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EFFECT OF 5E INSTRUCTIONAL LEARNING MODEL ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN PHYSICS

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Abstract
This study investigated the effect of 5E (Engage, Explore, Explain, Elaborate, and Evaluate) instructional learning model (5E ILM) on senior secondary school students' achievement in Physics. A quasi-experimental, non-randomized control group, pretest and posttest design was used for the study. The sample size for the study consisted of 126 physics students drawn from the population of 428 senior secondary school II (SS 2) physics students in 16 government owned co-educational senior secondary schools in Nnewi Education Zone. Purposive sampling was adopted to select eight schools with two stream classes out of the 16 co-educational schools. Random sampling without replacement was used to draw four schools with intact classes that was used for the research study. Open balloting was adopted to select schools for experimental and control group, two schools each for the group. Two research questions and two null hypotheses guided the study. An instrument titled Physics Achievement Test (PAT) were used for data collection. The validation of the instruments was done by three experts. The instrument was estimated on reliability co-efficient using K-R-20 for PAT which yielded a reliability index of 0.72. The data collected PAT was analysed using mean and standard deviation to answer the research questions, while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). From the result findings, it was observed that physics students taught Physics with 5E ILM had higher mean achievement score than their counterpart taught Physics with conventional traditional lecture teaching method (TLTM) after the posttest treatment. Furthermore, it was shown that there was there was a high difference in interaction effect of method and gender on students' mean achievement scores in physics between students taught Physics with 5E instructional learning model and students taught Physics with conventional traditional lecture teaching method (TLTM) after the posttest treatment. Educational implication of the research study implies that from the results findings, 5E ILM promotes learning achievement among physics students. It was recommended that if all sectors that are involved in school system programming will incorporate 5E ILM in Physics curriculum planning and other relevant science subjects, there will be observed learning achievement among physics students and other related subjects. Therefore, the contribution to knowledge of 5E ILM towards Physics learning is that it fosters a deeper knowledge of Physics principles

and concepts by letting students investigate and explore ideas. This enhances students' achievement in physics.

Keyword: 5E Instructional Learning Model, Learning Achievement, Physics and Students

Introduction

Physics is a systematical study or discipline that studies the interaction between energy and matter and its paramount importance in the universe and phenomenal activities of nature. The need to improve in Physics learning programme for national development should be of great necessity as Physics plays an immeasurable role in many factors of career, life, technology, micro and macro life science. Furthermore, Pember (2014) further posited that physics attempts to answer philosophical questions about the nature of the universe and provide solutions to technological problems. Physics is also referred to as the science of measurement and its knowledge has contributed greatly to the production of instruments and devices that are of tremendous benefit to the human race (Agommuoh, 2015). Physics is also a discipline that is involved with scientific thinking and mind-set that requires students to be tested through observation and experimentation (Wilbert, 2020). Studies by Okafor (2018) observed that physics learning not only exposes physics students to understand that creativity and innovation are associated with scientific and technological advancement but also inculcates in the students the attitude towards scientific thinking as a way of life. Physics learning also encourages the students to work based on scientific studies, develop a positive attitude, and most importantly increase their knowledge and skills in active scientific ideas.

Against this background, it is necessary that those who study physics should understand the content and concepts for them to be able to apply knowledge gained, outside the classroom. Therefore, proper understanding of Physics concepts based on quality instructions will likely improve students in Physics. Hence, there is need to examine what would be done to allay students' under-achievement in physics which are persistently reported by West African Examination Council (WAEC) Chief Examiner's report. One of the reasons that have been attributed to physics students' under-achievement in secondary school Physics is their inability to understanding Physics concepts (Okafor & Umezulike, 2021). Zewdie (2019) also posted that the under-academic achievement in Physics can be attributed to other factors such as an excessive utilization of conventional teaching methods due to insufficient teaching period for physics classes, lack of interest for learning among physics students, and physics students' misconceptions of the subject. Furthermore, the findings of Erugul and Crgrik (2020) noted that wrong explanation of Physics concepts and numerical expression also contribute to physics students' difficulty in understanding Physics concepts. Therefore, for effective Physics teaching and learning to take place, Atkin and Karplus in their theoretical research

(1962) argued that there is a set order of events in learning processes that facilitates learning, which they termed the learning circle; this learning cycle involves three key elements: exploration, introduction stage and concept application.

