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ADOPTING PROCESS-ORIENTED GUIDED INQUIRY LEARNING METHOD FOR ENHANCEMENT OF CHEMISTRY STUDENTS' ACHIEVEMENT IN DELTA STATE

By

[1]OMOSOR, Makaraba Ruth, Prof. O. P. AJAJA[2], Prof. E. KPANGBAN[3]
[1,2&3]Department of Science Education Delta State University, Abraka

ABSTRACT

The study examined the use of process-oriented guided inquiry learning method for the enhancement of chemistry students' achievement in Delta State. Two research questions were raised, and two hypotheses were formulated and tested at 0.05 levels of significance. A quasi-experimental design with a non-equivalent pre-test, post-test, and control group design using a 2 x 2 factorial design was adopted for the study. The population of this study comprises a total of 29,409 Senior School II (SS II) students. A sample of 95 SS2 students was drawn from two secondary schools in Delta State. The purposive non-randomised sampling technique was used for the selection of the schools. The Chemistry Achievement Test (CAT) was used for data collection. The reliability index was 0.85. Data collected using the CAT was analysed using one-way analysis of variance (ANOVA) and independent t test. The major findings of the study are that there was a significant difference between the mean achievement scores of chemistry students in process-oriented guided inquiry learning and the control group in Delta State, and there is no significant difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided inquiry learning in Delta State. Based on the findings of this study, it was concluded that the use of process-oriented guided inquiry learning enhances the academic achievement of chemistry students in Delta State. Besides, it was concluded that variation in academic achievement has nothing to do with sex but is entirely related to the instructional methods. Based on the findings of this study, it was recommended, among others, that chemistry teachers make a deliberate effort to incorporate process-oriented guided inquiry learning into the teaching of chemistry so as to promote better academic achievement among secondary school students.

Keywords: Process-Oriented Guided Inquiry Learning, Chemistry' Achievement, sex

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INTRODUCTION

Chemistry is the branch of science that deals with the composition and properties of matter and how matter interacts with energy. It encompasses a wide range of subfields, including organic chemistry, inorganic chemistry, physical chemistry, and biochemistry. Chemistry begins by exploring the concept of matter and energy. Matter is anything that has mass and occupies space, while energy is the ability to do work or cause change. Chemistry studies matter and energy, atoms, and their properties. It is an interdisciplinary field that combines principles from physics, biology, and mathematics. Atoms consist of protons, neutrons, and electrons, and their arrangement determines their properties. Chemistry is crucial in understanding matter composition, structure, and raw material utilization.

Chemistry is a fundamental science that plays a crucial role in various aspects of our lives. It impacts industries, environmental conservation, healthcare, and materials science. Chemistry provides the tools and knowledge necessary to address challenges and find solutions to complex problems. By understanding chemistry, we can improve our lives and advance as a society**.** Chemistry is crucial in manufacturing textiles, fertilizers, herbicides, insecticides, and fungicides, as well as managing natural resources, providing health facilities, and ensuring a favorable living environment. Teaching chemistry instills scientific knowledge and fosters a science-oriented attitude, contributing to individual and societal development in Nigeria. Attainment of the benefit associated with chemistry is dependent on the instructional method used by the teacher who implements the curriculum.

The teaching method used by a teacher can either enhance or hinder students' learning, influencing their social power and self-reliance. The primary goal of a teacher is to ensure the success of their lesson, which is tied to the teacher's quality. Teachers are responsible for helping students achieve maximum achievement through appropriate instructional methods (Omiko, 2017). Oloyede and Demide (2018) argue that poor achievement chemistry among secondary school students in Nigeria are due to teaching problems, with the lecture method being the most common teaching method, particularly in Delta State. The lecture method is a teacher-centered approach where a teacher delivers preplanned lessons to students verbally on a specific topic, using minimal resources. This method is popular and fast for disseminating knowledge in traditional classrooms. The lecture method enables passive learning, allowing students to process and apply knowledge to real-life tasks. Researchers like Wanjohi (2016) and Sanda and Mazila (2017) suggest that lectures are effective but not in producing meaningful learning. They argue that teachers often fail to engage students and encourage ownership of their learning due to syllabus coverage. Lectures also encourage "rote" learning, leading to incorrect responses without explanation. Angelin and Cecily (2015) recommend minimizing the use of lecture methods as they provide learning capabilities. It is therefore very pertinent to search for an approach to the teaching of chemistry that aims at understanding rather than juggling facts.

