

EFFECTIVENESS OF PROCESS-ORIENTED INSTRUCTIONAL STRATEGY ON SENIOR SECONDARY TWO CHEMISTRY STUDENTS' ACHIEVEMENT IN WASE LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA

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Abstract

This study investigated the effectiveness of process-oriented teaching strategy on senior secondary two students' achievement in Chemistry in Wase Local Government Area, Plateau State, Nigeria. A sample of 120 senior secondary two students was drawn from a population of 3206 chemistry students. Quasi-experimental research design was employed, particularly the non-equivalent control group pre-test post-test. The instrument for data collection was the Chemistry Achievement Test (CAT), which had a reliability coefficient of 0.73. The study aimed to answer two research questions and test two hypotheses at a significance level of 0.05. The findings of the study indicated that the process-oriented teaching strategy had a positive impact on students' achievement in Chemistry in secondary schools. There was a significant difference in the post-test scores between the control group and the treatment group after the treatment group was exposed to process-oriented teaching strategy. The treatment group had higher scores. Furthermore, there was a significant difference in the pre-test and post-test scores of the experimental group after being exposed to a process-oriented strategy, with the post-test scores being higher. Additionally, there was no statistically significant difference in the post-test scores between male and female students in the treatment group, approximately equal. Based on these findings, the study recommended that process-oriented teaching strategy should be employed for effective teaching and learning of chemistry and other science subjects, as it was empirically shown to enhance students' achievement.

Keywords: achievement, chemistry, gender, process-oriented, instructional strategy

Introduction

For any nation to develop technologically, it must apply scientific knowledge and principles in the day to day affair of its economy. According to Appoji (2017), this is to effectively impact on health, agriculture, transportation, energy production, industry, communication and commerce. This can be achieved by ensuring that students are effectively taught the basic skills in science and technology that will enable them live effectively within the global community. Trowbridge (2017) seems to agree with this assertion when he states that basic skills in science and technology will help in grooming students that will develop interest in learning science in the secondary school and beyond.

In recognition of this, the federal government of Nigeria while emphasizing the need for the teaching and learning of science in the 9-3-4 curriculum, formulated a policy on admission ratio of 60 science: 40 other (FRN, 2014). The teaching and learning of Chemistry concepts in the modern age have assumed a dimension that students and teachers are expected to embrace new methods of instruction. This is expected to guide the teaching and learning to conform to modern trends. This conformity is expected to yield positive outcome in the students' achievement. Modern educational system as it relates to the sciences and Chemistry in particular is expected to encourage technological advancement that can meet with the challenges associated with globalization. It is therefore important that the right instructional techniques be embraced. Chemistry is a branch of science which deals with the study of matter, properties, composition, changes undergone by matter and the uses of matter. It probes into the principles governing the changes matter undergoes, the complexity of the nature and changes that take place in the universe. The teaching and learning of chemistry involves the use of science process skills which are mental tools used in the discovery and acquisition of scientific knowledge. It involves conversion, procession production rebirth and transfiguration. Chemistry has been identified as one of the important science subjects and its importance in science and technological development of any nation has been widely reported (Abimbola, 2016). It was as a result of the recognition given to chemistry in the development of an individual and a nation, that it was made a core-subject among the natural sciences and it has been made a prerequisite subject for most of science and science related disciplines such as Medicine, Engineering, Pharmacy, Agricultural science among others in tertiary institutions.

In spite of the importance of Chemistry, students' achievement in chemistry reveals that only a very negligible number of students performed very well in senior secondary school certificate examinations (Muhammad, 2014). The issue of poor academic achievement among students in Nigeria has been of much concern to all stakeholders; this problem is so much that it has led to the widely falling standard of education in Nigeria. This implies that Chemistry teachers must evolve all means and utilize effective teaching strategies to increase students' interest and subsequently improve their achievement in Chemistry examination at the senior secondary school examinations. Improper teaching strategy has been identified as part of the underlying factors responsible for students' poor performance in the sciences.