In support of the above-term scheme, Appiah-Twumasi et al. (2021) noted that for any instructional teaching and learning model or strategy to yield desirable Physics learning, there should be consistency in applying such learning instruction widely to have the desired effect on physics students' learning outcome. Furthermore, adopting such teaching and learning models or strategies equip the physics students with the opportunity to learn through student-centred learning approaches which have the ability to create and facilitate meaningful physics learning. To achieve such desirable Physics learning outcome, Cakir (2017) highlighted that steps upon which if effectively applied, students can learn with interest and they include introduction, discovery, description, expansion and assessment. These learning steps to Cakir (2017) enable physics students develop more learning interest, retain more and apply what they learned by engaging in significant and constructive appealing learning activities. Therefore, to develop learning interest and improved positive academic achievement of physics students, there is the need that physics teachers teach Physics by using adequate and appropriate effective instructional models instead of persistent use of conventional instructional learning approach such as lecture teaching method, problem-solving, and among others. In the observations of Ahmad et al. (2019) revealed that students often atimes cannot maintain knowledge which has been offered to them through conventional teaching method. However, reviewed literatures show that use of effective teaching such as constructivist learning approach facilitate learning and makes it more meaningful.

Constructivist learning is considered a veritable tool for shifting physics teaching from the traditional conventional teaching method to innovative and informative learning approach. In constructivist physics class according to Appiah-Twumasi et al. (2021: 4), "the teacher poses a problem and monitors students' exploration, guides students inquiry and promotes new pattern of learning." Constructivist view of learning recognizes the fact that physics students' needs time to express their current Physics learning, interact with the learning materials, substances and equipment to develop a range of physics learning experiences. Grau et al. (2021) noted that among the constructivist teaching and learning models which have being proven to be effective for physics learning is the 5E Instructional Learning Model. Adopting 5E instructional learning model in physics teaching and learning could be the gate way towards enhancing physics learning among physics students. In research findings of Turan (2021) noted that the observation from teachers' experiences in the 5E instructional teaching and learning model varies in terms of time allocation, resources, method courses, training, content knowledge and classroom size, which influences teachers' pre-service practice. Adding to that, Ellah and Achor (2018) also observed that

5E constructivist approach was superior to conventional instructional method in facilitating students' achievement and attitude towards physics adding that statistically significant difference was observed in the mean achievement scores of male and female students in physics after treatment with the female students performing statistically higher than the male students. Also, Nguyen and Bui (2021) show in their research findings that learners show more interest and excitements to learn in the 5E teaching model than the traditional teaching.

The 5E instructional learning model was developed in 1987 in the Biological Science Curriculum Study in order to promote collaborative, active learning in which students work together to solve problems and investigate new concepts by asking questions, observing, analyzing, and drawing conclusions (Lesley University, 2022). To Ellah and Achor (2018: 125) 5E instructional learning model describes a phase of learning that lead students through five phases which are described using words that begin with the letter E: Engage, Explore, Explain, Elaborate, and Evaluate. However, the 5E instructional learning model is a learning cycle that will guide physics students through five learning experiences to comprehend, draw a meaningful understanding of physics concepts and creates knowledgeable channels for Physics, beginning with their initial understanding of Physics (engage) and how they finally react towards physics learning (evaluate). Several other studies that carried out on the utilization of 5E instructional learning model in teaching and learning which include the study by Olanrewaju et al. (2018: 58) who revealed that using 5E instructional learning model is better employed when introducing a new concept in physics topics to physics students to hasten their learning understanding. Similarly, Addae and Agyei (2018) equally showed that students taught using the 5E instructional learning model, performed significantly better with the learning instruction.

Despite the importance of physics to the scientific and technological development of any society and nation, students' academic achievement in physics has consistently been under expectation as shown by West African Examination Councils' (WAEC) Chief Examiners' reports and also from various research findings. The Chief Examiner's report also portrayed that under-expected achievement in physics is a strong indication of students' poor conceptual understanding of the of Physics concepts. Reviewed related research findings show that some of the causes of the under-expected achievement in Physics could be attributed to the various kinds of instructional strategies utilized by physics teachers in the teaching and learning process.