In POGIL, students are facilitated by the teacher as they work in small groups. Described by Villagonzalo (2014) as a student-centered philosophy and science pedagogy based on research, Process Oriented Guided Inquiry Learning (POGIL) uses carefully designed materials to guide students as they construct and rebuild their knowledge in small groups as they engage in guided inquiry. An alternative term for POGIL is collaborative learning, which involves guided inquiry within a cyclical process of exploration, concept invention, and application. Providing students with concrete experiences could improve their understanding of chemistry. Gale & Boisselle (2015) propose that POGIL allows learners to develop their own approaches to chemistry to develop their own understanding. By

developing higher-order thinking skills, POGIL activities encourage students to gain a deeper understanding of science course material.

The foundation of POGIL is the idea that knowledge is acquired by students via social interactions in which they share and debate what they understand with others. Through carefully scaffolded exercises, students collaborate in groups of three to six to uncover the principles being taught in a topic. Students are first exposed to a model, diagram, issue, or collection of facts as part of the POGIL technique. Next, they must collaborate in groups to respond to a series of questions that build an idea or principle (guided inquiry). As a result, it makes advantage of cooperative learning components. The concept that learning consists of two parts—content and process—is also the foundation of the POGIL approach. The ability to gain a thorough comprehension of a topic and the capacity to use that knowledge to solve new problems—the process component of learning—are the crucial skills for success in any field, even if material is also vital. According to Medina, Plaza, and Stowe (2013), the POGIL strategy's process skills provide a way to develop students who can solve issues as a team or in a group.

When instructors use POGIL, they don't teach; instead, they let students learn on their own by having them explore the material by working in small groups with peers to complete activities (Brown, 2015).

To enable in-depth comprehension of course material while at the same time fostering advanced cognitive skills, POGIL learning tasks concentrate on key science concepts and cognitive processes. The rationale for this study stems from the fact that although POGIL has been proven to be very effective in teaching chemistry at the tertiary level of education, its effectiveness in enhancing secondary school students' academic achievement in Delta State colleges has not been clearly established.

Academic achievement" refers to the quantified learning level demonstrated by students in school exams. It encompasses admirable learning in academic areas, including information and skills acquired. Academic achievement is the grade students receive for following instruction and learning. It can also be the demonstration of knowledge acquired through classroom exposure or developed skills in academic disciplines. Illahi and Khandai (2015) emphasize the importance of student achievement in educational institutions. It is a crucial outcome for parents, teachers, and students. Students can be classified as high, average, or low achievers. Factors such as learner characteristics, school environment, curriculum development, teaching methods, and home factors influence students' achievement. This study aims to address the knowledge gap on the impact of adopting Process-Oriented Guided Learning (POGIL) on chemistry students' achievement, as most teachers are unaware of its benefits and are not effectively teaching students to become aware of their own learning patterns. In the study, an attempt was made to ascertain the effect of POGIL on student academic achievement and ability in chemistry in Delta State, and also to determine whether the effect was gender dependent.

Statement of the Problem

Every day, there is growing concern about what instructional methods should be used in secondary schools to stop the downward trend in learners' achievement in chemistry. Based on the researcher's firsthand observations, it seems that chemistry instructors still use the lecture method instead of the cutting edge approach that encourages student engagement. The primary issue influencing the achievement of learners in chemistry can be the instructors' failure to use cutting-edge instructional strategies like the process-oriented guided learning model.

The process-oriented guided learning model, on the other hand, has been reported to have produced the desired effective teaching in secondary schools so that students' academic achievement improves. It has been used as an effective strategy to enhance students' achievement both in other subjects and outside of Nigeria. To the best of the researcher's knowledge, there is currently no empirical evidence demonstrating whether this process-oriented guided learning approach might improve students' academic progress among Delta State secondary school students studying chemistry. Hence, the problem of this study is therefore to determine the effects of process-oriented guided inquiry learning, on chemistry students' academic achievement and sex in Delta State?

Research Questions

The following research questions were answered in this study:

1. What is the difference in mean achievement score of chemistry students taught with process-oriented guided inquiry learning and the control group in Delta State?
2. What is the difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided learning model?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in mean achievement score of chemistry students taught with process-oriented guided inquiry learning and the control group in Delta State.
2. There is no significant difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided inquire learning in Delta State.

