The effects of School location on students' academic achievement in senior secondary physics based on the 5E learning cycle in Delta State, Nigeria

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This study examined the effects of school location on secondary school students' academic achievement in Physics based on the 5E learning cycle. The design of the study was a non – randomized prêt-test, post-test control group quasi-experimental design. The population of the study was 66,345. Two hundred and forty-three students were sampled from six schools. Four hypotheses were tested at 0.05 level of significance. The hypotheses state that there is no significant difference in mean achievement scores in Physics between urban and rural students taught using 5E leaning cycle among others. The statistical tools used were mean, standard deviation and Analysis of Covariance (ANCOVA) were used in testing the hypotheses formulated. The result amongst others showed there is no significant difference between rural and urban students' achievement taught using 5E learning circle (Fcal. (113) = F crit (0.005), p>0.05). Based on the findings, it was recommended among others, that 5E learning cycle be adopted in Nigeria secondary schools as a teaching method and that faculties of education in various schools of higher learning should ensure that 5E learning cycle is included as a method of teaching Physics

Keywords: school location, 5E learning cycle, physics, interaction effects and students achievement

1 Introduction

The International Union of Pure and Applied Physics (IUPAP) defines Physics as the scientific study of matter and energy and their interactions with each other, which plays a key role in the future process of mankind. Advancement in physics often translates to the technological sector and, sometimes to the other sciences, Mathematics and Philosophy (IUPAP, 1999). For instance, advancement in Physics, relative to electromagnetism, has led to the spread of electrically driven devices; advancement in thermodynamics has led to the development of motorized transport; just as advancement in mechanics has also led to the development of calculus, quantum chemistry, and the use of instruments such as electron microscope in microbiology. Okoronta (2004) asserts that Physics is a vehicle for achieving long-term goals of science because it is instrumental to technological and socio economic growths across the globe. Physics, as a subject, is the foundation

upon which the scientific and technological advancement of a nation rests (Ogunleye &Babajide, 2011). It is the link between all the science subjects at the secondary school level and technological courses at the tertiary levels of education.

In spite of the importance of Physics, its teaching and learning have been in decline in Nigeria as shown by its low enrollment. The reason is not far-fetched. Ogunleye and Babajide (2011) state that there are observable problems plaguing the learning of Physics in Nigeria. They include poor infrastructure, lack of qualified manpower, non – availability of, or poorly equipped laboratories, wrong teaching methods, among others. Such problems often lead to students' poor performance in external examinations, such as the West African Examination Council (WAEC) or Joint Admission and Matriculation Board (JAMB), (Abamba, 2012)

Research by Ogunleye and Babajide (2011) affirm that Physics students at the secondary school level continue to exhibit poor performances in the subject. The methods of teaching adopted by teachers go a long way in determining how students learn, and this ultimately affects their academic achievement. Eze (2003) blames the persistent low achievement on persistent use of traditional teaching methods, especially the lecture method which has been very ineffective in teaching pedagogy. Hence, Eze (2003) advocate a shift from the traditional methods to more effective ones that will engage the students' domains (affective, cognitive and psychomotor) of learning. Teaching is not just a process of passing information by the teacher or showing how much a teacher can express himself but one that affords students the opportunity to interact with both humans and available material resources. Agbowaro (2008) states that meaningful learning is active, constructive, intentional, authentic and cooperative. Therefore, it is imperative for teachers to employ methods that are student-centered. According to Bybee, Tylor, Gardner, Scaffer, Powell, Westbrook and Landes (2006), science teachers' globally strive to improve their instructional practices to enhance students' learning. According to them, science teachers, curriculum experts have identifying research findings to incorporate into materials in order to facilitate connections between the teachers, the curriculum, and the students. Bybee et al. (2006) state that the use of coherent and coordinated sequencing of lessons and instrument models have become popular in science education at present.

