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Effect of Gender on Students' Attention and Academic Performance in Analytical Chemistry Using Collaborative-Predict-Explain-Observe-Explain (CPEOE)

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Abstract

This research investigated the possibility of enhancing senior secondary school students' academic performance irrespective of gender in analytical chemistry concept using Collaborative-Predict-Explain-Observe-Explain (CPEOE). The study adopted a quasi-experimental research design. Analytical Chemistry Attention Inventory (ACAI) and Analytical Chemistry Performance Test (ACPT) were the instruments used for data collection. Cronbach Alpha was used to ascertain the reliability index of ACAI which gave reliability value of 0.87. The internal consistency of ACPT was tested using Kuder-Richardson (KR-21) formula which yielded a reliability value of 0.96. The population was 7,152 SS2 students offering chemistry in Makurdi, Benue State, Nigeria. A sample of 157 students drawn from 3 schools in Makurdi Local Government Area of Benue State, Nigeria was selected using multi-stage sampling techniques. Four research questions and four null hypotheses guided the study. The research questions were answered using Mean and Standard Deviation scores while the null hypotheses were tested at 0.05 level of significance using results from Analysis of Covariance (ANCOVA). The study revealed among others, that there was no significant difference between the mean attention rating of male and female students taught analytical chemistry {$F_{1, 78}$ = 1.020, P>0.05}. It was also revealed that that there is no significant difference between the mean academic performance of male and female students taught analytical chemistry using CPEOE {$F_{1, 78}$ = 4.890, P>0.05}. It was recommended among others that since CPEOE is not gender sensitive. Hence, both male and female students should be involved in CPEOE classroom to enhance their attention and academic performance in analytical chemistry. Serving teachers should be encouraged to use CPEOE in teaching analytical chemistry concepts.

Keywords: CPEOE, students' attention, academic performance and analytical chemistry concepts

1. Introduction

One of the specific objectives to be achieved for

chemistry in the curriculum is to provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective and to provide students with the skills needed to succeed in post-secondary school and in the chemical industries (NERDC, 2012). Chemistry is the central in the drive of global sustainable economic, science and technology development. It plays vital roles in food, clothing, housing, medicine and transportation. It is therefore necessary that students offering chemistry in senior secondary schools should understand the subject so that they can apply the knowledge to everyday interactions. Chemistry is the study of matter, analyzing its structure, properties, reactions and the use of such reactions to form new substances (Ajayi, 2019). Analytical chemistry which is the main focus of this study is a branch of chemistry that deals with the analysis of different substances. It involves the separation, identification, and the quantification of matter. It is utilized in pharmaceutical industries as the shelf lives of many medicines are determined with the help of analytical chemistry. It can be employed in the process of chromatography where the blood samples of a person are classified. It has been found very useful in different industries such as food factories, chemical industries, agricultural industries and in scientific laboratories.

Students who offer chemistry and science related courses in higher institutions are expected to pass chemistry in SSCE at credit level and above. Despite this expectation, poor performance in chemistry by students appears to have persisted. The issue of poor academic performance in chemistry at the SSCE in Nigeria has been widely documented. For instance, Ajayi and Atsuwe (2024) revealed that all the senior secondary candidates that registered for the Senior Secondary Education Certificate Examination in Makurdi in 2019 only 39.09% passed chemistry at credit level and in the subsequent years the percentage passes at credit level dropped to 36.68% in 2020 and only 37.75% in 2021. This poor academic performance is attested to by Chief Examiner report of WAEC (2021/2022) that students' performance in chemistry is relatively poor especially in some aspect of analytical chemistry such as identification of fats and oils, acid/base titration, test for oxidants and reductants, mole ratio, determination of degree of purity, crystallization and solubility.

Students' poor academic performance in chemistry is often blamed on poor teaching methods that do not put into consideration the students' attention and prior experience in teaching and learning processes. It has been observed that not much attention is placed on effective teaching strategies of this subject. This has led to failure to produce the desired results in terms of students' attention and academic performance. Poor teaching method invariably translates to students' inattention and poor academic performance. Most Nigerian chemistry teachers use discussion method most frequently in their classrooms which usually degenerate into mere talk and may be monopolized by few individuals. Based on this, the nation's quest for chemistry to produce citizens equipped with the right scientific skills for national development will become a mirage, if effective modality is not put in place to incorporate innovative methods that promote meaningful learning.

Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things. Gaetana (2019) defined attention as the ability to mentally focus, attend and sustain concentration over a period of time. Attention can be defined as that faculty of the intellect which focuses single mindedly on one object without interruption. Attention can be summarized as complete concentration using intense mental effort. The critical factor in the learning process, according to Hale and Lewis (2020) is attention. Unless the attention of the learner is captured, optimal learning will not occur. Teachers need to capture the attention of learners during a lesson, irrespective of their learning style and, if the attention of learners tends to wander, teachers should be able to shift rapidly to a new activity to capture it once again. It is therefore important to determine what appeals to different learners during a lesson and in this context the use of innovative strategies such Collaborative-Predict-Explain-Observe-Explain (CPEOE) strategy may be an option to consider.

In this study, attention is the students' behavioural and cognitive process of selectively concentrating on chemistry classroom learning. The effective teachers should know how to focus students' attention automatically. Teachers should be knowledgeable about sensitive ways, which the teaching strategies should involve, to affect students with special needs like

inattentive students or hyperactive students, whose attention should be diverted towards the lesson and basic activities during the class. The teacher can play a crucial role in awakening talents and developing participation to attain attention. Yusuf (2019) believed that learning is likely to be enhance, and students' academic performance would be better if they are given more time and if their attention is directed towards the learning tasks and activities using innovation instructional strategies. This assertion calls for the need to find innovative strategy such as CPEOE instructional strategy that have the potentials to equip learners to think about their cognition, monitor their learning activities and evaluate the results of these activities and thereby enhancing their conceptual understanding.

Collaborative learning engages learners in active learning where they work and learn together in small groups to accomplish shared goals. In collaborative learning students explore their ideas, clarify them for themselves and to one another, expand and modify them and finally make them their own. CPEOE model is a five-step conceptual change instructional model and it is from this step the acronym "CPEOE" is derived. CPEOE is an instructional model where learners in a small group setting collaboratively make predictions for an event and explain the reasons for their predictions, then conduct and observe a laboratory experiment and are required to compare their observations with their predictions, thereby enhancing conceptual understanding of scientific knowledge. Ajayi (2019) opine that the CPEOE is done by requiring learners to carry out five tasks as follows:

Phase 1: Collaborate (C)

Before presenting students with all the relevant background information, divide learners into groups of 3-6 depending on the class size to collaboratively learn and more specifically as joint problem-solving group(s).

Phase 2: Predict (P)

In the Predict (P) step, information about an experiment or event is given to students and the students are supposed to predict the outcome of this even or situation. The prediction stage provides students an opportunity to focus on observation and it promotes motivation.

Phase 3: Explain (E)

In this stage, they are expected to give explanation or reason for their prediction. In this step, the students' understanding, and alternative conceptions are identified while they are discussing on their task.

Phase 4: Observe (O)

The students describe what they see in the observe (O) step. This may be an experiment, an event or a video related to the learning issue. These activities should be easy for observation, and they should constitute a conflict.

Phase 5: Explain (E)

In this Explain (E) step, the students inquire differences between their prediction and observation in order to reconcile any conflict between their prediction and observation. The students discuss and share their explanations. In this way, they do not repeat the books; they can explain the phenomenon with their own sentences.

Ogunkunle (2014) opined that gender is dynamic and culturally determined whereby responsibilities are assigned to male and female children. The author further refers to gender as the characters, behaviours and roles which societies ascribed to male and females. One of the National objectives of Education as spelt out in the National Policy on Education (FGN, 2013) is to develop a Nigeria with bright opportunities for all citizens. The expectation of this policy is for equal opportunities to be made available for both male and female students to attain their maximum potentials in education. Instructional materials and teaching methods are expected to have gender equity if this policy is adhered to. Gender issues have attracted the attention of many educators and other researchers as a result of which a lot of literature exists on different aspects of the concept. For instance, numerous studies have been carried out on gender and social role; gender and work role; gender, and gender and academic performance. Gender issues in the learning process have continued to engage the interest of researchers in chemistry because of the influence it exerts on chemistry learning. Conceptually, gender has to do with socially constructed differences which lead to forms of inequality such that the male is regarded as superior and all-knowing and the female as inferior and incompetent. Gender inequality in chemistry has remained a perennial problem of global scope. The differences between boys and girls in relation to

chemistry academic performance have received a lot of attention in recent years. Some studies indicate that boys achieve better (Ogbeba & Ajayi, 2017), either no difference (Agamber, 2022) or girls outperform boys (Olorunyomi, 2018) have been demonstrated. Studies on gender differences in chemistry academic performance continued to yield inconsistent results and it has usually been attributed to unequal exposure of males and females to learning instructions relevant to chemistry learning. Thus, the study investigated if CPEOE instructional strategy have any effects on both male and female students' attention and academic performance in chemistry, especially analytical chemistry concepts in Senior Secondary School Chemistry Curriculum.