Purpose of the Study

The purpose of this study is to compare the effects of process-oriented guided inquiry learning, blended learning and lecture method on chemistry students' achievement and ability in Delta state. Specifically, the study sought to:

1. determine difference in mean achievement score of chemistry students taught with process-oriented guided inquiry learning and the control group in Delta State
2. determine the difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided inquiry learning in Delta State.

Theoretical Framework

Social Interdependence Theory (SIT) was adopted for this study.The Social Interdependence Theory (SIT), which is the second theory adopted for this study, was propounded by Johnson and Johnson (2002). Social Interdependence Theory (SIT) suggests that group members develop interdependence when they work together to achieve common goals. SIT consists of five essential elements: positive interdependence, individual accountability, face-to-face promotive interaction, interpersonal and small group skills, and group processing. Positive interdependence is crucial as it helps individuals realize their goals are linked to others', leading to better communication and problem-solving. SIT posits that each type of interdependence in cooperative learning environments influences individual learners' interactions and the group product's outcome. Thus, Social Interdependence Theory (SIT), is very relevant for this study.

Thus, Social Interdependence Theory (SIT) is very relevant for this study because POGIL teachers can use the principles of the theories to encourage active participation in the learning process and allow students to build on prior knowledge, interact with one another, and construct new understanding based on the lessons taught. Application of the assumption of Social Interdependence Theory (SIT), in POGIL classrooms will enable teachers to help students understand their performance and set their own goals for progress, developing the intrinsic motivation they need to experience success. Application of the assumption of Social Interdependence Theory (SIT), in POGIL classrooms will also enable teachers to guide learning by implementing group activities, creating collaborative dialogue, and facilitating interactive experiences. Students build on what they already know and learn new things based on what they are taught.

RESEARCH METHODS

Design of the Study

A quasi-experimental design, non-equivalent pre-test, post-test, control group design using a 2 x2 factorial design was adopted for the study. The design has treatments (instruction) at two levels Process-Oriented Guided Inquiry Learning (POGIL) and revision group across with gender at two levels (male and female)students. The diagrammatic representation of the 4x2 factorial matrix research design is shown below.

Table 1: Diagrammatic Representation of the Research Design

Group	Pretest	Treatment	Post test
Process-Oriented Guided Learning Model(POGIL)	O_1	X_1	O_2
Control (Revision group)	O_7	X_{no}	O_8

Where

O_1 = pretest for Process-Oriented Guided Learning Model (POGIL) group
X_1 = Treatment for Process-Oriented Guided Learning Model (POGIL) group
O_2 = posttest for Process-Oriented Guided Learning Model (POGIL) group
O_3 = pretest for control group
O_4 = posttest for control group
X_{no} = no treatment (control group)

The design indicates one experimental groups and a control group. Subjects in experimental group were exposed to Process-Oriented Guided Inquiry Learning (POGIL). The control group will not be exposed to any instructional strategy except revision.

Population of the Study

The population of this study comprises a total of 29,409 Senior School II (SS II) students offering chemistry in all the government-owned secondary schools in Delta State for the 2021/2022 session (Ministry of Basic and Secondary Education, Asaba, 2022).

Sample and Sampling Techniques

A sample of 95 SS2 students was drawn from two secondary schools in Delta State. The purposive non-randomized sampling technique was used for the selection of the schools.

Research Instrument

The instrument that was used for the study is Chemistry Achievement Test (CAT). The CAT was used for pretest and post test data. The CAT consists of two sections. Section

A contained instruction on the student's bio-data (gender). Section B has 50 multiple-objective test-items with option letters A-D. The items in the Chemistry Achievement Test (CAT) were adapted from Ababio (2016). The multiple test items will cover eight topics in chemistry. The topics were derived from the Nigerian Educational Research and Development Council (NERDC) chemistry scheme of work for Senior Secondary school II (SS2).