1.1 Origin and development of 5E

The 5E learning cycle is an instructional model that describes a teaching sequence that can be used for an entire program, specific units and individual lessons. It was developed by the Biological Science Curriculum Study (BSCS) through a team led by Roger Bybee in the late 1980's from the work of Atkin and Karplus who explored children thinking and their explanation of natural phenomena. By 1961, Karplus began connecting the developmental psychology of Jean Piaget to the design of instrumental material and science teaching. In 1901, J.M. Atkin shared Karplus' ideas about the teaching of science to young children. Their collaboration led to the development of a model of guided discovery that focused on exploration, invention, and discovery (Bybee et al., 2006; Kolis, Krusack, Stombaugh, Stow and Brenner, 2010; Ajaja and Eravwoke, 2012). In the 1980's, Lawson and others slightly modified the terms of the Atkin and Karplus model, though, in spite of the changes, the conceptual foundation of the learning cycle remained the same. According to Bybee, the new phases added to the SCS model are engagement and evaluation. The 5E learning cycle has become successful in improving students' achievement in science and in helping to improve the way students learn. According to Bybee (2011), the 5E learning cycle has been more successful than was imagined when it was originally developed and it is recognized internationally and applied in other disciplines other than science; adapted by curriculum developers outside the BSCS, and used by science teachers at all levels.

The 5E learning cycle consists of 5 stages which are engagement, exploration, explanation, extension and evaluation in that order.

1. Engagement: the teacher assesses the learners' prior knowledge, helps in engaging them in a new concept, using short activities in promoting curiosity and eliciting prior knowledge. According to them, such activities should connect past and present learning experiences, reveal prior conceptions, and organize students' thinking in achieving the learning outcomes of current activities (Bybee, 2011).
2. Exploration: this stage provides students with a common experience within which current concepts, processes and skills are identified and a conceptual change is facilitated. Learners may complete laboratory excise that allows them to use prior knowledge in generating new ideas, exploring possibilities and questions, designing and conducting preliminary investigations (Bybee, 2011).

3. Explanation: this stage focuses on students' attention on their engagement and exploration experiences, and enables them to demonstrate an understanding of concepts, process skills or behaviour (Bybee, 2011). It enables teachers to directly introduce concepts, processes or skills. Learners are allowed to explain their understanding of the concepts. The teacher's explanation or the curriculum may guide students towards a deeper understanding of the concept.

4. Extension (elaboration): teachers challenge and extend students conceptual understanding and skills. Through new experiences, students develop deeper and broader understanding, acquire more information, adequate skills, and apply their understanding of the concept by conducting additional activities (Bybee, 2011). Students conduct additional activities based on their new experiences.

5. Evaluation: according to Bybee et al. (2006), evaluation stage encourages students to assess their understanding and ability and provides opportunities for teachers to evaluate students' progress towards achieving the educational objectives. It is a diagnostic process which enables the teacher to determine whether the learner has attained understanding of concepts knowledge.

Since the development of 5E learning cycle, a lot of researches have been carried out to examine the instructional effectiveness of learning across different subjects in the sciences. Adams, Bevevino & Dangel (1992) explored the 5E learning cycle model approach and found that it encourages students to develop their own frame of thought. Caprio (1994) compared a class taught with traditional method in 1985 with one taught with 5E instructional model and found that the students taught by using 5E instructional model achieved higher.

Some studies conducted by using 5E instructional model revealed that the model increases the success of students, improves conceptual understanding and their attitudes (Kor, 2006 & Saglan, 2006 in Cardak et al., 2008). In another study, Seyhan & Morgil (2007) compared two classes taught with traditional methods with two classes taught with the 5E instructional method. They found that the experimental group had a much greater understanding of information, especially on questions that required interpretation. Keser & Akdeniz (2010) stated that the 5E learning cycle aids the teacher to structure and sequence potential learning experiences in a systematic and synergistic way that is consistent with a constructivist view of teaching and learning. They further said that the 5E learning

cycle is not an essential part of students' learning but a scaffold or framework for the teacher. Hence, students must be provided with learning environments that encourage them to explain their ideas and understanding and give opportunity for them to extend their knowledge of concepts to other contexts (Boddy et al., 2003).