1.1 Purpose of the Study

The purpose of this study was to investigate the effect of gender on students' attention and academic performance in Analytical Chemistry Concepts using CPEOE. Specifically, the study was set out to:

1) Ascertain the difference in the effect of CPEOE on male and female students' attention ratings in analytical chemistry concepts.
2) Find out the interaction effect of methods and gender on students' attention ratings in analytical chemistry concepts.
3) Determine the difference in the effect of CPEOE on male and female students' academic performance in analytical chemistry concepts.
4) Ascertain the interaction effect of methods and gender on students' academic performance in analytical chemistry concepts.

1.2 Research Question

The following research question guided this study:

1) What is the difference in the mean attention ratings between male and female students taught analytical chemistry concepts using CPEOE?
2) What is the interaction effect of methods and gender on students' attention ratings in analytical chemistry concepts?
3) What is the difference in the mean academic performance scores between male and female students taught analytical chemistry concepts using CPEOE?
4) What is the interaction effect of methods and gender on students' academic performance in analytical chemistry concepts?

1.3 Hypotheses

The following null hypotheses guided the study:

1) The difference in the attention ratings of male and female students taught analytical chemistry concepts using CPEOE is not statistically significant.
2) There is no significant interaction effect of methods and gender on the attention ratings of students in analytical chemistry concept.
3) The difference in the academic performance of male and female students taught analytical chemistry concepts using CPEOE is not statistically significant.
4) There is no significant interaction effect of methods and gender on the academic performance of students in analytical chemistry concept.

2. Research Design and Procedure

The study adopted a quasi-experimental research design. The study area is Makurdi, Benue State, Nigeria. Makurdi is the capital of Benue State, located in central Nigeria, and part of the middle belt region of central Nigeria. Makurdi is situated on the south bank of the Benue River. Makurdi and the surrounding areas had an estimated population of 365,000 (NPC, 2016). The major ethnic groups in Makurdi are Tiv, Idoma, Igede and so on. The population for this study comprises all the students offering chemistry in senior secondary school two in Makurdi, numbering 7,152 students from all the 78 approved senior secondary schools in Makurdi Local Government Areas of Benue State, Nigeria (Benue State Teaching Service Board, Statistics Unit, 2021). The sample of this study was made up of 157 SS2 students that were drawn from 3 schools using purposive sampling technique. Analytical Chemistry Attention Inventory (ACAI) and Analytical Chemistry Performance Test (ACPT) were the instruments used for data collection.

Analytical Chemistry Attention Inventory (ACAI) was a researcher made 25 items questionnaire which was intended to help students express their attention towards learning analytical chemistry. Each of the items is a 4-point Likert modified rating scale with 4 response options. The options are NT (Not True), ST (Slightly True), MT (Moderately True) and VT (Very True). The items were developed from information acquired through review of relevant literature by the researchers. Analytical Chemistry Performance Test (ACPT) was adapted from Senior Secondary Certificate Examination (SSCE) past examination question papers of 2018-2023. ACPT items were based on SSCE, which is standardized, since the target of the study is to improve the students' academic performance, at this level. The test instrument consists of two sections. Section A consists of bio-data information of the respondents, while section B consisted of 40 multiple choice objective items with four options (A, B, C, D) drawn from analytical chemistry concepts to which respondents are expected to provide the correct answers by selecting the correct option.

Analytical Chemistry Attention Inventory (ACAI), Analytical Chemistry Performance Test (ACPT) and the instructional packages (lesson notes) were face validated by presenting them to two experts in science education and one expert in Measurement and Evaluation. The items were scrutinized by these expects. Corrections and suggestions arising from these experts were used to review the instrument and the instructional packages. ACPT upon validation were trial tested to establish the reliability of the instruments by administering ACPT to a randomly selected 49 SS2 students at a senior secondary school which is not part of the schools selected for this study. After 1 week of 9 periods of teaching, the ACPT was administered with the help of the research assistants. Upon validation, Cronbach Alpha was used to ascertain the reliability index of ACAI which gave reliability value of 0.87. Kuder-Richardson (KR-21) formula was used to test internal consistency of ACPT. The instrument (ACPT) gave reliability value of 0.96. According to Maduabum (2011), the coefficients of 0.50-0.99 indicate that the instruments are reliable.

