



Effect of 5Es Constructivist Instructional Strategy on Secondary School Physics Students' Achievement in Enugu Education Zone

Dennis Uchenna Ugwoke¹, Bethran Ekwundu Oguama¹, & Carmelius Izuchukwu Ugwuanyi²

¹Department of Physics Education, Enugu State College of Education (Technical), Enugu

²Department of Science Education, Degree Programme Unit, Enugu State College of Education (Technical) Enugu,

Abstract

The study investigated the effect of 5Es constructivist instructional strategies on secondary school physics students' achievement in Enugu Education Zone. This study employed a pretest/post test quasi experimental control group design. A multi-stage sampling technique was used in selecting one hundred and forty (140) senior secondary class two (SS2) physics students from two secondary schools drawn. Fraction Achievement Test (FAT) was developed and used for data collection. Data was analyzed using mean and standard deviation while analysis of covariance (ANCOVA) was used to test the hypothesis at 0.05 level of significant. The findings showed that the experimental group exposed to 5Es constructivist model performed better than the control group exposed to lecture method of instruction and gender has a significance influence on the achievement scores of students as regards the two teaching approaches. The above findings were confirmed by the results of hypotheses one and two. H1 showed that there is a significant difference between achievements means scores of students taught with 5Es constructivist's instructional model and those taught with lecture method and H2 showed that there is a significant difference between the achievement scores of the students with regard to gender. The study recommends the incorporation 5Es constructivist instructional approach in physics curriculum at secondary school level. Also recommended is that 5Es constructivist instructional based mechanisms engage students in minds-on and hands-on activities. Its use in instructions would require sufficient instructional materials and space. Therefore, schools should as a matter of fact, take note and make adequate provisions.

Keywords: Gender, Cognitive, Achievement Test, Model and Constructivists.

Introduction

Science and technology are important tools for development and productivity in any nation. Science is important for every nation that wants to maintain its independence, sovereignty, self-reliance, ensure growth and have its head held high among civilized nation (Gabriel, 2012). This is because science and technology provides basic tools of industrialization and economic development in the areas of communication, transportation, information, pollution, energy and waste management control among others. In Nigeria, the study of science is of so great importance that a lot of emphasis has been laid on the teaching and learning of science with the major aim of science education as contained in national policy on education, being to equip the student to live effectively in this modern era (Federal Ministry of Education, 2004). This can be achieved by the inculcation in the learners, the necessary scientific skills and attitudes. The inculcation of scientific skills and attitude in learners can only be achieved through proper teaching of science, physics inclusive-as a natural science discipline and a foundation to the study of science in Nigeria.

In secondary institutions, one of the core science subjects through which Nigeria education system strives to raise a generation of science and technologically oriented citizenry is physics. However, physics is one of the oldest natural science subjects and is as old as mankind (Jillian, 2015). This follows as a result of man's quest to understand the nature of the world. Physics is one of the fields of knowledge that underlines the physical universe and applies constantly to peoples' life on daily basis. It is a fundamental science that attempt to provide a holistic and reliable presentation of the real world.

In this era of point and click, no individual who has the aptitude for and interest in science in general and physics in particular would like to be left behind in the pursuit of scientific knowledge. Every consideration is giving to how learning opportunity may be provided for the learners in physics using effective and efficient instructional materials that appeal to both visual and auditory sense organs



in order to ensure maximum understanding on the part of the students. Ugwuanyi (2009) noted that physics when properly taught develop in learners, science and technological skills which will assist them to make reference decisions; develop entrepreneurial skills and learn to live quantitatively and contribute to the societal technological advancement. The only way to attain these is to expose students at the secondary school level to opportunities that will enable them obtain the relevant skills and attitudes of scientific facts and knowledge, Joseph & Sopuruchi (2012). Despite the positivism of science to mankind, students still perform poorly in sciences. The low performance as reported in various science examinations (internal and external) is the evidence in science subjects in general.