Validity of Research Instrument

Three experts from Delta State University, Abraka, were requested by the researcher to help face validate the Chemistry Achievement Test (CAT). The specialists were asked to examine the treatment packages (lesson plans) and confirm the validity of the instruments. With CAT, content validity was verified using the requirements table. 50 CAT copies were created and given to SS II students in Benin City, Edo State, in order to assess the construct validity of the instrument. The data obtained was used to compute difficulty indicators and discrimination indicators for the items that made up the instrument. The value of the difficulty index of the CAT lies between 0.42 and 0.68. In the item analysis, the value of the discrimination index (D) of the CAT lies between 0.49 and 0.86.

Reliability of Instrument

The researcher conducted a reliability test on 50 SS II students in Benin City, Edo State, using the Chemistry Achievement Test (CAT). The reliability index was calculated using the Kuder-Richardson formula 21, and a reliability index of 0.85 was obtained, indicating the CAT has good psychometric properties.

Treatment Procedures

Before teaching, students in both experimental and control groups were pre-tested with the Chemistry Achievement Test to ensure equivalence. In the experimental classroom, POGIL was used to teach selected chemistry topics. Students were assigned to specific groups based on sex to achieve diversity and homogeneity. Each group was assigned a role, such as manager, presenter, recorder, or reflector, and given simple activities to introduce them. Each group was given a file to keep track of activities.

The POGIL teaching model was used in lessons for six weeks, teaching chosen chemistry topics. The model was introduced and presented by the facilitator, followed by group analysis and follow-up questions. The exploratory phase involved students understanding the model, followed by concept formation, where group members constructed new ideas and terminologies. The final phase, concept application, involved application, contextualization, and evaluation of the model. Assessments included pre-tests and post-tests. In the treatment, the teacher in the control group only gave the selected topics to the students in form of revision without any treatment method. At the end of the six weeks, a post-test was administered to the students with the same Chemistry Achievement Test (CAT) that was used during the pretest.

The script containing the answers provided by the students were scored. Since the test item in CAT is dichotomous, every correct answer was awarded one mark and every wrong answer were given zero marks, so that the maximum score for CAT was 50, respectively. The total marks earned by the students were used to compute the mean achievement score. The research questions were answered using mean scores and standard deviations obtain from the pretest and post test. Hypotheses 1and 2 were tested with t-test statistics whereas hypothesis

3was tested using Analysis of covariance (ANCOVA). All hypotheses were tested at 0.05 alpha levels of significance.

RESULTS AND DISCUSSION

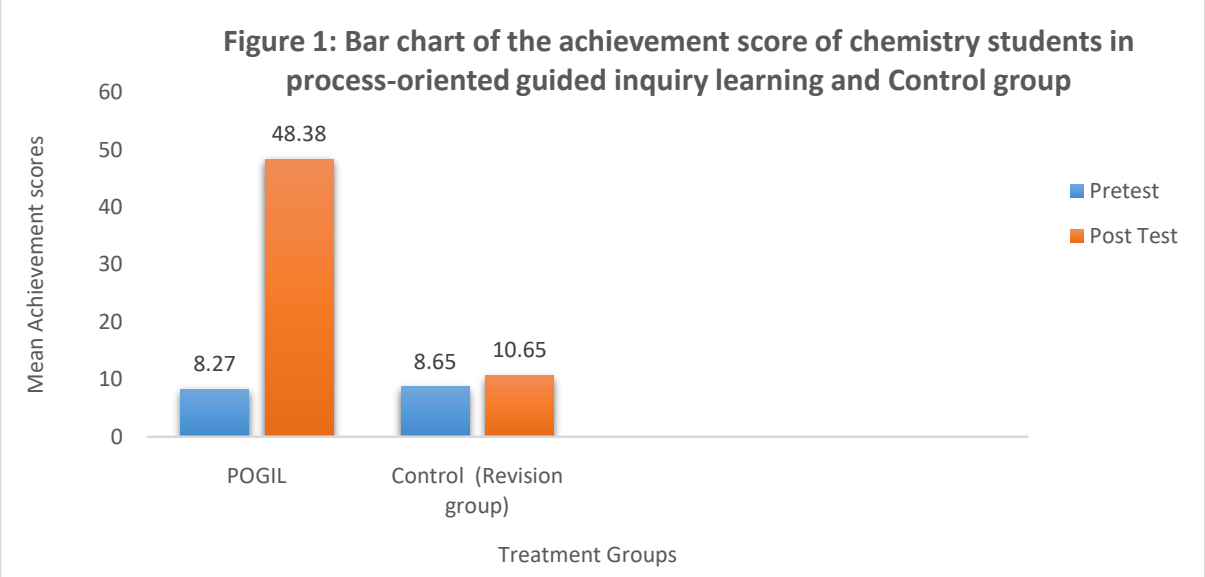
Research Question 1

What is the difference in mean achievement score of chemistry students in Process-Oriented Guided Inquiry Learning and the control group in Delta State?