During the main study, intact classes were assigned to experimental and control groups. Thereafter, Analytical Chemistry Attention Inventory (ACAI) and Analytical Chemistry Performance Test (ACPT) was administered as pre-test by the teachers that served as research assistants. This lasted for one week before actual teaching commences. During lessons, the teachers taught the experimental group analytical chemistry topics such as identification of fats and oils, determination of degree of purity, crystallization and solubility using CPEOE learning model in line with lessons procedure prepared by the researcher and the control group were taught the same analytical chemistry topics using the discussion lesson plans. This lasted for three weeks. At the end of these actual teaching periods, the pre-ACAI and pre-ACPT was reshuffled and administered as post-test which lasted for one week. Descriptive statistics of mean and standard deviation scores were used to answer the research question, while the inferential statistic of Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

3. Results

Presentations in this section are based on research question and null hypotheses.

3.1 Research Question One

What is the difference in the mean attention ratings between male and female students taught analytical chemistry concepts using CPEOE? The answer to research question one is presented on Table 1.

Table 1. Mean Attention Ratings and Standard Deviation Scores of Male and Female Students Taught Analytical Chemistry using CPEOE

Group	Gender	N	PRE- ACAI		POST- ACAI		Mean Gain within Gender
			$\tilde{x}$	δ	$\tilde{x}$	δ	
CPEOE Strategy	Male	44	6.14	1.74	17.71	5.19	11.57
	Female	35	6.12	1.76	16.99	5.12	10.87
Mean diff. between Gender			0.02		0.72		0.70

Table 1 reveals the mean attention rating and standard deviation scores of male and female students taught analytical chemistry concept using CPEOE instructional strategy. The data in Table 1 show that the pre-test mean scores for male and female students were 6.14 and 6.12 with standard deviation scores of 1.74 and 1.76 respectively while the post-test mean scores were 17.71 and 16.99 with standard deviation scores of 5.19 and 5.17 respectively. The mean difference of both sexes was 0.70. This difference though small is in favour of the male students. This implies that male students had slightly higher attention rating than their female counterparts in CPEOE.

3.2 Research Question Two

What is the interaction effect of methods and gender on students' attention ratings in analytical chemistry concepts? The answer to research question two is presented on Figure 1.

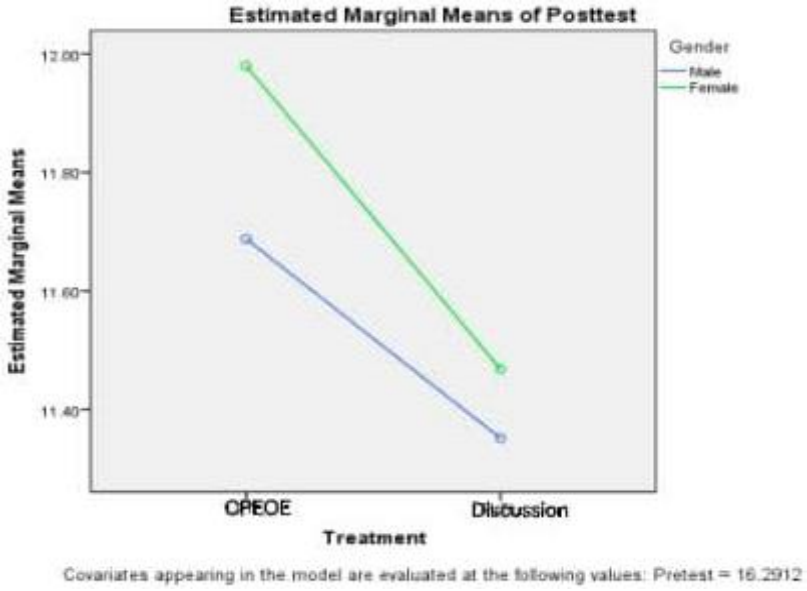

Figure 1. Graph of the Interaction Effect of Methods and Gender on Students' Attention in Analytical Chemistry

Figure 1 revealed that methods and gender have no interaction effect on the attention rating of the students in analytical chemistry. This is indicated by the separate lines in the respective instructional methods for the attention rating of male and female students in analytical chemistry. This implies that CPEOE is superior to discussion method at the two level of gender in terms of enhancing students' attention in Analytical Chemistry.