Cepni, Sahin & Ipek (2010) showed that instructional materials embedded with different techniques in the 5E learning cycle could be effective in removing alternative conceptions and providing conceptual changes more than existing material. Turki & Calik (2008) also found that students were highly motivated and their achievement were increased when 5E learning cycle model was employed in the teaching of exothermic and endothermic reactions. Tuna & Kacar (2013) observed students' scores in experimental group on academic achievement and permanence on trigonometry knowledge are higher than those of the control group statistically when 5E learning cycle was employed. The difference between the groups is statistically significant and in favour of the experimental group. Abdul, Muhammad, Khalid & Shahid (2010) worked on the teaching of Physics with the 5E learning cycle model. The study was aimed at measuring the effectiveness of the 5E learning cycle based on the constructivist approach in the teaching of Physics in public secondary schools. Results showed that the achievement level of students had a significant difference from the performance of students taught with traditional methods. They concluded that the instruction based on 5E learning cycle model yielded better student' performance than that of students taught by the lecture method. Ajaja & Eravwoke (2012) showed that students taught by using the learning cycle had a better achievement in Biology and Chemistry compared to their counterparts that were taught by the lecture method. Similarly, Balci, Cakiroglu & Tekkaya (2006) compared the effectiveness of 5E learning cycle with expository instructions and found that the activities of students in 5E learning cycle activated their prior knowledge and to overcome struggling with their misconceptions.

Ajaja (2013) showed that students in the 5E learning cycle and cooperative learning group significantly outscored those in the concept mapping and lecture group on both achievement and retention tests. Furthermore, students in 5E learning cycle and cooperative learning groups did not significantly differ on achievement and retention. Qarareh (2012) also observed that students taught by the use of the 5E learning cycle achieved better results than students in the group that was taught with the traditional method.

1.2 Limitations

However, since the application of 5E learning cycle in the teaching/learning process, a rage limitation has been observed. One such limitation is that teachers have been finding it difficult to use the model effectively such that major characteristics of the model are overlooked (Keith & Shelly, 2012). In addition to this, not extending the elaboration into novel areas beyond the specific concept has been identified educator using only verbal explanation during the 3rd stage (explain) has also been criticized (Keith et al., 2012; Fletcher in Somayeh & Shahram, 2015). Hence, researchers have called for proper training of both instructors and students before the commencement of instruction (Ajaja, 2013).

The model has also been criticized for being time-consuming both in implementation and in planning, with calls for increased time on the task before and during instruction (Ajaja, 2013; Claire, 2013). Kirschner et al. (2006) and Dodge, (2017) also observed the risk of developing new misconceptions by students with little background or experience in the concept. Furthermore, Ajaja (2012) observed that low ability students may find it very difficult to cope with the model and called for strong cooperation among members of a group under such program. Finally, the bulk of the limitations highlighted stern from the fact that most educators find 5E learning cycle novel and thus lack the skill required for the effective use of the model. There must be adequate tutelage for both instructors and students on their level of participation in all 5 stages of instruction

1.3 Urban and rural schools

The location of a school has a big role to play in the academic achievement of students at school. Akinyele (2011) stated that the immediate environment of a child plays a major role in his socialization. According to him, the area in which a school is located can affect the academic achievement of a student. In the same vein, Akpan (2001) has stated that school location is one of the major factors that affect students' academic achievements. A school located in a rural area is usually faced with problems like shortage of teachers, lack of laboratories, poorly equipped laboratories, among others in Nigeria. These shortcomings negatively affect both students' motivation and achievement. Evidence abound that the educational aspirations of students who study in rural are weaker than those of their urban counterparts (Hum, 2003; Arnold et al., 2005). Macmillan (2012) found that students in rural areas place less value on studies such that their achievements are

affected.

Adesoji and Olatunbosun (2008) have pointed out that the relationship between the location 0f a school and students' academic achievements has been reported. Urban students perform better than their counterparts in semi-urban and rural schools (Adepoju, 2001; Ogunleye, 2002; Ndukwu, 2002). Corroborating this, Hu (2003) said that, compared with urban students, rural students tend to have lower educational aspiration, place less values on academics, and have lower academic motivation. Owoeye (2002) found a significant difference between the academic performance of students in rural areas and that of their urban counterparts.students in urban areas are better.

On the other hand, Ajayi (1999) studied the relationship between academic achievement and school location and found that the there is no significant difference between academic achievement of students in urban students and that of students in rural students. Yusuf and Adigun (2010) also observed that whether a student attends a rural or urban secondary school does not make any difference in his academic achievement. Owoeye and Yara (2011) posit that in Nigeria, education in rural areas is usually full of difficulties.

