

The Effects of Cooperative, Competitive and Individualistic Learning Goal Structures on Chemistry Students Achievement In Secondary Schools In Delta State

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Abstract: *The purpose of the study was to determine the effects of cooperative, competitive and individualistic learning goal structures (CCILGS) on chemistry students' achievement. The design employed for the study was a quasi experimental. 258 SS II chemistry students participated in the study. Chemistry Achievement Test (CAT) validated by three experts was used for data collection. CAT had a reliability of 0.87. Data were analyzed with ANCOVA and Scheffe's test. The study's results include the following: a significant difference in mean achievement scores of chemistry students, but in favour of the cooperative learning (CooL) group among the three goal structures. It was concluded among others that CooL goal structure is the most effective strategy for learning chemistry while the other goal structures could act as alternatives. It was therefore recommended that CooL goal structure be adopted as the most appropriate strategy for learning chemistry in secondary schools.*

Keywords: Goal Structures, Cooperative Learning, Goal Structure, Competitive Learning Goal Structure, Individualistic Learning Goal Structure

Introduction

Chemistry is the study of the characteristics and behavior of matter. The universe's physical building blocks are called matter. It is anything that is both massy and takes up space (Brown, Le May, Burstein, Murphy & Woodward, 2009). Chemistry contributes significantly to our understanding of the world and its workings. It is a vital science that has a significant impact on man's daily living. Providing for man's basic necessities, such as food, clothes, and shelter, as well as improving health care and protecting the environment are all issues that chemistry plays a key role in, according to Brown et al. (2009). For this reason, the proper teaching and learning of the subject is advocated by all nations. Nigeria, therefore, needs the proper teaching and learning of chemistry to excel in science and technology.

However, personal experience and observation of classroom activities suggest that most of today's chemistry classroom teaching and learning is focused on activities through which learners acquire facts, rules, theories and action sequences is by the presentation of the content materials to them by their teachers in its final form (lecture)(Borich, 2004). Most of the lesson outcomes require only the lower levels of cognition, such as knowledge, understanding, and application. This may explain why consistent Senior School Certificate Examination Results (SSCE) by WAEC and NECO record poor performances of students in chemistry, because most students are unable to think independently of their teachers and go beyond the contents in the class notes and the recommended subject textbooks. Because of this, it appears that most schools' chemistry curricula may not be fostering in students the awareness of their own learning, critical thinking, and ability to develop their own thought processes and meaning. This situation as strengthened by WAEC and NECO annual reports therefore, calls for a review of the strategies students adopt in the learning of chemistry with the intention of isolating and

recommending the most effective learning strategies for the subject. This is the main rationale for this study.

Specifically, the learning situations of interest in this study are cooperative, competitive and individualistic goal structures (CCILGS) because of the peculiar characteristics and behaviours of students using the varying goal structures. The comparison of these learning situations is worth the effort considering the fact that they are used regularly in the class and the controversies that emerged from the review of previous studies. One of such controversies is; "if cooperative learning (CooL) strategy promotes higher achievement than does competition learning (ComL), or vice versa". Some psychologist, have insisted that competition promotes superior achievement to cooperation, while others concluded the opposite. The other controversy is; "whether CooL promotes higher achievement than do individualistic learning (IL) efforts, or vice versa". Additionally, some psychologists believe that individual reward structures encourage greater accomplishment than group structures do. These controversies, therefore calls for more research efforts to settle the controversies. This study is an attempt to achieve this through the use of empirical evidence.

Evidence from research works in literature indicates a very high volume of literature on CooL goal structure but very little recent ones on competitive and individualistic goals structures. Most of the works directed at competitive and individualistic goal structure were published in the 70s, 80s, and 90s and trickles of them in the 2000s, with most of these studies by Johnson and Johnson. The irony of the situation is that these learning strategies are the most used by students in Nigeria and yet no serious efforts are being made to compare their relative effectiveness with other learning strategies or goal structures. Personal experience and classroom observation indicates that in Nigeria, the use of cooperative goal structure in learning as defined in literature is not common. What is common is the existence of competitive groups which lack the features of cooperative groups like

what affect one group member affects all. It is clear that there is serious gap on which learning goal structure students learn best and this need to be filled for students learning to be effective and particularly in chemistry.

On the influence of sex on selection of goal structure, results showed that students employed a wider variety of learning techniques than those frequently favoured by their own sex. Both men and women most frequently use social strategies, while both utilize both the lowest frequency strategy. The gender of language learners is claimed to have a significant impact on their choice of language learning strategies when learning a foreign language, according to the most recent research findings (Aslan, 2009; Bozinovic & Sindik, 2011). Holding on this view, it thus tend to indicates that female students are more liable to have different learning strategies than male learners, this view is however peculiar with language learning which is dominated by female, weather this is true in science learning is one of the rationale for this studies. This position is however consistent with research which found that women in language learning tends to deploy more learning strategies than male learners (Bozinovic & Sindik, 2011).