3.3 Research Question Three

What is the difference in the mean academic performance scores between male and female students taught analytical chemistry concepts using CPEOE? The answer to research question three is presented on Table 2.

Table 2. Mean Academic Performance and Standard Deviation Scores of Male and Female Students Taught Analytical Chemistry using CPEOE

Group	Gender	N	PRE- ACPT		POST- ACPT		Mean Gain within Gender
			$\tilde{x}$	δ	$\tilde{x}$	δ	
CPEOE Strategy	Male	44	9.09	1.44	24.91	7.19	15.82
	Female	35	9.08	1.46	23.97	7.12	14.89
Mean diff. between Gender			0.01		0.94		0.93

Table 2 reveals the mean academic performance and standard deviation scores of male and female students taught analytical chemistry concept using CPEOE instructional strategy. The data in Table 2 show that the pre-test mean scores for male and female students were 9.09 and 9.08 with standard deviation scores of 1.44 and 1.46 respectively while the post-test mean scores were 24.91 and 23.97 with standard deviation scores of 7.19 and 7.12 respectively. The mean difference of both sexes was 0.93. This difference though small is in favour of the male students. This implies that male students had slightly higher academic performance than their female counterparts in CPEOE.

3.4 Research Question Four

What is the interaction effect of methods and gender on students' academic performance in analytical chemistry concepts? The answer to research question four is presented on Figure 2.

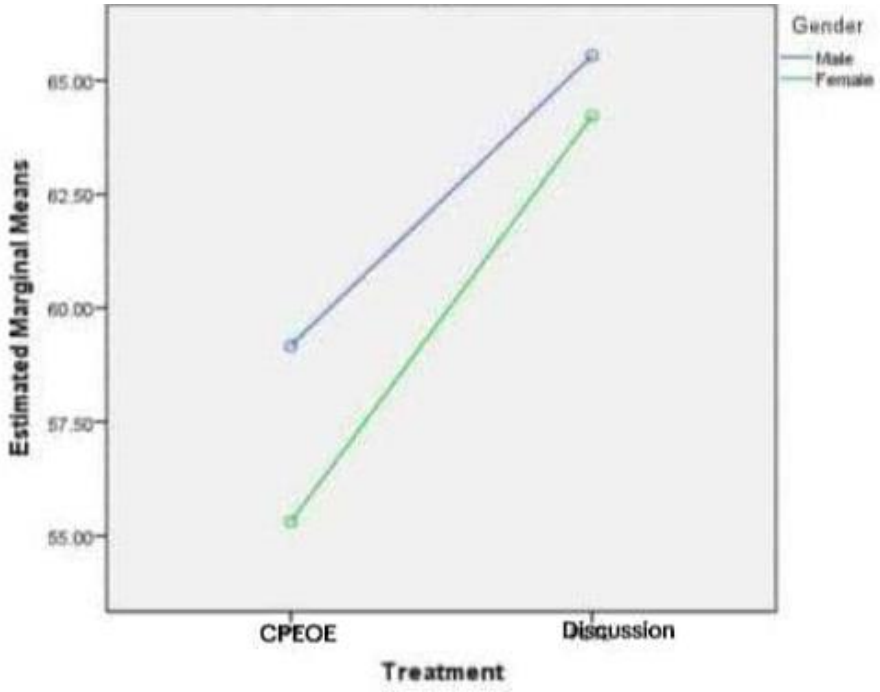

Figure 2. Graph of the Interaction Effect of Methods and Gender on Students' Academic Performance in Analytical Chemistry

Figure 2 revealed that methods and gender have no interaction effect on the academic performance of the students in analytical chemistry. This is indicated by the separate lines in the respective instructional methods for the academic performance of male and female students in analytical chemistry. This implies that CPEOE is superior to discussion method at the two level of gender. This implies that CPEOE is superior to discussion method at the two level of gender in terms of enhancing students' academic performance.

3.5 Hypothesis One

The difference in the attention ratings of male and female students taught analytical chemistry concepts using CPEOE is not statistically significant. The answer to hypothesis one is presented on Table 3.