In the light of this assertion, Sambo (2015) stated that there is a need for an approach in pedagogy that would encourage students' involvement. Students attempting to grapple with creative ways of solving problems that are presented in high schools or college courses can be solved merely by applying procedural knowledge with practice. The problem solving of this kind will require a process-oriented teaching approach. The aim of this process-oriented approach will be to produce students who know enough about a concept to grasp the knowledge embedded in the information and to be able to readily retrieve such knowledge and apply them to problem solving

Process-oriented instructional strategy is a teaching strategy that engages students in the classroom and promotes learning. It begins with introducing students to a model, diagram, problem, or set of data and then requires them to work as a team to answer a series of questions leading to development of a concept or principle. Thus, it uses elements found in team-based and problem-based learning. The strategy is based on the idea that learning has 2 components: content and process. While content is important for operating in any discipline, the ability to develop a deep understanding of a concept and the ability to apply that knowledge to solve novel problems the process component of learning is the critical skill.

Process-oriented strategy according to Vermunt (2015) is defined as instruction aimed at teaching thinking strategies and domain-specific knowledge in coherence. This new conception of instruction is derived from psychological research on the way students learn and on the

interplay between self-regulation and external regulation of learning. The process-oriented instructional strategy is anchored on constructivism theory of learning (CTL) by Vygotsky in 1972. Vygotsky's theory suggests that social interaction is important for learning because higher mental functions such as reasoning, comprehension and critical thinking originate in social interaction and are then internalized by individuals. Students can accomplish mental tasks with social support that students need to move learning forward. Vygotsky involves social interaction among students which makes the learning outcome simple to them which also enhances achievement which is the same with process-oriented teaching will guide the students perform better in Chemistry.

The role of students' gender in achievement cannot be overlooked. According to Abah (2014), the issue of gender has remained an important issue and it is very relevant in education because it has been linked to achievement and participation in certain professions. Vale (2016) discovered that gender difference in mathematics and science exists but they are declining over the years. Researchers such as Bamidele (2017) reported that graduates of science from the secondary schools, leave much to be desired in terms of their achievement in senior secondary certificate examinations.

However, none of the previous researchers have attempted the use of process-oriented instructional strategy to teach Chemistry in neither Plateau State nor Wase Local Government Area. Hence, the need to carry out this research to fill in the researcher intended to ask what was the effectiveness of process-oriented strategy on senior secondary two Chemistry students in Wase Local Government Area, Plateau state?

Purpose Of The Study

The main aim of this study was to study the effectiveness of process-oriented instructional strategy on senior secondary two chemistry students' achievement in Wase Local Government Area of Plateau State. The specific objectives of the study was to;

1. Determine the achievement of senior secondary two students in Chemistry before and after exposure to process-oriented instructional strategy.
2. Find out the achievement senior secondary two male and female students in the chemistry after exposure to process-oriented instructional strategy.

Research Questions

The following Research Questions were raised to guide the study;

1. What are the pre-test and posttest achievement scores of senior secondary Two students taught Chemistry using process-oriented instructional strategy and conventional method?
2. What are the post-test achievement scores of senior secondary Two male and female chemistry students when exposed to process-oriented instructional strategy?

Hypotheses

The following Hypotheses were formulated and tested and tested at 0.05 level of significance;

1. There is no significant difference between the post-test achievement scores of senior secondary Two students taught Chemistry using process-oriented instructional strategy and conventional method.
2. There is no significant difference between the post-test achievement mean scores of male and female students taught chemistry using process-oriented instructional strategy.

Methodology

The study adopted the non-equivalent control group pretest-posttest quasi-experimental design. The population for this study was all senior secondary two Chemistry students in Wase Local Government Area, Plateau state. The population of SSII students was 3206 in the year 2023.

The population consists of 2,102 males and 1,104 females. The sample for the study was made up of 120 students from two private secondary schools in Wase, Plateau state. This comprised of 68 males and 52 females.

Simple random sampling technique was used to select the two schools from the 27 (twenty-seven) public secondary schools in Wase Local Government Area of Plateau state.

The instrument used for this study was the Chemistry Achievement Test (CAT).