1. Teachers who are qualified don't like being posted to villages
2. Villagers prevent their children from going to school regularly because of the children's involvement in farming activities
3. Parents are reluctant to entrust their female wards to male teachers.
4. Lack of roads and communication facilities making it difficult to get books and teaching materials to the schools.

There is, therefore, disparity between the quality of teachers in urban schools and that of those in rural areas, and, this is reflected in students' achievement. The review has shown that more researchers hold the view that urban students do better than rural ones. This research is, therefore, designed to investigate whether the application of 5E learning cycle will significantly improve the achievement of students both in rural schools and urban schools irrespective of the location of the school.

Having established that students' academic achievement in the sciences, particularly in Physics is, in decline, it has become imperative to find methods and strategies that can curb this downward trend in students' achievement in that subject. Having examined the effectiveness of the 5E learning cycle in improving students' achievement in the learning of science subjects, and having and seeing the

poor achievement in the rural areas, this work therefore seeks to examine the effects of school location on students' achievement in Physics based on the 5E learning cycle. The general purpose of this study is to examine the effects of school location on students' academic achievement based on the 5E learning cycle. Specifically, the study will find out whether

1. There is a difference in the mean achievement scores in Physics between urban and rural students taught with the 5E learning cycle model.
2. There is a difference between the mean achievement scores of urban and rural secondary school students taught with the lecture method.

2 Research hypotheses

The following null (H_o) hypotheses were put forward to answer the problems stated and tested at 0.05 level of significance

1. Ho_1: there is no significant difference in the mean achievement scores of students in Physics between groups taught by the 5E learning cycle and those taught with lecture method.
2. Ho_2: there is no significant difference in the mean achievement scores in Physics between urban and rural students taught with 5E learning cycle model.
3. Ho_3: there is no significant difference in the mean achievement scores in Physics between urban and rural students taught with the lecture method.
4. Ho_4: there is no significant interaction effect between method and school location on students' academic achievements in Physics.

3 Materials and methods

3.1 Design of the study

A research design is the plan or logical structure of a study (Okorodudu, 2013). According to him, the nature of the problem and the hypotheses to be tested as well as the type of sample and the subjects determine to a large extent the design to be adopted. The study is a non-randomized pre-test, post-test control group quasi-experimental design. The population of the study is sixty-six thousand, three

hundred and forty-five (66,345). Two hundred and forty-six students were sampled using simple random sampling technique from six secondary schools in Delta State (two from each senatorial district out of the three senatorial districts) using stratified sampling.

3.2 Instrumentation

The research instruments designed by the researcher and used for this study include

1. Physics Achievement Test (PAT). The test was constructed by the researcher on topics in the concept of light waves. The topics treated include reflection of light waves, refraction of light waves and applications of light waves. The test consisted of 50 multiple-choice questions with options A-D or E from past West African Examination Council (WAEC) questions. A table of specification prepared showed that 48% of the question tested their knowledge of the concepts, 36% tested comprehension, and 16% tested application of the concepts.
2. Instructional packages for the instructors (lesson play). They include (a) comprehensive lesson plan on 5E learning cycle on the concept of light waves (b) comprehensive lesson plan based on the traditional method (lecture method).

3.3 Validity and reliability

Factor analysis is a statistical method used to describe variability among observed correlated variables in terms of a potentially lower number of unobserved variables called factors. The Physics Achievement Test (PAT) was administered to 31 participants who were involved in the pilot test. The instrument was found valid in content, construct and face. In establishing the reliability of the instrument, Kuder-Richardson formula 21 (KR 2_1) was used to estimate the internal consistency reliability of PAT. KR21 coefficient calculated was 0.71. Based on this value, the Physics achievement test was found reliable. The factor analysis of items in Physics Achievement Test (PAT) was processed so that the test could be estimated for content and construct validity. The factor analysis of the PAT began with the processing of Descriptive Statistics and Initial Communalities. The Descriptive Statistics of mean and standard deviation of total items retained for the 31 (intact

class) participants who were involved in the pilot test of the PAT instrument at Delta State University Secondary School were reported. A total of 50 items were selected out of the initial total items of 78 that were factor analysed. These 78 items selected were computed for content and construct validity using Factor Analysis Output from principal component analysis (PCA).