Table 3. ANCOVA Result for Attention Rating of Male and Female Students Taught Analytical Chemistry using CPEOE

Source	Type III sum of squares	*df*	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	28.984[a]	2	14.492	.174	.503	.006
Intercept	17.812	1	17.812	221.107	.000	.652
TPr[ACAI]	.899	1	.899	.107	.713	.000

Gender	.131	1	.131	1.020	.251	.012
Error	4.974	77	.065			
Total	1119.001	79				
Corrected Total	2.998	78				

Note: R squared = .042 (Adjusted R Squared= -.029).

ANCOVA Test result in Table 3 reveals that there is no significant difference between the mean attention rating of male and female students taught analytical chemistry using CPEOE {$F_{1, 78}$ = 1.020, P>0.05}. The null hypothesis is therefore not rejected. This means that CPEOE enhanced both male and female students' attention in Analytical Chemistry. Meanwhile, the effect size of 0.012 is considered as very small. This implies that, only 1.2% of the difference in the attention of male and female students taught analytical chemistry was explained by CPEOE. Hence, the difference in the attention rating of male and female students taught analytical Chemistry using CPEOE has small statistical effect size.

3.6 Hypothesis Two

There is no significant interaction effect of methods and gender on the attention ratings of students in analytical chemistry concept. The answer to hypothesis two is presented on Table 4.

Table 4. Analysis of Covariance for Attention Ratings of Students taught Analytical Chemistry using CPEOE and Discussion Method

Source	Type III sum of square	*df*	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	3493.193[a]	4	873.298	32.004	.000	.449
Intercept	399.508	1	399.508	84.099	.000	.439
TPr^{ACAI}	72.167	1	72.167	1.882	.130	.034
Group	431.001	1	431.001	92.005	.000	.812
Gender	1.007	1	1.007	1.327	.140	.007
Group*Gender	.401	1	.401	.151	.210	.014
Error	629.110	154	4.085			
Total	9824.030	157				
Corrected Total	1613.303	156				

Note: R squared = .427 (Adjusted R Squared= .423).

ANCOVA Test result in Table 4 reveals that there is no significant interaction effect of methods and gender on the mean attention rating of students in analytical chemistry {$F_{1, 156}$ = .151, P>0.05}. The null hypothesis is therefore not rejected. Meanwhile, the effect size was 0.014 which is considered a small effect size. This implies that 1.4% of the interaction in the attention rating among methods was explained by treatments and gender. Therefore, the interaction of treatments and gender on students' attention rating has small statistical effect size. Therefore, there is no need for separation of instructional method for male and female students since CPEOE can be used successfully for the two groups to enhance their attention in chemistry classroom.

3.7 Hypothesis Three

The difference in the academic performance of male and female students taught analytical chemistry concepts using CPEOE is not statistically significant. The answer to hypothesis three is presented on Table 5.

Table 5. ANCOVA Result for Academic performance of Male and Female Students Taught Analytical Chemistry using CPEOE

Source	Type III sum of squares	*df*	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	177.002[a]	2	88.501	.204	.411	.001
Intercept	34.002	1	34.002	109.010	.000	.412
TPr^{ACPT}	.660	1	.660	.201	.349	.000
Gender	.190	1	.190	4.890	.382	.001
Error	8.014	77	.110			
Total	3219.000	79				
Corrected Total	5.009	78				

Note: R squared = .222 (Adjusted R Squared= -.118).

ANCOVA Test result in Table 5 reveals that there is no significant difference between the mean academic performance of male and female students taught analytical chemistry using CPEOE {$F_{1, 78}$ = 4.890, P>0.05}. The null hypothesis is therefore not rejected. This implies that CPEOE enhanced both male and female students' academic performance in analytical chemistry. Meanwhile, the effect size of 0.001 is considered as very small. This implies that, only 0.1% of the difference in the academic performance of male and female students taught analytical chemistry was explained by CPEOE. Hence, the difference in the academic performance rating of male and female students taught analytical Chemistry using CPEOE has small statistical effect size.

3.8 Hypothesis Four

There is no significant interaction effect of methods and gender on the academic performance of students in analytical chemistry concept. The answer to hypothesis four is presented on Table 6.