Research findings equally show that the instructional teaching strategies utilized by physics teachers do not match the needs and aspirations of 21st century learners, as they only encourage rote memorization and do not encourage students' active participation with one another in the learning processes that could help in enhancing their problem solving and constructive thinking skill. Therefore, there is the need for physics teachers to utilize

instructional teaching approaches that could be used to identify physics students' learning difficulties, strengths and weaknesses to enable the teachers meet the needs and aspirations of the physics students. The active role which each student played in physics learning gives them a sense of responsibility which is essential in understanding concepts which otherwise would have been considered as difficult.

However, from the various studies reviewed, there is gross controversy regarding the effect of 5E instructional learning model on students' academic achievement. Hence, the need to further investigate the study to determine the effect of 5E instructional learning model on secondary school students' achievement in physics in Nnewi Education Zone of Anambra State.

Research Questions

The following research questions guided the study:

1. What is the mean achievement scores of students taught physics using 5E instructional learning model and those taught with conventional traditional lecture teaching method (TLTM)?
2. What is the interaction effect of method and gender on students' mean achievement scores in physics?

Research Hypotheses

The following null hypotheses were tested at a 0.05 level of significance.

1. There no statistical significant difference in the mean achievement scores of students taught physics using 5E instructional learning model and those taught with conventional traditional lecture teaching method (TLTM).
2. There no statistical significant interaction effect of method and gender on students' mean achievement scores in physics.

RESEARCH METHOD

The study employed a quasi-experimental design. The pretest-posttest non-equivalent control group design was adopted. This design was considered appropriate for this study because intact classes (Non-randomized groups) was used for the study.

The population of the study consisted of all 428 senior secondary school (SS 2) physics students from 16 co-educational secondary schools in Nnewi Education Zone in Anambra State. Co-educational schools were used because one of the sub-variables in the study is gender. Also SS 2 physics students were used because topics for the study were form SS 2 Physics syllabus, and also SS 2 class is not an exam to reduce tension on the students.

The sample size for this study consisted of 126 (63 males and 63 females) physics students draw 16 co-educational secondary schools in Nnewi Education Zone. Co-educational secondary schools were used only because the sub-variable for this study was gender. Purposive sampling was adopted to select eight schools with two stream classes out of the 16 co-

education schools. Random sampling without replacement was used to draw four schools with intact classes that was used for the research study. Open balloting was adopted to select schools for experimental and control groups, two schools each for the groups. Schools used for experimental treatment were taught using 5E instructional learning model while the control group schools were taught with TLTM. The schools for experimental treatment consisted of, school A with 15 males and 17 females physics students and school B with 18 males and 11 females physics students, which gives a total number of 61 (33 males and 28 females) physics students for experimental treatment, while the schools for control treatment consisted of, school A with 15 males and 18 females students and school B with 15 males and 17 females physics students, which gives a total number of 65 (30 males and 35 females) physics students for control treatment.

The instrument was Physics Interest Scale (PIS). The PIS were a 30 items interest scale that were scored on a four-rating scale of Strongly Agree (SA = 4 points), Agree (A = 3 points), Disagree (D = 2 points) and Strongly Disagree (SD = 1 point). Participating students indicated the extent they agree with the items. The instrument was face validated by experts measuring in Measurement and Evaluation, Science Education and Pure Industrial Physics department from Chukwuemeka Odumegwu Ojukwu University, Anambra State. The experts were specially requested to assess the suitability of the research instruments, the appropriateness of the instruments, assess whether the instruments meet the specifications, assess the appropriateness of the language of the instruments and the suitability of the items for the intended subjects. A pilot test was conducted to determine the reliability of the instrument Physics Achievement Test (PAT). The reliability of the instrument was done using twenty-five SS 2 physics students from a school in Aguata Education Zone in Anambra State different from the area of study. The data obtained from the students' responses were used to estimate the reliability of the instrument. The reliability of PIS items was estimated using the Kuder Richardson testing (K-R-20) which gives a reliability index of .72.

RESULTS

Research Question 1: What is the mean achievement scores of students taught physics using 5E instructional learning model and those taught with conventional traditional lecture teaching method (TLTM)?

Table 1: Mean achievement scores of students taught physics using 5E instructional learning model and those taught with conventional traditional lecture teaching method (TLTM).