This study aims to fill the very large knowledge gap about how different goal structures affect students' learning outcomes in chemistry. Thus, in this study, attempt will be made to compare the effects of CCILGS on chemistry students achievement and also determine whether they are sex based and with the intention of isolating the most effective among them

Statement of the Problem

Although a lot of studies have been carried out by Johnson and Johnson which demonstrated that cooperative goal structure is the most effective for learning, not all researchers accepted his position as rivaled findings emerged. The two goal structures mainly used in Nigeria schools for learning are competitive and individualistic learning structured environments. The use of these learning structures have not significantly improved students achievements over the years as SSCE and annual reports by WAEC and NECO still indicate poor performances of students in chemistry. This therefore, calls for urgent evaluation of goal structures applied in chemistry learning to isolate and recommend the most effective among them for students.

Purpose of the Study

The purpose of this study was to determine the effects of CCILGS on chemistry students' achievement with the intention of isolating the best among them. Specifically, the study determined if:

1. there is any difference in chemistry achievement score among students who studied with varying goal structures;
2. there were differences in chemistry achievement scores between male and female students who studied chemistry using CCILGS;
3. there is interaction effect of goal structures and sex on chemistry achievement;

Research Questions

The following research questions were raised for the study:

1. What is the difference in mean chemistry achievement scores among students who studied chemistry using CCILGS?
2. What is the difference in mean chemistry achievement scores between male and female students who studied chemistry using CCILGS?

Hypotheses

To further direct this study, the following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in mean chemistry achievement scores among students who studied chemistry using cooperative, competitive and individualistic goals structures.
2. There is no significant difference in mean chemistry achievement scores between male and female students who studied chemistry using cooperative, competitive and individualistic goal structures.
3. There is no significant interaction of goal structures and sex on chemistry achievement.

Materials and Methods

Quasi experimental design was employed in the study. The design consists of three learning groups (cooperative learning, competitive learning & individualistic learning) and two levels of sex (male & female). Studies which investigate the effects of two or more independent variables at the same time are best carried out using factorial designs. Also studies where intact classes were used and hence no random assignment of subjects into treatment groups, the design is described as quasi experimental design. The variable matrix of the design is shown in table 1:

Table 1: Graphical Representation of the Design

Groups	Sex	Treatment
- Cooperative	Male female	& O ₁ x O ₂
- Competitive	Male female	& O ₃ x O ₄
- Individualistic	Male female	& O ₅ x O ₆

Key

O_{1,3,5} pre- achievement test
 O_{2,4,6} post- achievement test
 X treatment with cooperative, competitive and individualistic goal learning structures.

The study's population consisted of 18,879 SSII students (Male 9,455 and Female 9,424) in public secondary schools in the three Senatorial Districts and per local government area for 2018/2019 academic session. The sample for the study consisted of 258 SSII chemistry students in nine intact classes from the three Senatorial Districts in Delta State.

Data were collected with Chemistry Achievement Test (CAT). Three experts—one seasoned chemistry teacher,

one chemistry educator and one measurement and evaluation specialist—performed the face validity of the CAT. A table of specifications on all the items in the six-week learning plan was used to determine the content validity of the CAT. A pilot test was used to determine the construct validity of the CAT. The reliability of CAT was done using the Kuder- Richardson 21 formula ($K21$) = 0.87. Mean and standard deviation were used to provide answers to all research questions. ANCOVA was used to test the validity of the hypotheses, and then a Post-Hoc Analysis was performed to ascertain the direction of the difference with Scheffe's test.

Results and Discussion

✓ What is the difference in mean chemistry achievement post- test scores among students who studied chemistry using CCILGS?

Table 2 Comparison of Chemistry Achievement Post-Test Scores of Students who Studied Chemistry Using CCILGS

Group	N	Mean (\bar{x})	SD	Order of Performance
CooL	98	51.40	8.57	1 st
ComL	78	46.25	8.81	2 nd
IL	82	42.90	8.71	3 rd

Table 2 indicates that students in the CooL goal structure group (51.40) scored the highest mark in the chemistry achievement test. This was followed by students in the ComL goal structure group who score a mean of 46.25, students in the IL goal structures group took the third position (42.90) in the order of performances in the chemistry achievement test administered at the end of treatment.