To establish the content validity of the instrument, Eigen value of above 1 was used to select factor components into the PAT instrument. The factor matrix of all factors or components had to be rotated to determine the weight of each item within each of the components. The cumulative variance for all rotated sums of squared loading was estimated as 89.45%. This is an indication of the content validity of PAT. It revealed that PAT covered up to 89.45% of the domain of Physics Achievement Variable with a total of unexplained variance of 10.55%. Therefore, on the whole, the cumulative Eigen value of 89.45% is above 50% and hence the PAT was considered content valid.

In establishing the construct validity, the factor matrix of all factors or components had to be rotated using Varimax to determine the weight of each item within each of the components. Eigen value of above 1 was used to select factors that genuinely measure similar construct. From the observed scores, latent variables were identified with the number of items measured by the construct. Since rotated factor loading matrixes range between 0.29 and 0.81, it can be concluded that PAT has construct validity.

The Physics Achievement Test, after selection, was given to three experts in science education to establish the face validity of the instrument.

3.4 Treatment procedure

- Training of instructors

The physics teachers used for the experimental group were trained on the skills of using 5E learning cycle for teaching. This exercise lasted for three days (a day was devoted to a teacher in a school). The process started with explaining the meaning of 5E learning cycle, its origin, modifications and applications in the teaching-learning process. The next stage was done using the 5E training manual adopted from SEDL (2012), explaining the role of teachers and students on every stage of the model.

- Treatment proper

The researcher obtained an official permission from the heads of the six (6) secondary schools for the study. The Physics teachers in each school were used as research assistants. Where the school has more than one Physics teacher, the research assistant was the teacher assigned to Senior Secondary 11 (SSII). The researcher gave them orientation on the purpose of the study to ensure uniformity and ensure that each conformed to the content and method assigned. For the research assistants in the experimental groups, the researcher explained how to follow up the students at every stage and guide their transition to the next stage of instruction based on the 5E learning cycle. The researcher explained the kind of questions to be asked at different stages of the cycle. The level of their involvement at every stage was also explained to the teachers. The researcher embarked on several supervision visits to the schools to check on the effectiveness of the teachers with respect to the treatment procedure assigned to that school.

At the end of the orientation exercise, the research assistants for the experimental groups were handed a copy of the instructional lesson plans based on the 5E instructional model and the necessary instructional materials for the instructions to commence. In addition, copies of lesson plans for the control groups as well as the necessary instructional materials were given to the assistants in order to commence teaching.

The researcher visited each school before the commencement of instruction, and administered the test (Physics Achievement Test, PAT) with the assistance of the research assistants in each school. The students were given the necessary instructions and asked to answer the questions within specified time frame. After the test, the researcher retrieved the answer sheets and the question papers from them and marked. This accounted for the pre-test scores. Also, the researcher handed the test (PAT) to the research assistants a week to the end of the program to administer to the students within three days after instruction has been concluded. They were collected back by the researcher for marking. This accounted for the post-test scores.

3.5 Method of data analysis

The data obtained were analysed using descriptive statistics (mean and standard deviation) while hypothesis 1, 2 and 3 were tested using the Analysis of Covariance (ANCOVA).

4   Results and Discussions

Data gathered were analysed and the results are presented below.

4.1 Test of assumptions

The following tests of assumptions were established to justify the use of ANCOVA.

1. The covariate was measured before treatment
2. The Crombach alpha using the reliability procedure was established
3. More than one covariate were used
4. The linearity was established. The straight line shows a linear relationship with each other.
5. The significant interaction between the covariate and the treatment is 0.4. This is above 0.05 level of significance, thus, establishing the homogeneity of regression slope.

4.2   Test of hypotheses

- Result on hypothesis 1

 The hypothesis examined whether there is no significant difference in the mean achievement scores of students in Physics between groups taught by using 5E learning cycle and those taught by using the lecture method.

   From table 1, the experimental group had a mean achievement score of 25.50 while that of control group had a mean achievement of 15.25 in post-test score over 50. The difference in mean achievement is 10.25. Also, the standard deviation for post-test experimental group is 5.16 while that of control is 3.19.   This shows that there is a difference in the mean achievement in favour of the experimental group.

An inferential statistics will be used to establish whether the difference is statistically significant.

Table 1. Mean and standard deviation (SD) of both experimental and control groups.