		Pretest		Posttest		
Variable	N	$\overline{x}$	SD	$\overline{x}$	SD	Mean Gain
5E Model	61	45.71	7.09	92.52	4.98	46.81
Lecture Method	65	42.48	7.95	82.99	8.15	40.51

The result in Table 1 showed that the posttest mean achievement scores of students taught physics with 5E instructional learning model were 92.52 while that of students taught with conventional traditional lecture teaching method (TLTM) was 82.99. Therefore, students who were taught physics with a 5E instructional learning model had higher mean achievement scores than students who were taught physics using the conventional traditional lecture teaching method (TLTM) after the posttest treatment.

Research Question 2: What is the interaction effect of method and gender on students' mean achievement scores in physics?

Table 2: Interaction effect of method and gender on students' mean achievement scores in physics.

			Pretest		Posttest		
Teaching Method	Gender	N	$\overline{x}$	SD	$\overline{x}$	SD	Mean Gain
5E Model	Male	33	47.34	8.13	91.17	5.07	43.83
	Feamale	28	50.42	5.19	94.78	4.75	44.36
Lecture Method	Male	30	41.00	8.38	80.50	9.98	39.50
	Female	35	43.53	7.73	88.52	6.28	44.99

The result in Table 5 showed that the posttest achievement mean on the interaction effect of method and gender on students' mean achievement scores in physics of male and female students taught physics with 5E instructional learning model was 185.95, while that of male and female students taught physics with conventional traditional lecture teaching method (TLTM) was 169.02. Therefore, there was a high difference in interaction effect of method and gender on students' mean achievement scores in physics between students taught Physics with 5E instructional learning model and students taught Physics with conventional traditional lecture teaching method (TLTM) after the posttest treatment.

Result of the Test Hypotheses for Physics Achievement Test

Table 3: ANCOVA for achievement mean scores in Physics

Tests of Between-Subjects Effects

Dependent Variable: Posttest Achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1355.336[a]	4	338.834	91.406	.000
Intercept	269.146	1	269.146	72.606	.000
Pretestach	925.427	1	925.427	249.648	.000
Gender	24.179	1	24.179	6.523	.011
Method	292.203	1	292.203	78.826	.000
gender * method	16.933	1	16.933	4.568	.034
Error	715.436	121	3.707		
Total	52089.000	126			
Corrected Total	2070.773	125			

Table 3 showed a statistical mean effect for method F (1, 125) = 78.826, p>.000. The result of the first null hypothesis was rejected indicating that there was a statically significant difference in the mean achievement scores of students taught physics using 5E instructional learning model and those taught with conventional traditional lecture teaching method (TLTM).

More so, Table 3 revealed that there is a significant difference in gender*method F (1, 125) = 4.568, p>.034. The result of the 2 hypothesis was rejected, indicating that there was a statically significant difference in interaction effect of method and gender on students' mean achievement scores in physics.

DISCUSSION

The findings were discussed under the following sub-headings:

Mean Achievement Scores of Students Taught Physics using 5E Instructional Learning Model and those Taught with Conventional Traditional Lecture Teaching Method (TLTM).

From the analysis of the findings, it was observed that there was significant difference in the mean achievement scores in physics of students taught using 5E instructional learning model and those taught using conventional traditional lecture teaching method (TLTM). This was in agreement with the research findings of Karthikeyan and Densia (2021) that carried out an investigation study on effect of 5E learning cycle model in teaching physics on students' academic achievement and the permanence of their knowledge. From their findings, Karthikeyan and Densia (2021) observed that statically difference exist between students in the experimental group taught physics with 5E learning cycle and the control group students' scores after the posttest treatment; also the students' scores in the performance test. This results observation was in agreement with the opinion of Sakiyo and Badau (2019) assertion that in order to get a positive learning outcome from students at the end of any learning process, there is the need that teachers should adopt

students' active participation teaching and learning approach which will help students coordinate learning with their own learning understanding and create their own knowledge with the information lay down before them. Furthermore, Sotakova and Ganajova (2023) equally noted that adopting 5E learning model in teaching and learning not only those students were able to have expected achievement at the end of the learning outcome but also enhance their permanence of knowledge in Physics. Also Olanrewaju et al. (2018) research study on effect of 5E's instructional model on senior secondary school chemistry students' achievement in hydrocarbons holds the view that students taught with 5E instructional learning model achieved significantly higher than their counterpart taught using lecture method.