Table 2:
Comparison of The Mean (X) achievement score of chemistry students in Process-Oriented Guided Inquiry Learning and the control group in Delta State

	N	Pretest		Post Test		Mean Gain
Treatment group		$\bar{X}$	SD	$\bar{X}$	SD	
Process-oriented guided inquiry learning	40	8.27	1.09	48.38	8.62	40.10
Control Group	55	8.65	2.11	10.65	1.35	2.00
Total	95					

Table 2 revealed the mean and standard deviation of mean achievement score of chemistry students taught with process-oriented guided inquiry learning, and those without it in Delta State. The means of the pretest and posttest scores of students taught using Process-oriented guided inquiry learning are 8.27 and 48.38, with standard deviations of 1.09 and 8.62, respectively with mean gain of 40.10. The means of the pretest and posttest scores of students in the control group are 8.65 and 10.65, with standard deviations of 1.33 and 1.55, respectively with mean gain of 2.00. The difference between the pretest and posttest mean achievement scores indicates that those taught using process-oriented guided inquiry learning has the highest mean gain and the control having the least mean gain. These mean gain are clearly illustrated using the chart in figure 1.



To find out whether the mean difference is significant, Ho_1 was tested with Analysis of variance (ANOVA) and presented in Table 3 below.

Hypothesis 1: There is no significant difference in mean achievement score of chemistry students in Process-Oriented Guided Inquiry Learning and the control group

Table 3: Analysis of Variance (ANOVA) **Comparison of the Mean(X) Achievement Score of Chemistry Students IN Process-Oriented Guided Inquiry Learning and the Control Group**

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
PRETEST	Between Groups	3.336	1	3.336	1.083	.301
	Within Groups	286.411	93	3.080		
	Total	289.747	94			
POSTTEST	Between Groups	32514.494	1	32514.494	16015.180	.000
	Within Groups	188.811	93	2.030		
	Total	32703.305	94			

Table 3 showed that the ANOVA comparison of the pre-test scores of chemistry students in Process-Oriented Guided Inquiry Learning and the control group is not significant ($F = 1.083$, $P \geq 0.05$). This implies that the students were the same in respects to the knowledge of the chemistry concepts before the treatment commence. In the post-test scores, students in Process-Oriented Guided Inquiry Learning scored the highest marks. The students in the control group scored the lowest marks. The ANOVA result ($F=16015.180$, $P\leq .05$) indicated a significant difference in mean achievement score of chemistry students in Process-Oriented Guided Inquiry Learning and the control group. With this result, Ho1 was rejected. Thus, there is a significant difference in mean achievement score of chemistry students in Process-Oriented Guided Inquiry Learning and the control group

Research Question 2

What is the difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided learning model?

Table 4: Comparison between the Mean Achievement Scores of Male and Female Students Taught chemistry using Process-Oriented Guided Learning Model.

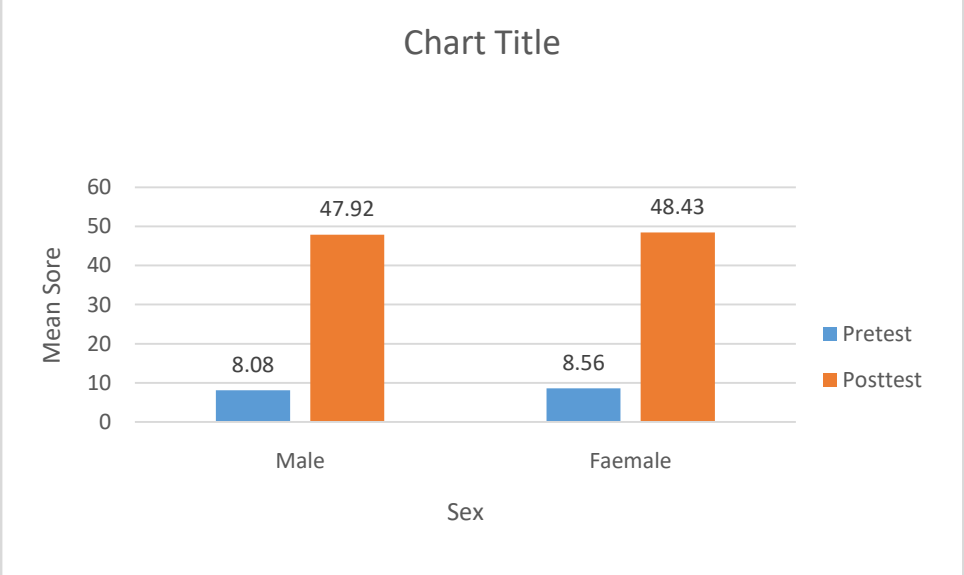
Gender	N	Pretest Test		Post Test		Mean Gain
		Mean	Std. Deviation	Mean	Std. Deviation	
Male	24	8.08	1.28	47.92	9.41	39.84
Female	16	8.56	.63	49.06	7.52	40.50
Total	40					