The Chemistry Achievement Test (CAT) comprised of 20 multiple choice items which covered the sub-topics treated in the study. These questions were adapted from the Senior Secondary Certificate Examination (WAEC). The CAT comprised two parts namely A, and B. Part A solicited student's basic information such as gender, and class. Part B consisted of 20 multiple choice questions with options A-E. This CAT was used as pre-test before the treatment to determine the entry level of equivalence of the two groups and as post-test after the treatment. The mean and standard deviation were the statistics used to answer the research questions and the students t-test to test the hypotheses.

Results

Research Question One:

1. What are the pre-test and posttest achievement scores of senior secondary Two students taught Chemistry using process-oriented instructional strategy and conventional method?

Table 1: Mean Achievement and Standard Deviation of Students Taught Chemistry Using Conventional and Process-Oriented Teaching Methods at Pre-Test

Group	N	PRE-TEST		POST-TEST		Mean Gain
		??	S.D	??	SD	
Control	65	34.08	8.380	49.08	7.801	17.378
Experimental	55	35.55	8.315	66.45	10.830	

N = Number of Students $\bar{x}$ = Mean Scores; SD = Standard Deviation

Table 1 revealed the achievement scores of students in control and experimental groups before they were taught Chemistry using conventional and process-oriented teaching methods. The students in the control and experimental groups had mean scores of 34.03 and 35.55 with standard deviations 8.380 and 8.315 respectively. It can be deduced from the results presented in the table that the pre-test mean achievement scores of students in control and experimental were very close and approximately equal. This implies that, before the treatment, the mean achievement scores of students are approximately equal. Students taught using a conventional method (control) had a mean score of 49.08 while students taught using a process-oriented method (experimental) had 66.45. The standard deviation of students in control is 7.801 while that of experimental group is 66.45. As the table revealed, the mean gain between the two groups is 17.378 which is quite wide. Comparing the mean achievement scores between the students in control and experimental groups at post-test, it can be deduced that students taught using a process-oriented method of teaching had the higher value of mean score which implies that they performed better than the students taught using conventional method of teaching. This implies that discussion method is more effective than the traditional method of instruction.

Research Question Two

What are the post-test achievement scores of senior secondary two male and female chemistry students when exposed to process-oriented instructional strategy?

Table 2: Mean Achievement and Standard Deviation of Male and Female Students Taught Chemistry Using Process-Oriented Teaching Method at Post-Test

Gender	N	$\bar{x}$	S.D	Mean Gain
Male Students	31	66.13	10.141	0.746
Female Students	24	66.88	11.870	

N = Number of Students $\bar{x}$ = Mean Scores; SD = Standard Deviation

Table 2 revealed the mean achievement scores of male and female students taught Chemistry using process-oriented teaching method at post-test. The mean achievement scores of male and female students are 66.13 and 66.88 respectively. The mean gain between the two gender is 0.746. Also, the table showed that the standard deviation of male students is 10.141 while that of female students stands 11.870. From the results, it showed that male and female students had equal mean score implying that when process-oriented teaching method is employed in teaching process, both genders will perform equally with respect to academic achievement. The standard deviations between the two gender also indicated unanimity of the values as both are far away from approaching zero.

Testing Of Hypotheses

HO₁: There is no significant difference between the post-test achievement scores of senior secondary Two students taught Chemistry using process-oriented instructional strategy and conventional method.

Table 3: t-Test Analysis on the Difference Between the Mean Achievement Scores of Students Taught Chemistry Using Conventional and Process-Oriented Teaching Methods at Post-Test

Group	N	Mean	Df	t _{-cal}	P-value	Decision
Control (Conventional Method)	65	49.08	118	10.188	0.003	Rejected
Experimental (Process-Oriented Method)	55	66.45				

t_{-cal} = 10.188, p = 0.003 < 0.05 the null hypothesis is rejected

Results in Table 3 showed the result of an independent sample t-test between the mean achievement scores of students taught Chemistry using conventional (control) and process-oriented (experimental) teaching methods at post-test. Testing at an alpha level of 0.05, t_{-cal} = 10.188 with a p-value of 0.003 which is less than the alpha level of 0.05 (p = 0.003 < 0.05) indicating a significant difference in the scores between the two groups as they were taught using different teaching methods. Therefore, the null hypothesis which states that **there is no** significant difference in the post-test achievement mean scores of students in control and experimental groups is rejected.