Interaction Effect of Method and Gender on Students' mean Achievement Scores in Physics.

Besides, it was observed that there was a significant difference in the interaction effect of method and gender on students' mean achievement scores in physics. This was in agreement with the research findings of Karthikeyan and Densia (2021) that carried out an investigation study on effect of 5E learning cycle model in teaching physics on students' academic achievement and the permanence of their knowledge. From their findings, Karthikeyan and Densia (2021) observed that statically difference exist between male and female students in the experimental group taught physics with 5E learning cycle and those the control group after the posttest treatment; also the students' scores in the performance test. From their observation, the male students in the experimental group had the highest mean achievement score followed by their female counterparts. That the male and female students mean achievement in the control group is intermediately in the same rage but from all indication, the test scores of male and female students taught using 5E instructional model is statically higher than those on control group taught with lecture method. Also Bunkure (2019) research study on efficacy of 5E learning strategy in enhancing academic achievement in Physics among students in Rano Education Zone, Kano State, Nigeria, recorded a significant high achievement scores between students taught chemistry with 5E instructional learning model and their counterpart taught using lecture method. This is because, learning through 5E instructional model promotes students-based learning philosophy in which the teacher takes on the non-traditional role of a mentor, letting the students to discover solution for themselves, but rather, adopting the 5E instructional learning model in teaching and learning creates an enabling environment where students can discover learning information themselves, thereby acquiring positive interest towards the subject. Teaching with 5E instructional learning model emphasizes a variety of different types of methods that shifts the role of the teacher from dispatcher of learning information to facilitating students' learning, thereby promoting students' interest to learning.

Conclusions

Based on the above discussion, the following conclusions were drawn:

From the analysis of the first research question, it was observed that there was significant difference in the mean achievement scores in physics of students taught using 5E instructional learning model and those taught using conventional traditional lecture teaching method (TLTM). The study was able to prove that the use of constructivist learning approach in teaching and learning such as 5E instructional learning model helps in improving students' achievement in Physics. This is because students can easily retain and recall lesson activities in which they were actively involved in the learning process and as well gain massive expected grades, than to what they are passively seated and listening to.

The findings of the second research question showed that there was a significant difference in interaction effect of method and gender on students' mean achievement scores in Physics. The study was able to prove that the use of constructivist learning approach in teaching and learning such as 5E instructional learning model not only proven to assist learners to effectively get involved in the programme of learning but it is a learning model that allows the students to construct their learning knowledge through social activity and also engage their minds to a successful learning outcome. This is because students can easily retain and recall lesson activities in which they were actively involved in the learning process and as well gain massive expected grades, than to what they are passively seated and listening to.

The 5E instructional learning model contributions to knowledge towards teaching and learning of Physics includes:

1. Better learning and comprehension of physics: The 5E instructional learning model fosters a deeper knowledge of Physics principles and concepts by letting students investigate and explore ideas. This enhances students' achievement in physics.
2. The improvement of analytical and problem-solving abilities: With a focus on experimentation, analysis, and evaluation, the 5E instructional learning model aids in the development of critical thinking, problem-solving, and scientific inquiry literacy in students.
3. Improved comprehension and application: The 5E instructional learning model enhances students' comprehension and transfer of learning of new concepts in Physics by giving them chances to apply Physics ideas to practical settings.

Recommendations

Concerning the discussions and conclusion drawn from the study, the following recommendations were given:

1. From the findings of the study, it was observed that significant difference exist in mean achievement scores of students taught Physics with 5E instructional learning model and those taught with conventional traditional lecture teaching method. The findings indicated that teaching physics using 5E instructional model was more efficient than teaching without using 5E instructional model. A detailed analysis of the Physics concepts test indicated that the 5E instructional learning model aided the physics students have positive achievement in Physics. Therefore, teachers should be encouraged to employ constructivist learning approach such as 5E instructional learning model that will encourage students' active participation in the learning activities. Being that students learn more effectively by what they see, practice, and perform, teachers should understand that students in physics class have different capacities of learning and adaptations, thus, employing constructivist learning process or cycle will makes learning more permanent and concrete in the minds of the students.

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