Test	Teaching Method	N	Mean	SD
Pretest	5E model	113	8.86	3.15
	Lecture	133	8.64	3.18
Posttest	5E model	113	25.50	5.16
	Lecture	133	15.25	3.19

Analysis of covariance (ANCOVA) was carried out to determine the difference is significant and the result is presented in table2.

The result of the ANCOVA gives an $F(246) = 360.591$ which is significant at 0.05 level of significance. This implies that there is a statistically significant difference in the achievement of the groups. From the result, there are enough reasons to reject hypothesis 1. Therefore, there is a significant difference in the mean achievement scores of students taught using 5E learning cycle and those taught by using the lecture method in Physics. Furthermore, the value of Adjusted R Squared is 0.596. This implies that the 5E learning cycle contributed 59.6% to the achievement of students.

Table 2. Summary of analysis of covariance (ANCOVA) for the significance of difference in physics test scores between students exposed to 5E learning cycle and lecture method.

Dependent variable: post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6441.352a	2	3220.676	182.041	.000
Intercept	10724.767	1	10724.767	606.193	.000
Pretest	25.904	1	25.904	1.464	.227
Treatment	6379.578	1	6379.578	360.591	.000
Error	4299.156	243	17.692		
Total	108701.000	246			
Corrected Total	10740.508	245			

a. R Squared = .600 (Adjusted R Squared = .596)

- **Result on hypothesis 2**

Hypothesis 2 examined whether there is no significant difference in the mean achievement scores in Physics between urban and rural students taught by using 5E learning cycle.

Table 3 shows the mean achievement of rural and urban students in pre-tests are 9.18 and 8.87 with a standard deviation of 3.25 and 2.85 over 50 respectively. The post test scores are 25.57 and 25.32 while the standard deviations are 5.88 and 4.64 respectively. From the result of the discipline statistics, there is a difference in the mean achievement scores in Physics between rural and urban students taught by using 5E learning cycle method.

Table 3. Mean and standard deviation between urban and rural students taught using 5E learning cycle.

Test	School location	N	Mean	SD
Pre-test	Rural	44	9.18	3.25
	Urban	62	8.87	2.85
Post-test	Rural	47	25.57	5.88
	Urban	62	25.32	4.64

When subjected to inferential statistics using ANCOVA, the result is presented in table 4. The ANCOVA result reveals that F (113) = 0.004 is not significant at 0.05 level of significance. This result shows that the F – ratio of 0.004 is not statistically coefficient. This implies that there is no statistically significant difference in the achievement of urban and rural students taught by using 5Elearning cycle.

Table 4. Result of analysis of covariance (ANCOVA) of test scores between urban and rural students on achievement in groups taught using 5E learning cycle

Dependent variable: post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7.571[a]	2	3.785	.140	.870	.003
Intercept	6622.269	1	6622.269	244.723	.000	.690
Prettest	7.350	1	7.350	.272	.603	.002
Location	.097	1	.097	.004	.952	.000
Error	2976.624	110	27.060			
Total	76590.000	113				
Corrected Total	2984.195	112				

a. R Squared = .003 (Adjusted R Squared = .016)

- **Result on hypothesis 3**

Hypothesis 3 examined whether there is no significant difference in the mean achievement scores in Physics between urban and rural students taught by using the

lecture method. Table 5 shows the mean achievement scores for rural and urban students in pre-test are 9.74 and 8.48 respectively, while the post test scores are 13.75 and 15.67 over 50 respectively. From the result of the description statistics, there is a difference in the mean scores in Physics between rural and urban students taught by using the lecture method.

Table 5. Mean and standard deviation between urban and rural students taught using lecture method.

Test	School location	N	Mean	SD
Pretest	Rural	34	9.74	3.57
	Urban	84	8.48	2.92
Posttest	Rural	34	13.71	3.58
	Urban	84	15.67	3.04

In determining whether the difference was significant, ANCOVA was employed. The result of F (133) = 2.914 is not significant at 0.05 level of significant. This implies that there is no statistically significant difference in the achievement of urban and rural students taught with the lecture method. Therefore hypothesis 3 is accepted.

