Effect of Activity Student-Centered Experiment and Improvisation Teaching Strategy on Students' Chemistry Achievement in Federal Capital Territory, Abuja

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Abstract

The impact of the Activity Student-Centered Experiment and Improvisation (ASEI) teaching approach on the academic achievement of chemistry learners at senior secondary schools located in the Federal Capital Territory of Abuja was examined by the researcher. Research questions and research hypotheses were developed from the study's research objectives. The research design used for this investigation was pretest posttest control group quasi-experimental research design. Purposive sampling was used to select 160 students from among the 1,680 SS One chemistry students that made up the study's population. The data for the study were collected with the use of Chemistry Achievement Test (CAT) that was validated by two experts in science education and educational measurement and evaluation. The Kuder Richardson formula-21 was employed to determine the reliability of CAT and a co-efficient value of 0.89 was obtained. The data collected were analysed using descriptive statistics to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the research hypotheses. The findings of the study revealed that using the ASEI method of instruction improves learners' chemistry achievement more than the use of traditional methods. It was recommended among others that in-service and pre-service educator training programs in Nigeria should incorporate the application of the ASEI strategy for instruction by educators' trainers. This will make it possible for educators who teach chemistry to implement category exercises that incorporate the use of the ASEI teaching strategy in their teaching process.

Keywords: Activity student-centered, Experiment, Improvisation, Chemistry achievement

Introduction

Chemistry is the driving force behind robust growth in economies on a global scale. It is necessary for the manufacturing of fuel and alloy materials for transportation, food (fertilizers and insecticides), textiles for clothing, cement, concrete, steel, and bricks for housing, and medications. The technological and scientific developments of the modern era have an everyday effect on man. The content's their significance, potency, and their relevance enable it to meet the needs of a larger population.

It has been established that chemistry education is one of the key pillars assisting in the transformation of our nation's economy. One way that chemistry influences technology is through bringing

the tasks of creating stock levels, molding, constructing, and other activities into the domain of contemporary science (Emeji, 2019). The goal of the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project, which was developed in collaboration with the Japanese government by the Government of Nigeria's Ministry of Education, Science, and Technology (MOEST), is to raise the academic performance and accomplishments of chemistry students. Strengthening of Mathematics and Science in Secondary Education, or SMASSE for short, is a program of learning whose main goal is to assist Nigerian secondary schools in raising their students' the fulfillment in math and science. Academic achievement and gender in a learner might be related.

According to Siocha et al. (2023), there are several reasons why girls in Nigeria perform poorly in science classes and other technology-related activities. The absence of appropriate regulations which encourage them and unfavorable cultural context attitudes and practices are two factors that discourage girls from engaging in scientific pursuits. Consequently, a pertinent plan built on knowledge gained from successful models and lessons learned at all levels—regional, national, and international—should be the basis for achieving gender parity in science and technology (Siocha et al 2023). In schools, there is a propensity for boys more than girls to favor science and technology courses. Because of their attitude regarding them, boys perform better academically in these subjects than girls do. Boys tend to go into science and technology fields after school. This is a widely studied topic because it is a global phenomenon shared by many systems of instruction.

The main factors contributing to low academic achievement in Chemistry were constantly recognized as comprehensive syllabuses, insufficient funds, and inadequate personnel. Science and math have been strengthened in secondary schools as a result of the Ministry of Education and other public belief that action is necessary (Chendo, 2019). This seminar attendees will acquire the skills to implement the Activity, Students, Experimentation, and Improvisation pedagogy. The project seems to be the perfect solution for Nigeria's predicament, given that the country has always suffered from a dearth of educational resources. One of the teaching strategies employed in the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project is the Activity Student-Centered Experiment and Improvisation (ASEI) teaching strategy.

