**International Journal of Multidisciplinary Research and Development**
**Online ISSN: 2349-4182, Print ISSN: 2349-5979**
**Impact Factor: RJIF 5.72**
**Received: 02-05-2018; Accepted: 05-06-2018**
**www.allsubjectjournal.com**
**Volume 5 Issue 6; June 2018; Page No. 01-05**

# Effect of collaborative and individualized learning strategies on students' performance and retention in organic chemistry

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**Abstract**
The main purpose of this study was to investigate the effect of learning collaborative and individualized learning strategies on students' performance and retention in organic Chemistry in Rivers State. Quasi-experimental design was adopted. The population consisted of all senior secondary two (ss11) Chemist Through purposive sampling technique two schools were selected and randomly assigned to the experimental and control groups. 115 students were involved in the study with 58 students in the collaborative intact group and 57 students in the individualized intact group. Three objective and three hypotheses guided the study. The instrument for data collection was a research-made test tagged Organic Chemistry performance Test (OCPT) which consisted of twenty-five (25) multiple-choice objective test items on general ability in Organic Chemistry constructed by the researcher. The instrument was validated by experts in Science Education and Chemistry evaluators. The instrument had a reliability coefficient of r = 0.78 using a test-retest method of estimating reliability. Both groups were presented with a pretest (OCPT) then after, the experimental group was taught organic chemistry with the collaborative learning method while the control group was taught using the individualized learning strategy. Both groups were thereafter post tested with OCPT. The data obtained were analyzed using mean and standard deviation for the research questions, while t-test and ANCOVA were used for the hypotheses which were tested at 0.05 level of significance. The results showed that the experimental taught organic chemistry using, collaborative learning strategy (CLS) performed better than the control group taught using individualized learning strategy (ILS). And that there was no significance difference between male and female performance in both collaborative and individualized learning strategies. In addition, the study also found that there is no significant interactive effect of learning strategies and gender on students' performance and retention in organic chemistry. Based on the findings, it was recommended that teachers of Chemistry should intensify effort to ensure that students of Chemistry participate in group learning (collaborative) for better performance in organic Chemistry concepts.

**Keywords:** collaborative, individualized, learning strategies, organic chemistry, retention

## Introduction

The importance of Science and indeed Chemistry cannot be overemphasized especially in any society of the world. Literature abounds on the numerous items Science and especially Chemical Science has helped mankind to produce. Some of these items include the production of iron for construction work, soaps and detergents for washing, various kinds of pigmentations for all types of coloring activities and the host of others. All these are made possible because of knowledge of Chemistry which is regarded by the science community as the foundation upon which industrial growth and economic prosperity are rooted.

No wonder the question, what on earth is not chemistry? Reported in (International Charter Chemist of Nigeria) (ICCON, 2014) [12] has remained an enigma since 1998. Ikoku (2013) [11] noted that Chemistry and Chemical technology are among the disciplines essential for national development. Nations should on continuous basis ensure the production of required number of adequately trained and properly oriented Chemists, Chemical engineers, Chemical laboratory technologists and technicians in order to ensure the responsibility of creating a viable Chemical industry as well as supplying the Chemical manpower expertise required by other industries. Chemistry is so inclusive that it serves as a pre-requisite to the study of all science based disciplines. Hence, Chemistry is nicknamed "Central Science". So also, the Federal Ministry of Education with the National Policy on Education FRN (2014) gave prominence to Science subjects like Chemistry, Physics, Mathematics and Computer Sciences. Chemistry is one of the science subjects taught at the senior secondary school levels of Nigerian education system. Chemistry teachers should endeavor to employ all means and utilize effective teaching strategies to increase the interest of students in Chemistry, which will subsequently improve performance in Chemistry examinations such as the Senior Secondary School Examination (SSCE).National Examination council (NECO), General certificate in examination (GCE), University matriculation Exam (U M E).

In contemporary times, learning strategies that are strongly advocated included collaborative learning strategy and individualized learning strategy. These two learning strategies are being conversed because of their effectiveness as reported

in literature. This is sequel to the fact that traditional method of teaching science at the secondary school level has been widely implicated for being responsible for the undesirable state of science education in Nigeria (Ezeliora, 2004; Osinubi 2013) [8, 14], especially in terms of students' performance in their external examinations.

