 O_{2 Ind} represents post-test scores for individualized group method (2nd experimental group)
 X_{Ind} represents treatment for individualized group method (2nd experimental group)
 O₁₁ represents pre-test scores for control group method
 O₂₁ represents post-test scores for control group method.

Table 2: Randomized Control-Group Pre-Test-Post-Test Design.

Groups	Male		Female		Total
	High Self-concept	Low Self-concept	High Self-concept	Low Self-concept	
Experimental Group 1 Co-operative Method	13	13	13	13	52
Experimental Group II Individualized Method	13	13	13	13	52
Control (Conventional Teaching)	13	13	13	13	52
Total	39	39	39	39	156

Chemistry Achievement Test (CAT)

This is student cognitive achievement in chemistry with test items developed by the researcher in accordance with the content of the teaching manual (lesson objectives) specified for the treatment. CAT which comprised of twenty-five (25) multiple-choice items with four alternatives (A,B,C,D) per item constructed from a test blue-print (Table 3).

Examples of items of CAT are:

1. Hydrocarbons are organic compounds that contain: (a) carbon and oxygen (b) carbon, hydrogen and oxygen (c) carbon and sulphur (d) hydrogen and carbon only.

2. Which method is often employed in the separation of the hydrocarbons found in petroleum? (a) catalytic cracking (b) polymerization (c) fractional distillation (d) hydrogenation.

3. Additives are substances which help to improve the quality of (a) isomer (b) gasoline (c) cracking (d) sulphur.

The pre-test was conducted, before giving any treatment to the experimental and control groups. The pre-test items were used thereafter to determine the level of achievement after treatment. At the end of subjecting each group to a particular treatment, the same items initially administered were re-administered to each group to observe the dependent variable for changes as a result of the manipulation using the treatment. The test at this time is known as post-test. The test items were initially presented to four chemistry professionals and one lecturer to check for adequacy, structuring and relevance of content and coverage.

Teaching Manual

Below are the details of breakdown of topics into weeks:

- Topic: Organic Chemistry
- Sub-Topic: Hydrocarbons
- Objectives: At the end of the lessons, students should be able to:

- a) Define organic chemistry, hydrocarbons, isomerism, cracking, nomenclature and so on.
- b) Differentiate hydrocarbons from other organic compounds like carbohydrates.
- c) State and explain the classes of hydrocarbons.
- d) State the differences between: (i) saturated and unsaturated compounds, (ii) aliphatic and aromatic compounds.
- e) Describe the preparation of Ethane.
- f) List the properties and uses of hydrocarbons.

Week 1: (i) Introduction and administration of pre-test to all the experimental groups and the control group.
(ii) Meaning of Organic Chemistry and hydrocarbons.

Week 2: Alkanes (single bond)
(i) Properties
(ii) Preparations
(iii) Uses

Week 3: Alkenes (double bonds)
(i) Properties
(ii) Preparations
(iii) Uses

Week 4: Alkynes (triple bonds)
(i) Properties
(ii) Preparations
(iii) Uses

Week 5: Nomenclature

Week 6: Revision and Administration of Post-Test

Self-Concept Questionnaire

The self-concept questionnaire contains sections A and B which was used to collect the bio-data and demographic characteristics of the respondents and a four-point Likert-type scale. Students were asked to indicate their opinion by ticking any of "Strongly Agree (SA)", "Agree (A)", "Disagree (D)", and "Strongly Disagree (SD)" in front of each item. The questionnaire consists of fourteen items, aimed at determining students' self-concept. Examples of items on self-concept questionnaire (SCQ) are:

- (i) I am confident to ask and answer questions in the class.
- (ii) I am usually happy when there are assignments to do.
- (iii) I can pass any examination without sweat.

Table 3: Table of Specification of CAT.

Cognitive level Content area	INSTRUCTIONAL	OBJECTIVES		
	Remembering 40%	Understanding 35%	Thinking 25%	Total
1 Meaning of Organic Chemistry & Hydro carbons	2	2	1	5
2 Alkanes (properties and preparation)	1	2	1	4
3 Alkenes (properties and preparation)	3	2	1	6
4 Alkynes (properties and preparation)	2	1	1	4
5 Nomenclature	2	2	2	6
Total	10	9	6	25

Validity

To ensure the validity of the CAT and SCQ before they were both used as pre-test and post-test. Chemistry Achievement Test (CAT) and Self-Concept Questionnaire (SCQ) were validated by giving it to four experienced secondary teachers for critique and suggestions which were used to modify the final version of the instruments.