The Strengthening of Mathematics and Science in Secondary Education (SMASSE) project was initiated by the Federal Government of Nigeria and the Japanese government through the Ministry of Education, Science and Technology (MOEST) with the aim of enhancing the academic performance and learning of chemistry learners. The main objective of the subject matter that is known as Strengthening of

Mathematics and Science in Secondary Education, or SMASSE, is to assist secondary schools in Nigeria in improving the grade point average assessments of learners in mathematics and science.

The United States Department of Education and the Japan International Cooperation Agency (JICA) are working together on it (Sunday et al., 2022). Activity, Student-centered, Experiment, and Improvisation is an abbreviation for "ASEI." It is a method of instruction that seeks to organize the entire educational experience around the student. As a result, the activity based/student-centered techniques is to replace the "banning style and chalk and talk" technique in theory. In order to make a measure, ASEI acknowledges that instead of just reproducing words verbatim, learners also interpret words in their own ways. To produce scientific knowledge, they must be given the opportunity to integrate their mental procedures, previous understanding, and monitoring.

At present, gaining a lot of attention is the instructional paradigm shift known as the student-centered ASEI teaching strategy. It seems that there are differences in definitions of educator-centered instruction among the contributors. Some define it narrowly as just engaged studying, while others describe it more generally as the transfer of power from the teacher to the learners, choice in studying, and engagement in learning (Chendo, 2019). The Activity Student-Centered Experiment and Improvisation (ASEI) conduct states that effective education and instruction, and subsequently good math and science performance, depend on having engaging educational events. The tasks at hand are meaningfully mouths-on (discussions), minds-on (psychological thinking, argumentation), hands-on (manipulation), and heart-on (those that spark students' curiosity or emotions regarding the matter). In order to support successful education, the ASEI approach strongly emphasized learners complete a well-planned academic assignment that involves monitoring and improving their performance. This resulted from ASEI's realization that significant education takes place in environments where learners actively engage in guided, carefully thought-out activities meant to acquire expertise and abilities.

Activities and experiments that have been created to provide learners with possibilities to learn important concepts, develop the abilities that are required, and enjoy developing what they are studying are typically included in an ASEI lesson. It is advised for learners to indicate on what they have learned in order to improve the instruction and make sure they learn related concepts in the future. Nwenyim (2022) stated that what a learner does is truthfully more significant when evaluating what is learned than what the teacher does, lacking taking away from the vital function participated by the teacher. The goal of guidance is to make students learn. The following steps are part of the ASEI teaching strategy, the trainer splits the class into categories as soon as he gets into the room to teach, with the intention of having the groups finish the hands-on assignments or operations in tandem. The teacher will arrange the teaching aids on the tables for

each group before the lesson begins. The teacher will ask learners to name the items being studied, and a classification will be decided depending on their abilities and characteristics.

After describing how to finish the tasks, he will ask the students to point out these items in their groups. Throughout instruction, the teacher will give the students directions on how to finish the tasks. He guides the learners along the way and gives them guidelines so they can finish their assignment effectively. Participants are encouraged to ask questions as the course of study goes along if they have any questions. The educator provides an in-depth description of the material to the class after the group reports. Group members read the papers that learners have written to the class after the educator asks them to share their thoughts or conclusions. The educator goes over the lesson's goals and psychological goals after the demonstrations are finished. He then asks open-ended questions of learners to gauge whether the lesson's goals have been reached.

Lastly, the teacher summarizes the subject matter to wrap up the class. The educator gives assignments at the end of class requiring to be looked in the following afternoon. The way that students are performing academically in the subject of chemistry worries both the government and educators. Over the past 20 years, Nigerian schoolchildren's achievement in chemistry has not been uplifting, regardless of the subject's importance in a country's development (Otutu, 2014). Many reasons have been suggested for this chemical threat. Among the many influencing variables are insufficient laboratories, poor teaching strategies, and the attitudes of both teachers and students. The researcher is driven to look into how the ASEI strategy affects chemistry achievement among learners in Federal Capital Territory, or FCT, Abuja, in an effort to address this issue.