Due to these predicaments, researchers have continued to search for appropriate methods and strategie that will enable Chemistry students gain proper understanding and application of Chemistry concepts and principles that will enhance performance. Some of such methods and strategies as reported in literature are; problem solving, project, field trip, concept mapping, played-way, discovery/inquiry method, Computer Assisted Instruction (CAl) collaborative approach and individualized learning strategies to mention but a few (Gbamanja, 1999; Alamina, 2016; Achonye & Ajoku, 2013) [10, 4, 2].

However, in this work, collaborative and individualized strategies captured the interest of the researcher in view of the fact that much work has to be done in the area of delivery of instruction. That is, the use of collaborative and individualized learning strategies vis-à-vis performance of students in organic Chemistry.

Consequently, a succinct presentation of the meaning collaborative and individualized strategies at this juncture becomes imperative. Thus, collaborative learning strategy is also synonymous to cooperative learning strategy. Collaborative learning strategy is a team process where members support and rely on each other to achieve an agreed-upon goal (Barkely, Cross, & Howell-Major, 2005). Collaborative learning according to (these researchers Major) is based on the view that knowledge is a social construct and further emphasized that collaborative activities are most often based on four principles:

1. The learner or student is the primary focus of instruction
2. Interaction and "doing" are of primary importance
3. Working in group is an important mode of learning and
4. Structured approaches to developing solutions to real-world problems should be incorporated into learning.

Collaborative learning can occur peer-to-peer or in larger groups. On the other hand, individualized instructional strategy according to Wikipedia (2017) [16] is a method of instruction in which content, instructional technology (such as materials) and pace of learning are based upon abilities and interests of each individualized learner. The idea of individualized instructional strategy is hinged on students completing units of work at their own pace before moving on to more complex units of tasks.

Some research work that have investigated on either of the two learning strategies or both in relation to students performance as reported in literature included that of Abdulsalam and salf (2012) [1] Adolphus (2012) [3], Barkely *et al* (2015) who found out that students taught with collaborative learning approach performed better than those taught with demonstration approach and that gender does not significantly affect the understanding of students when taught with collaboration or demonstration approach. In the same vein, Alavi, (2014) investigating the use of a group decision support system (GDSS) in a collaborative learning process to enhance students learning style and evaluation of classroom experiences in Nandi District of Kenya and found out that GDSS supported collaborative learning evaluation of classroom experience than non-GDSS. In addition, the final test grades of the group of students who were exposed to GDSS-supported collaborative learning were significantly higher than those of the other group of students who participated in the experiment. In 2004, Pepple investigated the effects of collaborative learning and individualized instruction on students' achievement in Chemistry in senior secondary schools in Port Harcourt City Local Government Area of Rivers State. The findings of the study indicated that there was a significant main effect of the treatment on the achievement of students in Chemistry; also there was significant main effect of mathematical ability on students' achievement in Chemistry. However, there was no significant main effect of gender on achievement of students in Chemistry. Other research works in support of collaborative strategy are those of David, Michael, Hannafin and Simon (2015) [7]; Abdulsalem and Salf (2012).

Chemistry and especially Organic chemistry is one of the perceived difficult concepts by both students and teachers at senior secondary level of education. Experience has shown that the effective and efficient use of the right learning and teaching strategies enhance the teaching and learning of science hence the methods or strategies adopted in the learning of science particularly Chemistry is an essential ingredient for smooth, successful growth and development (Okebukola, 2012).

In a classroom setting, if students are involved in only passive learning, it would lead to limited knowledge retention, let alone engaging them in thinking or promoting functional understanding. Literature replete that involving students directly and actively in the learning process promotes meaningful learning (Peter, Abiodun, & Jonathan, 2016). However, a teaching-learning process which makes the learners passive and inactive directly or indirectly affects their performance negatively. Evidence is shown in the results of students presented by both NECO and WAEC every year. The poor performance rate is not acceptable if Nigeria is to move forward industrially. The failure rate is indeed a problem and a course of concern to all stakeholders in the educational sector.

Consequently, the problem of this study is what is the effect of collaborative and individualized learning strategies on students' performance and retention in organic Chemistry in Rivers State? To resolve this research problem, the following research questions were posed and answered in this study:

1. What is the effect of collaborative learning strategy on male and female students' performance and retention in organic chemistry?
2. What is the effect of individualized learning strategy on male and female students' performance and retention in organic chemistry?
3. What is the joint effect of collaborative and individualized strategies learning strategies and gender on students' performance and retention in organic Chemistry?

To answer these research questions the following null hypotheses were formulated as tentative answers to the research questions and further tested at 0.05 level of

significance.