Reliability

The reliability coefficients of the instruments were determined using test-retest reliability method. The instruments were first administered and then re-administered on the same respondents (20 students) after one week. The result of the first test and second test outcomes were compared to ascertain the reliability of the instruments. The schools and students used for establishing the reliability of the instruments did not take part in the major study. The reliability coefficients of CAT

and self-concept questionnaire are 0.711 and 0.743, respectively.

Method of Data Analysis

The data collected were analyzed using Analysis of Covariance (ANCOVA). All the hypotheses were tested at 0.05 level of confidence using a two-tailed test.

RESULTS

Interpretation of finding on Hypothesis One

HO₁ – There is no significant effect of treatment on student achievement in organic chemistry

In table 4 above, there is significant main effect of treatment on students' achievement in chemistry ($F_{2, 143} = 299.781, P < 0.05$).

Table 4: ANCOVA of Effect of Treatment and Moderating Variables (Gender and Self-Concept) on Students' Achievement in Organic Chemistry.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3329.113	12	277.426	79.022	.000
Intercept	866.489	1	866.489	246.812	.000
Pretest	232.082	1	232.082	66.106	.000
Treatment	2104.901	2	1052.450	299.781	.000*
Gender	9.727	1	9.727	2.771	.098
Self Concept	11.924	1	11.924	3.397	.067
Treatment x Gender	3.080	2	1.540	439	.646
Treatment x Self-Concept	910	2	455	130	.879
Gender x Self-Concept	4.338	1	4.338	1.236	.258
Treatment x Gender x Self-Concept	668	2	.334	.095	.909
Error	502.034	143	3.511		
Total	20675.000	156			
Corrected Total	3831.147	155			

*Significant ($p < 0.05$)

This shows that the treatment is effective in enhancing student achievement in organic chemistry. The treatment (cooperative, individualized and control) considered in this study has the potential to improve students' achievement.

Interpretation of Finding on Hypothesis Two

HO₂ – There is no significant effect of gender on student achievement in organic chemistry.

From the Table 4, the main effect of gender on students' achievement in organic chemistry is not significant ($F_{1, 143} = 2.771$, $P > 0.05$). Thus, efficacy of these teaching strategies in organic chemistry according to this finding has nothing to do with student gender.

Interpretation of Finding on Hypothesis Three

HO₃ – There is no significant effect of self-concept on student achievement in organic chemistry.

From the same Table 4, self-concept does not have significant effect on achievement in organic chemistry ($F_{1, 143} = 3.771$, $P > 0.05$). Thus, efficacy of these teaching strategies in organic chemistry according to this finding has nothing to do with student self-concept.

Interpretation of Finding on Hypothesis Four

HO₄ – There is no significant interaction effect of treatment and gender on student achievement in organic chemistry

Hence, two – way interaction effect of treatment and gender does not have significant effect on achievement in chemistry ($F_{2, 143} = .430$, $P > 0.05$). Since the main effect of treatment is significant but the interaction effect with gender is not significant, it then means that the treatment does not depend on gender to be effective. In other words, the treatment is not sensitive to gender and will be effective irrespective of student gender. This is an advantage in the use of cooperative and individualized methods. They will work for male and female students alike.

Interpretation of Finding on Hypothesis Five

HO₅ – There is no significant interaction effect of treatment and self-concept on student achievement in organic chemistry

Also, the two-way interaction effect of treatment and self-concept does not have significant on student achievement in chemistry ($F_{2, 143} = .130$, $P > 0.05$). This implies that the treatment will be effective irrespective of student self-concept (whether high or low). This is also an advantage in the use of cooperative and individualized methods. They will work for both students of low and high self-concept.

Interpretation of Finding on Hypothesis Six

HO₆ – There is no significant interaction effect of gender and self-concept on students' achievement in organic chemistry

Similarly, gender and self-concept have no significant interaction effect on students' achievement in organic chemistry ($F_{2, 143} = 1.236$, $P > 0.05$)

Interpretation of Finding on Hypothesis Seven

HO₇ – There is no significant interaction effect of treatment, gender and self-concept on students' achievement in organic chemistry.

The three – way interaction treatment, gender and self-concept has no significant effect on student achievement in organic chemistry ($F_{2, 143} = .095$, $P > 0.05$). Thus, the treatment will work irrespective of student gender and self-concept. This is because; the main effect of treatment on student achievement in organic chemistry is significant.

In summary, all the null hypotheses are being upheld except hypothesis one that states; there is no significant main effect of treatment on students' achievement in organic chemistry.