Regardless of the crucial nature of chemistry, inadequate proficiency in the subject has long been an issue. Many of the instructional strategies used to help learners learn chemistry have not greatly benefited pupils for a long time. This suggests that chemistry education has not resulted in students learning chemistry or applying most of the concepts to real-world scenarios. A lot of variables, which comprises of the skills and abilities of the teachers, how they instruct, their abilities, the attitudes of learners, and their incapacity to experiment, have been connected to the low achievement and negative attitudes of the students. One consequence of low chemistry achievement on national development is a decrease in the proportion of students enrolled in tertiary courses related to chemistry. It is necessary to remedy what has occurred as a result.

Of all the things mentioned as possible reasons why students perform poorly, the examiner is most worried about the teaching approach utilized in chemistry classes. Subsequently, the project was broadened and transformed into a national self-initiative. One method that is frequently employed to deal with the

previously mentioned problem is the ASEI strategy. Large amounts of cash and supplies have been given to the initiative. Yet, not much has been discovered about how well students fared when taught chemistry using the ASEI approach since the conclusion of the third cycle. So, the question is: To what extent does the strategy improve the achievement of learners in chemistry? In light of this, the author was inspired to look into how the ASEI approach affected the chemistry achievement of students in the FCT.

Purpose of the Study

The study intends to:

i. ascertain the mean difference between the achievement scores of chemistry students taught using ASEI teaching strategy and conventional teaching method.
ii. determine the mean difference between the achievement scores of male and female students taught chemistry using ASEI teaching strategy.

Research Questions

The following research questions were answered by the study.

i. What is the mean difference in the achievement scores of senior secondary school students taught chemistry using ASEI teaching strategy and conventional teaching method?
ii. What is the mean difference between the achievement scores of male and female senior secondary school students taught chemistry using ASEI teaching strategy?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance**.**

H_{01}: there is no significant difference between the achievement scores of senior secondary school students taught chemistry using ASEI teaching strategy and conventional teaching method

H_{02}: there is no significant difference between the mean achievement scores of male and female students taught chemistry using ASEI teaching strategy.

Methodology

This study adopt a quasi-experimental non-equivalent experimental research design. A continuing cohort of respondents received treatment as part of the design, and an additional pair of individuals functioned as an untreated group. The population of the study comprises of 1,680 SS One Chemistry students who attended 18 Government Senior Secondary Schools in the Federal Capital Territory of Abuja. The total of 160 SS One science students in the intact groups from the four study schools were the sample

for the research. They were selected at random and comprised of 65 female and 95 male students. Purposive sampling techniques was used to select four schools from two distinct area municipalities which are Kwali and Gwagwalada area councils in Abuja. The Chemistry Achievement Test (CAT) was the instrument used by the researcher to collect data. Two experts from the Department of Science Education, University of Abuja and an expert in educational measurement and evaluation from the University of Agriculture, Makurdi validated the Chemistry achievement test. A trial test of the Chemistry Achievement Test (CAT) items was conducted on thirty students from Government Secondary School Okpo in Kogi State. Since SS One students are exposed to the same chemistry curriculum, this school was not included in the study. Students were chosen with the understanding that their characteristics are similar to those of the population. The Kuder Richardson formula-21 was employed to determine the reliability of the Chemistry achievement test and a co-efficient value of 0.89 was obtained. There were two stages to the experimental process. The research participants took the pre-test one week prior to the administration of the experimental treatment (ASEI teaching strategy) as the first stage. Following the pre-test, the participant spent four weeks in intact groups learning about the chosen content of acids, bases, and salts, as well as carbon and its compounds. After the collection of data, the research questions were answered using descriptive statistics, specifically mean and standard deviations while the research hypotheses were tested using inferential statistics of Analysis of Covariance (ANCOVA) at 0.05 significant level.