1. There is no significant difference in the mean score of male and female students' performance and retention in organic Chemistry when exposed to collaborative learning strategy.
2. There is no significant difference in the mean score of male and female students' performance and retention in organic chemistry when exposed to individualized learning strategy.
3. There is no significant interaction effect of collaborative and individualized strategies and gender on students' performance and retention in organic Chemistry.

**Methodology**

This study adopted pre-test, post-test, non-randomized Quasi-experimental design. An illustration of the design is presented on Table 1.

**Table 1:** Illustration of Pretest-posttest Quasi-experimental design

| Group | Pretest | Treatment | Posttest |
|---|---|---|---|
| Experimental | O1 | X1 | 02 |
| Control | O3 | X1 | O4 |

Where O1 and O3 = Pretest scores, O2 and O4 = Posttest scores, X1 = collaborative strategy X2= individualized.

The population of the study consisted of all senior secondary school two (SSII) students of chemistry in four public co-educational secondary school totaling 469 in Eleme Local Government Area of River State. Through purposive sampling technique two schools were selected and randomly assigned as experimental and control groups. The class assigned to collaborative strategy had 58 students while the individualized strategy group had 57 students. In their intact classes. Hence, 115 students constituted the sample size of the study. The instrument for the study was constructed by the researcher and validated test, named Chemistry Organic performance Test (COPT) based on the content of instruction for SSII. The instrument consists of two parts, A and B. Part A, covered learners' Bio data, part B was a twenty-five (25) multiple-choice objective test items with options A to D. The reliability coefficient of the instrument was 0.78, established through test-retest method of estimating reliability as a measure of its stability over time.

The pretest-CAT was administered to the samples in their intact classes in the selected schools to establish the equivalence of the subjects for the study. Normal school period for learning Chemistry on the school time table was used for the study. This was three periods per week of 40 minute per period for two (2) weeks. 240 minutes in all =4hrs. After the treatment for two weeks, the students were subjected to the same test as post test though the test –items were re-numbered (Re-shuffle).That is the post-test contains the same questions only the items were reshuffled in numbering. The Chemistry teachers of the sampled schools were trained and properly guided to serve as research assistants. The data collected were analyzed using mean, and standard deviation for the research questions and t-test and Analysis of covariance (ANCOVA) for the hypotheses.

**Results**

**Research question 1:** What is the effect of collaborative learning strategy on male and female students' performance and retention in organic Chemistry?

**Hypothesis 1:** There is no significant difference in the mean score of male and female students' performance and retention in organic chemistry when exposed to collaborative learning strategy.

To answer this research question and test its corresponding hypothesis, independent t-test statistic was employed and the result presented in Table 2.

**Table 2:** t-test analysis of the effect of collaborative learning strategy on male and female students' performance and retention in organic chemistry

| Variables | Gender | N | Mean | SD | Mean | df | t | Sig |
|---|---|---|---|---|---|---|---|---|
| Retention | Male | 37 | 65.47 | 1.46 | 3.24 | 68 | 2.004* | .049 |
| | Female | 33 | 68.71 | 1.76 | | | | |
| Pretest | Male | 37 | 42.31 | 1.58 | 4.23 | 68 | 0.294 | .769 |
| | Female | 33 | 38.08 | 0.98 | | | | |
| Posttest | Male | 37 | 72.38 | 1.09 | 3.40 | 68 | 0.314 | .314 |
| | Female | 33 | 68.98 | 1.11 | | | | |

*Significant, $p < 0.05$ level of significance

Table 2 shows that the mean score for the pretest for male and female were 42.31 and 38.08 respectively while posttest were 72.38 and 68.98 and retention was 65.47 and 68.71 respectively. On further statistical testing only the t-value for retention was found to be significant, df = 68 at 0.05 level of significance. The null hypothesis is therefore rejected with respect to students' performance but accepted with respect to retention. The result shows that there is no significant difference in the mean score of male and female students' performance in organic chemistry when exposed to collaborative learning strategy.

**Research question 2:** What is the effect of individualized learning strategy on male and female students' performance and retention in organic chemistry?

**Hypothesis 2:** There is no significant difference in the mean score of male and female students' performance and retention in organic Chemistry when exposed to individualized learning strategy.

To answer this research question and test its corresponding hypothesis, independent t-test statistic was deployed and the

result presented in Table 3.