Table 6. Analysis of Covariance for Academic Performance of Students taught Analytical Chemistry using CPEOE and Discussion Method

Source	Type III sum of square	*df*	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	4281.100[a]	4	1070.275	56.001	.000	.340
Intercept	501.009	1	501.009	84.099	.000	.431
TPr^{ACPT}	89.097	1	89.097	1.882	.130	.031
Group	345.001	1	345.001	101.001	.000	.712
Gender	.895	1	.895	2.003	.265	.005
Group*Gender	.381	1	.381	.171	.310	.002
Error	833.000	154	.289			
Total	9868.000	157				
Corrected Total	1993.001	156				

Note: R squared = .447 (Adjusted R Squared= .401).

ANCOVA Test result in Table 6 reveals that there is no significant interaction effect of methods and gender on the mean academic performance of students in analytical chemistry {$F_{1, 156}$ =.171, P>0.05}. The null hypothesis is therefore not rejected. Meanwhile, the effect size was 0.002 which is considered a small effect size. This implies that 0.20% of the interaction in the academic performance among methods was explained by treatments and gender. Therefore, the interaction of treatments and gender on students' academic performance has small

statistical effect size. Therefore, there is no need for separation of instructional method for male and female students since CPEOE can be used successfully for the two groups to enhance their academic performance.

4. Discussion of Findings

The study investigated the effect of gender on Students' attention and academic performance in analytical chemistry concepts using CPEOE. The finding of this study revealed that male students had higher attention rating than their female counterparts using CPEOE, but ANCOVA test revealed that the difference was not significant. However, there was scarcity of studies on effect of gender on students' attention using CPEOE. This finding agrees with Ogbeba and Ajayi (2017), who found that no gender disparity exists in the achievement of male and female chemistry students taught stoichiometry using hands-on activities. In the same vein, this finding is also in line with Arslan and Emre (2021), Ozcan and Uyanik (2022) findings that Predict-Observe-Explain (POE) is an effective strategy in improving students' academic achievement, scientific process skills and attitude towards science than conventional teaching method. However, the finding contradicts Abe (2011) who found that female outperformed male in basic science using field-trip. The likely reason for this outcome may be attributed to the fact that CPEOE strategy helped the learners to explore concept and generate investigation. Furthermore, the students are given the chance to express their schema and experience the ideas behind the activity to satisfy their curiosity and thinking process compared to the discussion method.

The finding of this study revealed that male students had higher academic performance than their female counterparts using CPEOE, but ANCOVA test revealed that the difference was not significant. This finding is in line with Gernale, Aranes and Duad (2015) findings that students improved significantly in their achievement in elementary basic science when taught using POE strategy compared to those taught using traditional teaching method. Thus, the likely reason for this outcome may also be connected to the fact that the use of CPEOE provides a format for students to see how knowledge is developed through the process of reflecting on what they know and the investigation they undertake thereby enhancing conceptual understanding compared to discussion method that only promotes passive learning.

This finding of this study also revealed that there is no significant interaction effect between method and gender on attention rating and academic performance in analytical chemistry using CPEOE. It shows that CPEOE is superior to the discussion method irrespective of gender in fostering attention and academic performance in analytical chemistry. Therefore, there is no need for separation of instructional strategy for male and female students since CPEOE can be used successfully for the two groups.

5. Conclusion

It is evident from the findings of this study that no gender disparity exists in the attention rating and academic performance of male and female students taught analytical chemistry concepts using CPEOE learning model. This implies that CPEOE is very rewarding for students in terms of enhancing their classroom attention and academic performance regardless of their gender. It was also found that CPEOE enhanced students' attention and academic performance in analytical chemistry than discussion method regardless of gender. Since, there is no significant interaction effect between methods and gender. Therefore, CPEOE can be used successfully for the two groups to enhance their classroom attention and academic performance in analytical chemistry concepts. The following recommendations were made:

1) CPEOE is not gender sensitive. Hence, both male and female students should be involved in CPEOE classroom to enhance their attention and academic performance in analytical chemistry. Serving teachers should be encouraged to use CPEOE in teaching analytical chemistry concepts.
2) The curriculum developers should use CPEOE learning models to develop and refine the Analytical Chemistry Concept in SSCE Chemistry curriculum.

Workshop, conferences or seminars should be organized by Ministry of Education and other relevant educational stakeholders on the need for CPEOE activities in the teaching and learning of Analytical Chemistry Concepts in SSCE Chemistry Curriculum in order to enhance both male and female students' classroom attention and academic performance in Chemistry.

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