H₀; There is no significant difference between the post-test achievement mean scores of male and female students taught chemistry using process-oriented instructional strategy.

Table 4: Analysis on the Difference Between the Mean Achievement Scores of Male and Female Students Taught Chemistry Using Process-Oriented Teaching Method at Post-Test

Gender	N	Mean	Df	t _{cal}	P-value	Decision
Male	31	66.13				
Female	24	66.88	53	-0.251	0.800	Accepted

t_{cal}= -0.251, p=0.800 > 0.05 the null hypothesis is accepted

Table 4 presented the result of an independent sample t-test between the mean achievement scores of male and female students taught Chemistry process-oriented (experimental) teaching method at post-test. Testing at an alpha level of 0.05, $t_{cal} = -0.251$ with a p-value of 0.800 which is greater than the alpha level of 0.05 ($p = 0.800 > 0.05$), implying that the mean achievement scores between the male and female students do not differ but approximately equal. Therefore, the null hypothesis which states that gender does not have significant effect on students' achievement mean scores taught with process-oriented method of teaching post-test is retained.

Discussion

Findings based on research question one with respect to the mean achievement scores of students in control group (those taught with conventional method) and experimental group (those taught with process-oriented method) in secondary schools in Wase Local Government Area of Plateau State revealed that the pre-test mean achievement scores of students in control and experimental groups are approximately equal. This implies that, before the treatment, the mean achievement scores of students are approximately equal. This finding is in agreement with the finding of Aloranini (2012) whose research findings indicated that both control and experimental groups have the same entry level, which in turn proves the equivalence of the two groups at pre-test. The finding of DwiSurjono (2015) also supports the finding of this study that there is no difference in the pre-test mean of the experimental and control groups

Findings based on research question two in relation with the post-test mean achievement score of students taught Chemistry using conventional teaching method (control group) and those taught with process-oriented method (experimental group) in secondary schools in Wase Local Government Area of Plateau State revealed that students in experimental group recorded higher value of mean score compared to their counterparts in the control group. This implies that students in who were taught using process-oriented teaching method outperformed the students taught using conventional teaching method. it can be deduced that process-oriented strategy is effective and can improve students' learning outcome. Little wonder Agboghorma and Oyovwi (2015) established that process-oriented strategy is recommended as a vital tool to improve students' performance in Chemistry. The finding of this study also agrees with the submission made by [Verlinden](#) (2015) who established that Process-oriented guided inquiry learning (POGIL) teaching strategy improves students' performance and engages higher-level thinking skills.

Findings based on research question to in relation with the mean achievement score of male and female students taught Chemistry using discussion method at post-test in secondary schools in Toro Local Government Area of Bauchi State revealed that female students had a mean score a little above the mean score obtained by male students at decimal point which is narrow and

negligible and so can be concluded that when Chemistry is taught using a discussion teaching method, the achievement scores of both male and female students will be approximately equal or the same. This implies that gender does not influence students' achievement. This finding is in disagreement with the opinion of Muntoni and Retelsdorf (2019) who opined that gender plays a crucial role in students' academic achievement, this include gender stereotypes. The finding study also disagrees with the findings made by Talabi, Emiola, and Ogunsaki (2013) who in their study on activity level and academic ability of primary school children aged between 6-11 years in Kwara State, revealed that girls had better improvement in academic ability as activity level increased than the boys.

Moreover, Hypothesis one showed no significant distinction between the pre-test scores of the control and treatment groups following the implementation of the Chemistry achievement test (CAT). A P-value of 0.33 was obtained, which falls above the 0.05 probability level, providing substantial evidence to support the hypothesis. These findings are consistent with the research conducted by Usang and Okoli (2021), who examined the impact of the process-oriented strategy on the academic achievement of secondary school students in chemistry. Their study revealed that there is no significant difference in the mean academic achievement scores between students in the pre-test achievement test. The results have equal mean scores. Akanmu (2019) conducted a study on the effects of the process-oriented strategy on senior school students' performance in mathematics in Ilorin, Nigeria. Akanmu's research unveiled a statistically insignificant difference in the performance of students in their pre-test achievement mean scores.