Table 5: Univariate Tests of the Mean Scores of the Three Groups.

	Sum of Squares	Df	Mean Square	F	Sig.
Contrast	2104.901	2	1052.450	299.781	.000*
Error	502.034	143	3.511		

*Significant ($p < 0.05$)

Table 6: Pair-Wise Comparison of the Three Groups.

(I) treatment	(J) treatment	Mean Difference (I - J)	Std. Error	Sig. ^a
Co-operative	Individualized	8.200*	.400	.000
	control/lecture	8.646*	.388	.000
Individualized	co-operative	-8.200*	.400	.000
	control/lecture	.446	.380	.242
Control/lecture	co-operative	-8.646*	.388	.000
	Individualized	-.446	.380	.242

*Significant ($p < 0.05$)

In Table 5 above, there is significant difference in the students' mean scores among the three groups; co-operative individualized and lecture. ($F_{2, 143} = 299.71, p < 0.05$). Thus, students performed significantly at different levels in the three groups. This indicates that treatment may not be equally effective. It is therefore important to compare the three groups two-by-two to find out the group(s) that causes the difference. This is why the next table (Table 6) is important.

The essence of pair-wise comparison is to explain the cause of the significant difference reported in table 5. The groups are compared two-by-two. There is no significant mean difference between individualized and lecture methods. However, there is significant difference between co-operative and individualized methods. There is also significant difference between co-operative and lecture methods. Co-operative method is significantly better than individualized. Co-operative method is also significantly better than lecture method.

DISCUSSION OF FINDINGS

A major finding of this study is that there is significant main effect of treatment on student achievement in organic chemistry. Another finding of the study was that there is no significant effect of gender on students' achievement in organic chemistry. Finally, there is no significant effect of

self-concept on student achievement in organic chemistry.

The detail of the findings clearly shows that there is no significant difference in the interaction effect of treatment, gender and self-concept. Therefore the null hypothesis is upheld. It was found that there is no significant interaction effect of treatment and gender on students' academic achievement, from the study analysis. Also, there was no significant difference in the mean achievement score of female and male.

This finding corroborates the finding of Yusuf (2005) that gender has no influence on students' academic achievement in a co-operative competitive and individualized learning group. The result of this hypothesis also shows that the two-way effect of gender and self-concept on students' academic achievement has no significant effect. Adekoya and Olatoye (2011) also found no significant interaction effect between treatment and gender when two strategies were employed to teach science to different groups of students.

The result of the study is not surprising because earlier studies on the co-operative teaching method have found out that treatment enhances academic achievement. Several studies have also examined the influence of treatment on students' academic achievement (Slavin, 1990). Also, Yusuf (2005) reported significantly

difference in achievement of students' exposed to co-operative learning method in a study carried out among junior secondary school students in social studies.

In selecting teaching method(s) for a science class, teacher/instructor should consider the following factors:

1. The learners' age, their previous knowledge on the topic and their ability.
2. The science teacher should select a suitable method he/she can effectively handle.
3. The time the lesson will take place.
4. The size of the class where the lesson is being taught.
5. The resources that are at the disposal of the teacher
6. The number of students to be taught.

CONCLUSION

It has been asserted that the students' achievement in chemistry is fluctuating, despite efforts being made to stimulate the intellectual skill and personal growth of the students in science. The major cause of the poor performances is attributed to among others, the use of inappropriate instructional strategies employed by the chemistry teachers. However, this study lends empirical support to the fact that performance of students in chemistry could be greatly improved if they are exposed to co-operative learning method. The co-operative teaching method facilitates students' chemistry achievement more than individualized and other teaching methods do. While using this method, gender and self-concept do not affect students' academic achievement.

The treatment given to the three groups have significant effects on academic achievement though, participants in co-operative group performed higher than those in individualized and control/lecture groups. The findings of the study show that co-operative teaching method procedure has most significant effect on the achievement of students in organic chemistry.

RECOMMENDATIONS

Based on the findings of the study, it is hereby recommended that teachers of chemistry should expose the students to cooperative learning method to encourage social interaction, active engagement and self-motivation among learners. Also, teachers should be encouraged to attend regular workshops and seminars to acquaint themselves with requisite skills to use cooperative teaching method. Textbook writers should shift emphasis from teachers' activities to students' activities that will promote the incorporation of co-operative learning method in chemistry textbook. Curriculum planners should ensure that curriculum implementation put into practice the use of co-operative teaching method. The heads of educational institutions should supervise the implementation of the co-operative teaching method in their institutions.

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