✓ There is no significant difference in mean achievement scores among students who studied chemistry using CCILGS.

Table 3 ANCOVA Summary Table Comparing Chemistry Post Achievement Test Scores of Students who Studied with CCILGS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3318.799 ^a	3	1106.266	14.582	.000
Intercept	8688.199	1	8688.199	114.522	.000
Pretest	.161	1	.161	.002	.963
Groups	3294.567	2	1647.283	21.713	.000
Error	19269.604	254	75.865		
Total	596088.000	258			
Corrected Total	22588.403	257			

The determined F value of 21.713 is significantly higher than the critical limit, according to table 3 ($F=21.713$, $P 0.05$). This suggests that there are considerable differences

between the students' accomplishment scores in chemistry across the three goal structure groups. Due to the considerable differences in the students' performance across the three goal structure groups, H_02 is consequently rejected.

To determine the direction of significance the results obtained was further subjected to Post Hoc Analysis. The Post Hoc Analysis using Scheffe's test is shown in table 4.

Table 4 Scheffe's Post Hoc Analysis showing the direction of significance found among cooperative, competitive and individualistic learning group students

(I) Groups	(J) Groups	Mean df (I-J)	Std. Error	Sig. ^b
CooL	ComL	5.167*	1.363	.000
	IL	8.509*	1.306	.000
ComL	CooL	-5.167*	1.363	.000
	IL	3.342*	1.402	.018
IL	CooL	-8.509*	1.306	.000
	ComL	-3.342*	1.402	.018

Table 4 shows that there is a significant difference in chemistry achievement scores between students in CooL and ComL groups in favour of the cooperative group. The table also shows that there is a significant difference in chemistry achievement scores between CooL and IL group students and in favour of the CooL group. Finally the table showed that there is a significant difference in chemistry achievement scores between students in ComL and IL groups and in favour of the ComL group.

✓ What is the difference in mean chemistry achievement score between male and female students who studied chemistry using cooperative, competitive and individualistic learning strategies?

Table 5 Comparison of Male and Female Mean Chemistry Achievement Scores of Students who Studied with CCILGS

Group	N	Mean (x)	SD	Mean difference
CooL	98			
	Male	58	52.13	8.50
Female	40	50.35	8.68	
	ComL	78		
Male	47	46.85	8.48	1.50
	Female	31	45.35	9.37
IL	82			
	Female	47	42.72	8.81
Male	35	43.14	8.69	

Table 5 indicates that sex had very low minimal effect on chemistry students achievement using CCILGS. In the CooL group, the difference between the male and female students was by 1.78, in the ComL group, the difference between male and female students was by 1.50, while in the IL group the male and female students differed only by 0.42.

✓ There is no significant difference in mean chemistry achievement score between male and female students who studied chemistry using CCILGS.

Table 6 t-test Summary Table Comparing Male and Female Chemistry Students Achievement Scores who Studied With Cooperative, Competitive and Individualistic Learning Strategies (Goal Structures)

Group	N	Mean (\bar{x})	SD	df	t-cal	Sig.	Remark
Cool	9	51.4	8.5				
Male	8	50	8.5				
Female	5	52.1	0	9	1.01	0.31	NS
	8	3	8.6	6	4	3	
	4	50.3	8				
	7	46.2	8.8				
ComL	8	5	1				
Male	4	46.8	8.4	7	0.73	0.46	NS
Female	7	5	8	6	7	7	ted
	3	45.3	9.3				
	1	5	7				
	8	42.9	8.7				
IL	2	0	1				
Male	4	42.7	8.8	8	2.14	0.83	NS
Female	7	2	1	0		1	
	3	43.1	8.6				
	5	4	9				

In the Cool, ComL, and IL groups, there are no statistically significant differences in the achievement scores for chemistry between male and female students in the sixth table, $t=1.014$, $P> 0.05$ for the Cool group, $t=0.73$, $P> 0.05$ for the ComL group, and $t=2.14$, $P> 0.05$ for IL group. This finding did not lead to the rejection of hypothesis 3, as the computed t value at the P level of significance was higher than 0.05. This suggests that there were no appreciable variations in the male and female chemistry achievement scores among the three groups.

✓ There is no significant effect of interaction between goal structures and sex on chemistry achievement.