Studies carried out by Okoro (2005) indicated that there is a consistent poor performance of students in physics. A lot of opinions exist as to why the situation is so. Among them are; teachers' professionalism and poor method of instruction adopted by physics teachers. Fafunwa in Neboh (2009) stated that poor methods of teaching physics tend to defeat the objectives and skills, innovation, open-minded experimentation and individual ingenuity of the learners. Studies carried out by Ogbonna (2007) showed that the method employed in teaching physics in particular and science in general leads to students' degree of achievement. Their findings suggested that there is need to carry out studies to clarify issues related to achievement as it concerns method of teaching physics. The need to investigate the effect of 5Es constructivist instructional strategy (i.e. Engagement, Exploration, Explanation, Elaboration and Evaluation teaching/learning model) on students' academic achievement in physics arises since there is no consensus on the effect of constructivist instruction on achievement.

Presently, teachers are faced with the challenges of not being able to give lessons to their students in line with their pace or rate of understanding with the result that they have remained adamant and stock to the didactic teaching methods. The most avowed teaching method or view of learning which centered on making learning students-centered at the expense of teachers-centered is the 5Es constructivist approach (Gabriel, 2012). Gabriel noted that 5Es constructivist approach is activity oriented where the teacher act as a facilitator of learning, guiding the students through a series of questions that will lead them to develop their own conclusion on the subject matter, which help the learners to achieve optimally high. Madu (2014) suggested that good physics teachers join self, subject and students in the fabric of life because they teach from an integral and undivided self, they manifest in their own lives and evoke in their students, a capacity for connectedness. These suggest that learners should construct and reconstruct what is to be learnt at their own pace and in accordance to their rate of understanding. This is aimed at re-addressing students' misconception or alternative paradigm.

More so, to solve students' problem of poor achievement in physics and sciences in general, there is the need to shift from the conventional methods of physics instruction to a more innovative approach. An approach that should seek for a way of making teaching more precise while at the same time adjusting both the objectives and methods of learning to the needs, nature (interest and gender) and characteristics of the individual learners. In this approach, teacher is the facilitator of learning process (Uzoamaka, 2013). This innovative method not only enable each individual learners to work at his/her own pace thereby accommodating both fast and slow learners but also re-address each individual learner's prior knowledge.

Specifically, 5Es constructivist is activity oriented and hence calls for teacher's proper guidance and individual learner's active participation in attempt to make physics concepts more realistic and subsequent attainment of lesson objectives. The study however, sought to: ascertain the mean achievement scores of students taught elasticity and projectile using 5Es constructivist instruction and those taught using lecture method and determine the gender influence or effect on students' mean achievement scores as regard the teaching methods. Hence, the following research questions were developed to guide the study. Research questions: (1) what is the mean achievement score of students taught elasticity and projectile using constructivist instruction (the 5Es model) and those taught using conventional approach? (2) what is the gender influence on the mean achievement score of students as regard the teaching approaches?

Research Method

The design of the study is quasi-experimental utilizing pretest posttest non-equivalent group design. The design is often preferred for a class of experiment where experimental and control groups are assembled as intact class and no possibility of randomization. Intact class will therefore be used and there will be no random assignment of research subject to groups. The study encompasses government secondary schools in Enugu Education Zone. The zone constitute of Enugu North, Enugu East and Isi-



Uzo Local Government Areas. The population of the study comprised all senior secondary school class two (SS2) physics students in the thirty one (31) public schools in the zone. The schools are analyzed with respect to the local government in which they are situated as Enugu East Local Government Area, Enugu North Local Government Area and Isi-uzo Local Government Area. In Enugu East Local Government Area, we have ten (10) public schools, nine (9) in Enugu North and twelve (12) in Isi-uzo Local Government Area totaling to thirty one (31) in the zone.

The sample size for this study is one hundred and forty (140) senior secondary school class two (SS2) physics students of 2017/2018 academic year. The selection of the sample is done in three stages using multi-stage sampling technique. Stage 1: Out of the three local government areas in the zone, Enugu East and Enugu North local Government Areas are drawn using simple random technique. Stage 2: Selection of schools: out of the nineteen (19) public schools in the two choosing local government areas, girls secondary school, Abakpa Nike and New lay out secondary school, Enugu were choosing from Enugu East and Enugu North respectively using simple random technique. Stage 3: selection of subjects: two intact classes A and B that form the stream of senior secondary school class two (SS2) physics students in each of the chosen schools were used with (SS2) physics students’ population of eighty (80) in girls and sixty (60) in boys. The intact class A was randomly assigned to “5Es” constructivist based instruction and the other intact class B was randomly assigned to traditional method of instruction.