**Table 3:** t-test analysis of the effect of individualized learning strategy on male and female students' performance and retention in organic chemistry

| Variables | Gender | N | Mean | SD | df | t | Sig |
|---|---|---|---|---|---|---|---|
| Retention | Male | 25 | 52.70 | 1.99 | 55 | 0.463 | .498 |
| | Female | 32 | 52.40 | 2.81 | | | |
| Pretest | Male | 25 | 31.40 | 2.17 | 55 | 0.061 | .498 |
| | Female | 32 | 36.80 | 3.06 | | | |
| Posttest | Male | 25 | 61.73 | 1.81 | 53 | 3.366 | .069 |
| | Female | 32 | 59.47 | 2.56 | | | |

NS = Not Significant, p > 0.05 level of significance

Table 3 shows that the mean score for the pretest for male and female were 31.40 and 36.80 respectively while posttest were 61.73 and 59.47 and retention was 52.70 and 52.40 respectively. This implies that male students' mean score was higher than that of their female counterpart both in retention and posttest but, that of female was higher in pretest. On further statistical testing none of the t-values was found to be significant, df = 55 at 0.05 level of significance. The null hypothesis is therefore accepted. The result therefore is that there is no significant difference in the mean score of male and female students' performance and retention in organic chemistry when exposed to individualized learning strategy.

**Research question 3:** What is the joint effect of learning strategies and gender on students' performance and retention in organic chemistry?

**Hypothesis 3:** There is no significant interaction effect of learning strategies and gender on students' performance and retention in organic chemistry.

To answer this research question and test the corresponding hypothesis, a 2 X 2 analysis of covariance (two-way ANCOVA) was applied to the relevant data collected. This is because there are two independent variables (learning strategies with two levels, collaborative and individualized as well as gender which also have two levels, male and female students. The results are presented in Table 4.

In Table 4, LS*Gender indicates the interaction between the learning strategies and gender which is the main concern of this hypothesis. The calculated F-ratio $_{(1, 111)}$ = .466 which is not significant, since p > 0.05 level of significant. The null hypotheses which states that there is no significant interaction effect of learning strategies and gender on students' performance and retention in organic chemistry, is therefore, accepted.

**Table 4:** Interaction effect of learning strategies and gender on students' performance and retention in organic chemistry

| SV | DV | SS | df | MS | F |
|---|---|---|---|---|---|
| LS | Retention | 5366.675 | 113 | 5366.675 | 45.260* |
| | Pretest | 943.297 | 113 | 943.297 | 6.703* |
| | Posttest | 2194.722 | 113 | 2194.722 | 22.329* |
| GENDER | Retention | 54.923 | 113 | 54.923 | |
| | Pretest | 8.635 | 113 | 8.635 | .061 |
| | Posttest | 330.892 | 113 | 330.892 | 3.366 |
| LS*GENDER | Retention | 79.612 | 113 | 79.612 | |
| | Pretest | 588.994 | 113 | 588.994 | 4.185* |
| | Posttest | 45.832 | 113 | 45.832 | |
| Error | Retention | 13161.685 | 113 | 118.574 | |
| | Pretest | 15621.238 | 113 | 140.732 | |
| | Posttest | 10910.363 | 113 | 98.292 | |
| Total | Retention | 454227.000 | 113 | | |
| | Pretest | 177905.000 | 113 | | |
| | Posttest | 518638.000 | 113 | | |

*Significant, p < 0.05 level of significance
SV = Source of Variation
DV = Dependent Variables
LS = Learning Strategies (Collaborative and Individualized)

**Discussions**

The study investigated effects of collaborative and individualized learning strategies on students' performance and retention in organic Chemistry in Rivers State using senior secondary school two (SSS II) Chemistry students in two secondary schools in Eleme Local Government Area of Rivers State.

It was revealed that gender does not significantly affect students' performed in both collaborative learning strategy and individualized learning strategy. In addition, the interaction effect of learning strategies and gender was also found not to be significant. These findings are however dissimilar to earlier findings made by Adolphus (2012) [3], Alavi (1994), David, Micheal Hannafin and Simon (2010) [7] and Abdulsalem and Salf (2012) who in their separate research found out that students achievement in collaborative learning group was significantly higher than that of the learning group based on gender.

## Conclusion

From the findings, it could be concluded that both learning strategies impact positively on students' performance and retention in organic Chemistry based on the increase in the mean performance in post test but not on the basis of gender. Consequently the following are recommended:

## Recommendations

1. Teachers of chemistry should encourage students to participate in group learning for better performance and retention.
2. Chemistry students should cultivate the habit of collaborative learning strategy and individualized learning strategy in learning chemistry concepts. in the secondary schools as they are found to positively improve students' development and discovery of new concepts.
3. Girls retained chemistry concepts more than boys. Boys should endeavor to read /study more.

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