Table 4 revealed that the mean achievement scores of males and females in the process-oriented guided learning model group during the pretest were 8.08 and 8.56, with standard deviations of 1.28 and .63, respectively. Also, the mean achievement scores of male and female students taught chemistry using a process-oriented guided learning model during the posttest were 47.92 and 49.06. The difference between the pretest and posttest mean

achievement scores for the male and female students in the process-oriented guided learning model group was 39.84 and 40.50, respectively, with female students taught using the process-oriented guided Learning Model having a slightly higher mean gain than the males as clearly illustrated by figure 2 below.

Figure 2:

Bar chart of the mean achievement scores of male and female students taught chemistry using process-oriented guided learning model



To find out whether the mean difference is significant, Ho2was tested with t-test and presented in Table 5 below.

Hypothesis 2

There is no significant difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided learning model

Table 5

t-test comparing the Mean Achievement Scores of Male and Female Students Taught chemistry using Process-Oriented Guided Learning Model.

	Sex	N	Mean	Std. Deviation	Df	t-cal.	Sig. (2-tailed)	Remark
Posttest	Males	24	47.92	1.91	38	-1.06	0.29	Null hypothesis not rejected
	females	16	48.43	.51				

Level of significance=0.05

Table 5 is a summary of the t-test comparing the mean achievement Scores of male and female students taught chemistry using the process-oriented guided learning model. The table reveals that the p-value of the calculated t-value is greater than 0.05. With this result, $Ho_2$was not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students taught chemistry using the process-oriented guided learning model.

Discussion of Results

Finding from the testing of hypothesis one showed that there was a significant difference in the mean achievement score of chemistry students in process-oriented guided inquiry learning and the control group in Delta State. The possible explanation for this find could be that achievement is not by chance but rather an outcome of the instructional method explored by the teacher, as the post-test scores of all the students in all the groups were significantly higher than their pre-test scores. The results suggest that all the instructional methods studied can bring about learning, though at different levels. Hence it was found that Process-Oriented Guided Inquiry Learning brings about better learning among the students than the control. This result was consistent with research by Pakhira and Stains (2013), Soltis et al. (2015), and Degale and Boisselle (2015), which showed that using the POGIL technique enhanced students' test performance overall, enhanced their capacity for higher-order thinking, and created an engaging learning environment. The results indicated that there was not a significant impact on most measured attributes such as exam grade, attitudes and retention after the implementation of POGIL teaching. However, the observed trends seemed to favour POGIL strategy.

Analysis of hypothesis two indicates that there is no significant difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided inquiry learning in Delta State. The finding maybe due to the fact that the use of process-oriented guided inquiry learning enhances the achievement of both male and female students as the method provided equal opportunity all the students to participate actively in the learning process. This finding aligns with Barthlow and Watson (2014) who reported that the performance in the posttest of both female and male learners in their study was equally rated. This means that POGIL as a teaching strategy does not favour on particular gender. This result supports Alao and Abubakar's (2011) finding that there is no discernible difference in physics achievement between male and female students. The results concur with those of Amedu (2015), who found no relationship between gender and students' academic achievement in senior secondary schools. However, this result contradicts Bawaneh's (2018) findings, which indicated that there was a large gender gap in students' early achievement.