Results

Research Question 1: What is the mean difference in the achievement scores of senior secondary school students taught chemistry using ASEI teaching strategy and conventional teaching method?

Table 1: Mean Achievement Scores and Standard Deviation of Students in Experimental and Control Groups

Groups	**N**	**Pretest**		**Posttest**	
		Mean	SD	Mean	SD
Experimental	74	54.11	4.53	83.57	5.78
Control	86	53.50	4.36	61.63	6.06
Total	**160**				
Mean Difference		**0.61**		**21.94**	

The result on Table 1 revealed that the experimental group scored 54.11 on average in the pretest, with a 4.53 standard deviation, whereas the control group scored 53.50 on average with 4.36 standard deviation. Also it was revealed in the table that the experimental group scored an average of 83.57 on the posttest, alongside a standard deviation of 5.78, whereas the control group scored an average of 61.63, with a standard deviation of 6.06. The experimental group's mean gain was determined to be 29.46 based on the Pretest and Posttest scores, whereas the control group's mean gain was 8.13. The experimental and control groups' mean achievement score differences on the pretest were 0.61 and 21.94, respectively, on the posttest.

This indicates that there is more achievement gain by the experimental group between their pretest and posttest scores.

Research Question 2: What is the mean difference between the achievement scores of male and female students taught chemistry using ASEI teaching strategy?

Table 2: Mean Achievement Scores and Standard Deviation of Male and Female Students in Experimental Group

Groups	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	42	56.26	2.81	83.24	6.71	26.98
Female	32	51.28	4.84	84.00	4.32	32.72
Total	**74**					
Mean Difference		**4.98**		**-0.76**		

The result in table 2 indicates that, in the Pretest, the mean achievement score for male participants in the experimental group was 56.26 alongside a standard deviation of 2.81, whereas the mean achievement score for the female participants was 51.28 with a standard deviation of 4.84. In the posttest, the mean achievement score for the male participants in the experimental group was 83.24 with a standard deviation of 6.71, while the mean achievement score for the female participants was 84.00 with a standard deviation of 4.32. The mean gain for males was 26.98 based on the Pretest and Posttest scores, whereas the mean gain for females was found to be 32.72. The average variations in the pretest achievement scores between male and female participants was 4.98, whereas the posttest average variation was 0.76.

Testing of Hypotheses

Research Hypothesis 1: There is no significant difference between the achievement scores of students taught chemistry using ASEI teaching strategy and conventional teaching method.

Table 3: Summary of Analysis of Covariance (ANCOVA) of the Achievement Scores of Students in Experimental and Control Groups

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	19263.654[a]	2	9631.827	277.965	.000
Intercept	4127.656	1	4127.656	119.120	.000
Pretest	118.010	1	118.010	3.406	.067
Group	18850.716	1	18850.716	544.013	.000
Error	5440.246	157	34.651		
Total	848968.000	160			
Corrected Total	24703.900	159			

The ANCOVA analysis of the data gathered from the posttest results for learners taught chemistry using both the traditional teaching approach and the ASEI teaching strategy is shown in Table 3. The result

revealed that F-value (1,157) = 544.013, $p<0.05$, indicating the rejection of the null hypothesis. This reveals that the achievement scores among participants who were instructed in chemistry using the traditional method and the ASEI teaching strategy differed significantly. Hence, the null hypothesis is not accepted. This mean that there is significant difference between the achievement scores of students taught chemistry using ASEI teaching strategy and conventional teaching method. This suggests even more that the experimental group's ratings for success improved relative to those of the control group.

Research Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught chemistry using the ASEI teaching strategy.