Instrument used for data collection was Fraction Achievement Test (FAT) which serves as achievement test. Fraction achievement test (FAT) is designed to measure the cognitive achievement of the students before and after treatments. Test retest method of reliability was carried out. And Pearson Product Moment Correlation formula was used to compute the reliability coefficient. The reliability index obtained was 0.98 indicating high reliability of the instrument.

This work involved a multi-stage of data collection. Stage one: administration of PRE-FAT. One hundred and forty (140) copies of both the PRE-FAT in form of PRE-TEST were distributed and shared among the chosen subjects of the selected schools by the regular physics teachers in each of the schools who were trained by the researcher on the first week of the study. The copies were collected before treatment and no feedback on the PRE-FAT was giving to them. The scores of the students were recorded and treatment followed. In the second week of the study, the intact class A (experimental group) was taught the same topics using the “5Es” constructivist-based instruction model and the intact class B (control group) was taught using lecture method of instruction. On the third week of the assignment, POST-FAT was administered to the groups; scripts were collected, marked, scored and recorded. The data collected were tabulated and analyzed statistically using mean and standard deviation while analysis of covariance (ANCOVA) was used to test the null hypotheses.

Results

This section is concerned with the presentation of data collected from the respondents. The results were presented in tables according to the research questions and null hypotheses that guided the study.

Research question 1: What are the mean achievement scores of students taught elasticity and projectile using the 5Es constructivist based instruction model and those taught using lecture method?

Table 1: Mean and standard deviation (SD) of mean achievement scores of students taught elasticity and projectile using the 5Es constructivist-based instruction model and those taught using lecture method.

GROUP	PRE-TEST			POST-TEST		
	Mean	SD	N	Mean	SD	N
Experimental	2.7941	1.04466	68	7.2353	1.29428	68
Control	2.9306	0.9689	72	4.5833	1.26435	72
Total	2.8643	1.0051	140	5.8714	1.84212	140

Experimental Group (M = 7.24, SD = 1.29) and Control Group (M = 4.58, SD = 1.26). (See Appendix I)



Table 1 above revealed that the experimental group has a pretest mean score of 2.79 with a standard deviation of 1.04 and a posttest mean score of 7.24 with a standard deviation of 1.29 while the control group has a pretest mean of 2.93 with a standard deviation of .97 and a posttest mean score of 4.58 with standard deviation of 1.26. For each of the groups, the posttest mean score is greater than the pretest mean score showing that students performed well with both approaches. With posttest mean of 7.23 for the experimental group and 4.58 for the control group, it indicated that students in the experimental group achieved significantly better than their control group counterpart. This appears that the 5Es constructivist-based instruction model enhances students' achievement. Table 2 of hypothesis HO₁ below confirmed the above.

HO₁: There is no significant difference in the mean achievement scores of students taught elasticity and projectile using the 5Es constructivist model and those taught using lecture method.

Table 2: Analysis of covariance (ANCOVA) for the differences in the mean achievement scores of students in physics as regard the two teaching methods.

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	259.094a	4	64.774	41.133	.000
Intercept	385.146	1	385.146	244.576	.000
Preexam	10.193	1	10.193	6.473	.012
Group	241.718	1	241.718	153.496	.000
Gender	1.247	1	1.247	.792	.375
Group*Gender	.301	1	.301	.191	.663
Error	212.591	135	1.574		
Total	5298.000	140			
Corrected Total	471.686				
	471.686	139			

a) R squared = .549 (Adjusted R squared = .536).