Similarly, finding with respect to H_{02} as regards the difference between mean achievement scores of students in control and experimental groups revealed that the result of the p value obtained (0.003) is less than the alpha level of significance of 0.05 and this implies an existence of significant difference between the two groups. It was revealed that students taught Chemistry using process-oriented strategy recorded higher mean scores than those taught using conventional method. This finding is supported by what Oviawe and Lukmon (2017) found in their study which showed, among other things, that students taught technical drawing using the Process Oriented strategy had higher mean achievement and interest scores than those taught using the conventional teaching method.

Also, finding with respect to H_{03} as regards the difference between mean achievement scores of male and female students taught Chemistry using process-oriented strategy revealed that the result of the p value obtained (0.800) is greater than the alpha level of significance and this implies a nonexistence of difference. Therefore, it can be deduced that gender does not have significant effect on students' achievement mean scores when taught with process-oriented method of teaching. This finding is supported by Sakiyo and Waziri (2015) who found out in their study that there are no longer significant distinctions in the academic achievement of students based on gender. To further support the finding of the study, Eze (2017) also suggested in his study that gender no longer plays a significant role in determining students' performance in Chemistry. On the contrary, Jia and Wu (2020) in their study presented a different finding, indicating that boys tend to outperform girls in Chemistry. They further established that gender disparities still exist in terms of academic achievement, with boys generally exhibiting higher performance in the subject.

References

- Abah, C.O. (2014). Gender stereotyping in Nigerian secondary school physics textbooks. *Journal of the Nigerian Academic of Education*, 2(3), 14-26.
- Abimbola, I.O. (2016). *Philosophy of science for degree students*. Osogbo: Olatunbosun Publishers.
- Adesoji E. A., (2018). Students Teacher and School Environment. Factors as Determinant of achievement in senior secondary schools Chemistry in Oyo State, Nigeria. *UlurlarsiSosalAraUrmalaraDergisi*. The journal of International Social Research 1(2), 15-25
- Appoji, S. (2017). Effect of concept mapping on academic achievement of students in physics in relation to gender. *International Journal of Advanced Research in Education and Technology*, 4(1), 15-17
- Bamidele, E. F. (2013). Attitudes of Nigerian secondary school chemistry students towards concept mapping strategies in learning the mole concept. *Academic Journal of Interdisciplinary Studies*, 2(2), 457–484. Published by MCSER-CEMAS-Sapienza University of Rome. Retrieved June 28, 2019
- F.R.N (2014). National policy on education. N.E.R.D.C. Press Yaba Lagos Nigeria.
- Federal Ministry of Education (2017) Senior secondary education curriculum Chemistry for ss1-3. Abuja, Nigerian Education Research and Development Council.
- Ikeobi, I. O. (2010). Beyond the stereotype Thought and reflections on Education . The CIBN Press LTDPp 112-116
- Jegede (2017). Students' Anxiety towards Studying Chemistry in some selected Secondary Schools. *Educational Research and Review*, 1(2), 193-197.
- Muhammad, B. A., (2014). Influence of Conceptual Instructional Method on Students' academic Performance in Practical Chemistry Concepts. Among Secondary School Students Kaduna State, Nigeria. An unpublished PhD thesis at Ahmadu Bello University, Zaria, Nigeria.
- Osayimwense, N. (2017). *Theories of instruction and learning. A Literature review on 'concept mapping'*. Unpublished Master's assignment, department of curriculum and instructional technology, faculty of education. University of Benin, Benin City.
- Sambo, A. A. (2015). *Research methods in education*. Stirling–Horden Publishers (Nig) Ltd.
- [Verlinden](#), N. (2015) Process-Oriented Guided Inquiry Learning Strategy and its application. *American journal of pharmaceutical education* 79(1): 11. Retrieved 10/11/2017
- Vermunt, J.D. (2015) process-oriented teaching. *Eur J PsycholEduc* 10: 325. <https://doi.org/10.1007/BF03172925> Springer Netherlands
- Vygotsky, L. S. (1972). Thinking and speech. In R.W. Rieber & A.S. Carton (Eds.), *The collected works of L.S. Vygotsky, Volume 1: Problems of general psychology* (pp. 39–285). New York: Plenum Press. (Original work published 1934.)