Table 4: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Achievement Scores in Chemistry

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	87.110[a]	2	43.555	1.316	.275
Intercept	3481.857	1	3481.857	105.239	.000
Pretest	76.566	1	76.566	2.314	.133
Gender	4.316	1	4.316	.130	.719
Error	2349.053	71	33.085		
Total	519218.000	74			
Corrected Total	2436.162	73			

The ANCOVA analysis of the data gathered from the posttest results of male and female students who were taught chemistry utilizing the ASEI teaching strategy is shown in Table 4. The result revealed that F (1, 71) = 0.130, $p>0.05$, indicating the acceptance of the null hypothesis. This reveals that the achievement scores of male and female participants taught chemistry using the ASEI teaching strategy do not differ significantly. It shows that the instruction in chemistry using the ASEI teaching strategy will not make the achievement scores of male and female students to differ from each other.

Discussion of findings

The results of this study showed that the use of ASEI teaching strategy considerably improve students' chemistry achievement. The result in table revealed that, prior to the implementation of the treatment, the experimental and control groups' mean achievement scores were 54.11 and 53.50, accordingly, with associated standard deviations of 4.53 and 4.36 which does not show much difference in their pretest achievement. Conversely, following the treatment, the experimental and control groups' mean achievement scores were 83.57 and 61.63, for example, with corresponding standard deviations of 5.78 and 6.06. After the treatment, there was a mean difference of 21.94 and 0.61 in the achievement scores of the experimental and control groups respectively. This reveals unequivocally that students in the experimental group outperformed those in the control group in terms of chemistry achievement scores.

Moreover, in the hypothesis testing, the p value of 0.00 from the result in table 3 indicated that there was a significant difference in achievement scores of students taught chemistry using ASEI teaching strategy (experimental group) and conventional teaching method (control group). This demonstrates that implementing the ASEI approach to teaching of chemistry considerably improve students achievement. The significant difference could be as a result of involvement of students in class work or learning activities which is the child-centered and participatory aspect of ASEI that leads to constructivism, learning and causes retention in what is learnt. The results are consistent with those of Jackson and Joseph (2014), Otutu (2014), and Emeji (2019) who discovered that using the ASEI enhance student achievement in the Impact of Strengthening of Chemistry and Science in Secondary Education Program on the teaching and learning of Physics in mixed day secondary schools in Lari District, Central Province, Kenya. They stated that the application of the features of ASEI approach in the teaching of basic science promotes quality teaching and learning; improves performance of teachers in pedagogical skills and resources utilization as well as pupil's participation in classroom activities which consequently improves the students' performance.

Furthermore, the findings revealed that male and female participants had mean achievement score of 56.26 and 51.28 respectively before treatment, with standard deviation of 2.81 and 4.84. After treatment, the mean achievement scores increased to 83.24 and 84.00, accordingly, with standard deviations of 6.71 and 4.32. The male and female students' mean achievement scores before and after treatment were 26.98 and 32.72 respectively. This difference reveal that there is no significant difference between the male and female participants score after the teaching of chemistry using the ASEI teaching technique. Also, the result of the hypothesis testing in table 4 revealed a p-value of 0.719 which is greater than 0.05 alpha level. This indicate that there is no significant difference between the mean achievement scores of male and female students taught chemistry using the ASEI teaching strategy. It further shows that chemistry achievement of students taught using the ASEI teaching approach does not depend on gender of the participants. This result supports the findings of Dangpe (2015) and Abdullahi (2016), which show that there is no significant difference in the academic performance of male and female students. This means that the strategy had no significant impact on the achievement of students when comparison was made between male and female participants.

Conclusion

From the finding, it was concluded that the use of ASEI teaching strategy enhances students' achievement in chemistry more than the conventional methods. It can also be concluded that in the use of ASEI teaching strategy, gender did not have any significant influence on the achievement of students in chemistry.

Recommendations

Based on the results of this study, it is recommended that:

(i) Chemistry teachers should welcome and accept the usage of ASEI teaching strategy as one of the teaching strategies to be used in teaching and learning of chemistry in our schools.

(ii) Educational authorities should encourage teachers of chemistry to use ASEI teaching strategy in their teaching.

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