From table 2 above, Group F (1, 135) = 153.50, P < .000 Gender F (1, 135) = .79, P < .38 (See Appendix I)

Table 2 therefore revealed that group has a df of 1, error of 135 with f place value of 153.50 and .000 level of significance which falls within the beta value range at .05 level of significance. This indicates that HO₁ is rejected and hence, there is significant difference in the mean achievement scores of students exposed to the two teaching approaches. Therefore the need to maintain that those taught with 5Es constructivist instruction have their mean achievement score higher than those taught with conventional approach.

Research question 2: What is the gender influence in the mean achievement scores of students exposed to the two teaching methods.



Table 3: Mean and standard deviation (SD) of the mean achievement scores of male and female students exposed to the two teaching methods.

Group	Gender	Mean	SD	N
Experimental	Male	7.3548	1.17042	31
	Female	7.1351	1.39766	37
	Total	7.2353	1.29428	68
Control	Male	4.7931	1.26433	29
	Female	4.4419	1.2593	43
Total	Total	4.5833	1.26435	72
	Male	6.1167	1.76685	60
	Female	5.6875	1.88662	80
Total	Total	5.8714	1.84212	140

Table 3 above revealed that male students in the experimental group has a mean of 7.35 with standard deviation of 1.17 and the female counterpart had a mean of 7.14 with standard deviation of 1.40 while in control group, male has a mean of 4.79 with standard deviation of 1.26 and the female has a mean of 4.44 with standard deviation of 1.26.

With the mean of 7.35 for male and 7.14 for the female students in the experimental group, both achieved slightly higher than in the control group with a mean score of 4.79 for the male and 4.44 for the female. With a mean of 7.35 for male and 7.14 for the female in the experimental group, male students achieved slightly higher than the female.

HO₂: There is no significant gender influence in the mean achievement scores of students exposed to the two teaching methods.

From table 3 above, it was shown that gender has a df of 1, error of 135 with F place value of .79 and .38 level of significance which is far greater than the beta value range. The null hypothesis is therefore rejected. Hence, there is significant gender influence on students' achievement in physics.

Discussion

Table 1 revealed that the 5Es constructivist-based instruction model is effective in enhancing students' achievement in physics. The result agrees with that of many other studies Madu (2014); Ogbonna (2007); Uzoamaka (2013); Nwagbor and Obiekwe (2010) and Gabriel (2012) that reported effectiveness of constructivist instructional approach in facilitating science learning. In this experiment, the instructional model engaged the learners in active inquiry, simulating constructive learning activities. In effect, it provides effective scaffolds reasoning so as to generate meaning, correct instances and concepts, explain experimental outcomes and then to access appropriate scientific knowledge and be able to use them in new situations related to this. Stofflet & Nworgu in Uzoamaka (2013) noted that 5Es constructivist-based instructions result in conceptual change and meaningful learning.

The result as shown in table 2 ($F=153.50$) at .000 level of significance revealed that there was significant difference in the mean achievement of students in experimental and control groups. Hence, constructivist instruction approach is seen to facilitate students' achievement in physics. The finding is also in line with the view of Ukwungwu (2000) who opined that the way a learner learns depends on how the learning material is presented to him. The finding also strengthens the advocate of Uzoamaka (2013) that PEDDA and IEPT as a 5-step instructional process helps in facilitating students' learning and achievement. The 5Es constructivist-based model engages students in planned sequence of activities that move them from one learning stage to another. As activity oriented model, it engages the learners in a hand-on activity. In a nutshell, it allows the learners to explore or construct and reconstruct in order to learn and find answer to questions. This instructional model, at the expense of the conventional approach, has proved to be viable instructional tool in enhancing students' achievement in physics for a long term use. In other words, the instructional model through its activity oriented



learning approach, led students to significant achievement of the learned concepts. Hence the model could facilitate students' acquisition of scientific literacy.

In this study, the standard deviation of the overall students' achievement is 1.17 for the experimental group and 1.12 for the control group. Thus the standard deviation for the experimental group is greater than the control group counterpart. This implies that the students reasoning might have been more divergent than they were before the treatment.