Table 7 ANCOVA Summary Table of Post Test Scores Using Pre-Test Scores as Covariate on Interaction Between Goal Structures and Sex on Achievement

Source	Type III Sum of Square	df	Mean square	F	Sig.
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Corrected Model	3440.323 ^a	6	573.387	7.516	.00
Intercept	8697.294	1	8697.29	114.00	0
pretest	.660	1	4	7	.00
Groups	3077.720	2	.660	.009	0
Sex	56.281	1	1538.86	20.172	.92
Groups *	60.231	2	0	.738	6
Sex	19148.080	25	56.281	.395	.00
Error	596088.00	1	30.115	0	0
Total	0	25	76.287	.39	
Corrected Total	22588.403	8		1	
		25		.67	
		7		4	

Table 7 indicates that there is no significance effect of interaction between goal structure and sex on chemistry achievement, $F=0.395$, $P> 0.05$. The calculated F value is significant at P greater than 0.05. For this reason, hypothesis 4 is not rejected because there was really no significant effect of interaction between goal structure and sex on chemistry achievement.

Discussion of Results

The finding here, indicated that the achievement scores of the chemistry students who studied using the varying goal structures were significantly different according to table 8, $F =21.713$, $P< 0.05$. The results of the post-hoc analysis used to establish the direction of significance revealed that students in the Cool group significantly differed from those in the ComL group and in favour of the Cool group, that there was a significant difference in chemistry achievement between Cool and IL group students and in favour of the Cool group, and that there was a significant difference in chemistry achievement scores between students in the ComL and IL group and I. The order of performances established using the three goal structures are: learning with cooperative is first (51.40), competitive is second (46.25), and individualistic is third (42.90). By implication, the most effective learning strategy that should be used for chemistry learning is Cool goal structure.

The finding of superiority of cooperative learning strategy over the other strategies of learning agrees with the findings of most studies in literature. Studies conducted by Johnson, Johnson and Tauer (2010), Ajaja (2103), Najimudeen, Oloyede and Adegunle (2016) and Bukunola and Idowu (2012) found that students in Cool groups outperformed other students in other learning groups. The result obtained which linked Cool to significantly increased chemistry achievement scores may be due to the increased engagement of students in learning activities and carrying everybody along. The caring for all members of the group tends to improve critical thinking, reasoning ability and problem solving skills of all and which resulted in increased achievement for all.

In the ComL and IL goal structure groups, no cooperating team work for a purpose and direction exists. In the ComL group, members are striving to outscore their mates while in the IL group, every member wants to work at his/her

own pace. This may have accounted for the lower chemistry achievement scores found in the ComL and IL groups.

This study's finding further showed no discernible difference between male and female accomplishment scores in the chemical groups. Cooperative $t = 1.014$, $P > 0.05$, competitive $t = 0.73$, $P > 0.05$, individualistic $t = 2.14$, $P > 0.05$. This finding is significant since this result suggests that for any goal structure used for learning both male and female students gained equally. However, male and female students in the cooperative learning goal structure has been found to score more than those in other groups. This means that the other two goal structures could serve as alternatives to cooperative goal structure in chemistry. This statement is hinged on the fact that none of the goal structure is sex biased arising from the non-significant difference between males and females on achievement scores of students across the groups. This finding agrees with the findings of earlier researchers on similar studies. Examples include the studies by Ajaja (2013) and Ajaja and Eravwoke (2010). Both studies found that the male and female achievement in the two subjects were not significantly different. The results, which showed no statistically significant differences between male and female students' achievement scores in chemistry across all learning strategies, may be explained by the orderly and clear presentation of the material to be learned to all sexes, which may have encouraged all students to learn equally. The weekly briefing by instructors on the contents to be learned and what is expected of students at the end of the period may again have been responsible for the results obtained, that is the scores of the male and female students not significantly different.

Interaction means combined effects of two or more variables to influence a dependent variable. This study found no evidence of a significant relationship between sex and learning goal structures on the success of chemistry students. This implies that the chemistry students' achievement scores as obtained was not a product of the combined effects of sex and goal structures. The independent variables of goal structure and sex acted independently to influence students' scores in chemistry. The non-significant interaction effect between sex and goal structure to influence achievement score obtained may be explained with the fact that the two variables acted as main effect independent variables.

Conclusion

Based on the study's findings, it was concluded that Cool goal structure is the most effective strategy for learning chemistry, while competitive and individualistic goal structures can serve as alternative strategies for studying chemistry. It was further concluded that each of the independent variables acted separately to influence chemistry students' achievement and attitude scores.

Recommendations

Based on the study's findings, the following recommendations are offered:

1. Cool goal structure should be adopted as the major strategy for learning chemistry at the secondary level of education.

2. ComL and IL goal structure learning strategies should be used as alternatives when it is not possible to apply Cool goal structure.
3. Since sex was found as a limiting factor in the development of acceptable attitude towards chemistry in all the goal structures, it is recommended that chemistry instructors improve on their instruction and guide for all students irrespective of their sex to put all at the same level.

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