Conclusion

The study was conducted to examine the effects of process-oriented guided inquiry learning, on chemistry students' achievement in Delta State. From the finding of this study, it was concluded that the use of process-oriented guided inquiry learning enhances academic achievement of chemistry students in Delta State. Besides it was concluded that variation in academic achievement has nothing to do with sex but are entirely related to the instructional methods.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Chemistry teachers should make a deliberate effort to incorporate process-oriented guided inquiry learning method into the teaching of chemistry so as to promote better academic achievement among secondary school students.
2. In view of the fact that process-oriented guided inquiry learning is effective in teaching chemistry and enhancing students' academic achievement, the Ministries of Education should encourage textbook authors to incorporate practical ways of

using process-oriented guided inquiry learning in the teaching of chemistry concepts in secondary schools to improve students' achievement.

3. Regular workshops, seminars and symposia on effective utilization of process-oriented guided inquiry learning should be organized through universities for chemistry teachers in secondary schools to afford them the opportunity to learn the skills required for effective implementation of process-oriented guided inquiry learning method during chemistry teaching.

REFERENCES

Ajaja, O. P. (2013). Which way do we go in the teaching of biology? Concept mapping, cooperative learning or learning cycle? *International Journal of Science and Technology Education Research, 4*(2),18 – 29.

Alao, A. A., & Abubakar, R. B. (2011). Gender and academic performance of college Physics students: a case study of department of Physics/Computer science education, federal college of education, (technical), Omoku. Journal of Research in Education and Society, 1(1), 129-137.

Amedu, O.I. (2015). The Effect of Gender on the Achievement of Students in Biology Using the Jigsaw Method. *Journal of Education and Practice, 6*, 176-179.

Angelin, R.K & Cecily, H.S.J (2015). Effectiveness of lecture method Vs Panel of Discussion Among Nursing Students in India. *International Journal of Educational Science and Research (IJESR), 5 (*1), 77-84.

Barthlow, M. J. & Watson, S.M. (2014). The effectiveness Process Oriented Guided Inquiry learning to reduce alternative conceptions in Secondary Chemistry. *School Science and Mathematics,* 114 (5) (246 – 255).

Bawaneh, S. M. (2018). The correction of Hadith which was ruled and judged as weak or invented by following the revealed scientific fact. A theoretical and practical study," *Jordan Journal of Islamic Studies*: 14(3),

Brown, J. P. (2015). *Anatomy and physiology: A guided inquiry*. Wiley.

Chase, A., Pakhira, D., & Stains, M. (2013). Implementing Process-Oriented, Guided-Inquiry Learning for the First Time: Adaptations and Short-Term Impacts on Students' Attitude and Performance. *Journal of Chemical Education, 90*, 409-416.

Degale, S. & Boisselle, L.N. (2015). The effect of POGIL on academic performance and academic confidence. *Science Education International 26,* (1), 56-79.

Illahi, B.Y., & Khandai, H. (2015). Academic Achievements and Study Habits of College Students of District Pulwama. *Journal of Education and Practice, 7*, 19-24.

Oloyede, O. I., & Demide, C. O. (2018). Enhancing transition from concrete to formal cognitive functioning for improved achievement in chemistry. *African Journal of Research in Education, 2*(2), 129-134.

Omiko, A. (2017). Identification of the areas of students' difficulties in chemistry curriculum at the secondary school level. International Journal of Emerging Trends in Science and Technology 4(4), 5071-5077.

Sanda, A. & and Mazila, E. (2017). The Effect of Lecture and Discussion Methods of Teaching on Learner's Performance in Social Studies in Continuing Education Institution Borno State, Nigeria. *International Journal of Education and Educational Research*, 1(1), 1-40.

Soltis, R., Verlinden, N., Kruger, N., Carroll, A., & Trumbo, T. (2015). Process-oriented guided inquiry learning strategy enhances students' higher level thinking skills in a pharmaceutical sciences course. *American Journal of Pharmaceutical Education, 79*(1), 11-18.

Villagonzalo, E. C. (2014, March 6-8). Process oriented guided inquiry learning: An effective approach in enhancing students' academic performance (Conference Paper). *Presented at the DLSU Research Congress 2014* De La Salle University, Manila, Philippines.

Wanjohi, A.M (2016). Teaching and learning methods for Adult Learners. Hubpages.com/education/teaching-and-learning-method