Table 3 above showed that male students in the experimental group had a mean of 7.35 while their female counterpart had 7.14. In the control group as well, male students had a mean of 4.79 whereas the female had 4.44. The result showed that the male students in both groups achieved higher than the female counterpart. Further investigation in table 3 revealed that the F-ratio due to gender is .79 with .38 level of significant which is greater than the stipulated level of significance. The difference in the mean achievement of the male and female students as regard the two teaching strategies was statistically significant. The null hypothesis was therefore rejected. This finding is against the views of Ukazor (2011); Nworgu (1996); Ndukwe (1983); Abonyi (2014) etc. who noted that there was no gender difference in the achievement of boys and girls. The finding however, confirmed those of Onwukwe (2008) and Gabriel (2012) who showed significant gender influence in favour of boys in Biology and Physics respectively.

Conclusion and Recommendations

This study examined how the 5Es constructivist-based instructional model could enhance learners' cognitive process in terms of students' achievement in physics at the expense of the traditional approach. The 5Es constructivist-based model is found capable of not only enhancing students' achievement but also gender sensitive in physics. The model unlike the traditional approach enhances teaching and learning of physics by doing at the expense of reading and it calls for active participation of each individual learner in the learning process with reasonable functionality and pre-vision. Besides, since the model provides the students with opportunities to learn physics by doing, it therefore helps them examine or investigate the nature of things and arrive at observation and explanations that are satisfying and as well make sense to them thereby improving their academic achievement.

Students in the experimental group achieved higher than their control group counterpart. This is because both male and female students in the group benefited according their eagerness vigor and civility emulation in the teaching. This is necessitated by the fact that the model is an approach of constructive instructional strategy that offers the learners the opportunities of constructing and re-constructing learning experience.

The extra-cognitive impacts are suspected to be the major determinant of how the students enjoyed the instructions and these enhance their achievement. So there was interaction influence between the instructional approaches and gender

5Es Constructivist approach therefore has acclaimed as one of the best theories of learning. It is not only a theory of learning but also a philosophy of learning which prefers that learners construct knowledge for themselves. This strategy embraces all other teaching methods.

The results of this work have educational implications in science education programs. For instance, 5Es constructivist instructional strategies provide a framework or platform for identifying and modifying misconceptions based on pre-conceptions which the conventional approach in use could not. The existence of the alternative paradigm in the mind of the learners might have accounted for the consistent learning failures and students moving away from the science especially physics. The identification and modification of this misconception therefore would enhance students' achievement and interest for long term use. The 5Es constructivist instruction give opportunities for learning science by doing, stimulating curiosity and effective reasoning among others and these are the primary ingredients for effective and meaningful learning. In other words, the instructional environment of the constructivist instruction functions as scaffold for learners' discovery activities, organization and integration of concepts into learners' knowledge structure which help them to arrive at improved outcome that are satisfying. All these implies that physics teachers, science curriculum planners, physics textbook writers and science education policy makers should not hesitate to include the constructivist approach in physics curriculum programs and science in general.

Furthermore, interest is a strong factor for studying or doing something which calls for positive outcome. The learning of 'bits' of information through 'talk chalk' method had been widely criticized



because it makes learning uninteresting and boring since learners turn to active listeners at the expense of active participants. The talk chalk method therefore, encourages reading of science instead. The use of activity oriented approach of the 5Es constructivist-based model help students to arrive at instances or ideas organized and integrated in a manner that make sense to them. This learning opportunity makes way for better achievement and favorable interest to science learning including physics. Although the 5Es constructivist approach is beneficial to both male and female of the experimental group educationists/teachers should note that females are constructively and reconstructively weaker than males. The use of the model would go a long way in reducing examination malpractices commonly exhibited by students. The model would as well promote science students study habits and healthy mental operations during instructions.

Based on the above, the use of the 5Es constructivist –based instructional approach should be part of physics education curriculum program. Physics teachers need to be periodically given orientation course on the use of the 5Es constructivist model to help them get used to its application in instruction. The 5Es constructivist-based model activities needs much time. The preparation of official school time table should take cognizance of that and make provisions. The 5Es constructivist-based instructional mechanisms engage learners in minds-on and hands-on activities. Its use in instructions would usually require sufficient instructional materials and space. Schools should, as a matter of fact, take note and make adequate provisions.

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