Table 6. Result of analysis of covariance (ANCOVA) of test scores between urban and rural students on achievement in groups taught using lecture method

Dependent Variable: Post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	36.258ᵃ	2	18.129	1.790	.171	.027
Intercept	3017.837	1	3017.837	298.013	.000	.696
Prettest	10.246	1	10.246	1.012	.316	.008
Location	29.508	1	29.508	**2.914**	.090	.022
Error	1316.449	130	10.127			
Total	32398.000	133				
Corrected Total	1352.707	132				

a. R Squared = .027 (Adjusted R Squared = .012)

- **Result on hypothesis 4**

In determining the interaction between methods and location, ANCOVA interaction table was employed and the result is presented in table 7.

Table 7 shows F (228) = 2.178; P>0.141 which reveals that there is no interaction effect between method and location on students achievements in Physics. This

implies that the factors could not interact to affect the achievement of students in Physics.

Table 7. Summary of ANCOVA for significant interaction effect between the methods used and school location on achievement in Physics.

Tests of Between-Subjects Effects
Dependent Variable: post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6511.513[a]	4	1627.878	92.769	.000
Intercept	9305.457	1	9305.457	530.295	.000
Pretest	47.818	1	47.818	2.725	.100
Treatment	6361.421	1	6361.421	362.522	.000
Location	30.128	1	30.128	1.717	.191
treatment * location	38.219	1	38.219	2.178	.141
Error	4228.995	241	17.548		
Total	108701.000	246			
Corrected Total	10740.508	245			

R Squared = .606 (Adjusted R Squared = .600)

The graph of interaction in figure 1 shows an ordinary interaction because the lines does not cross each order. From table 7, F-cal (2.178)> F-crit (3.84) shows that there is no significant interaction effect between method and location on student achievement in Physics. Thus, the null hypothesis of non – significant interaction effect was accepted.
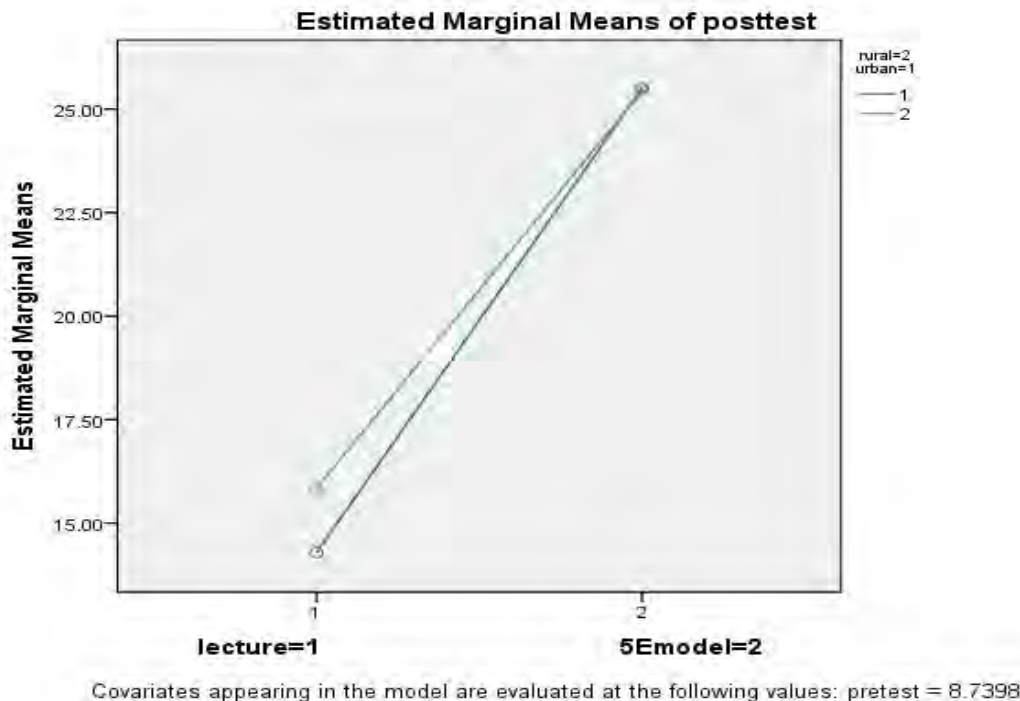

Figure 1. Graph illustrating significance interaction effect between method and location on students' achievement in Physics.

4.2 Test of hypotheses

This work examined the effects of school location on students' academic achievements based on the 5E learning cycle. The study also examined the interaction between the methods employed and school location.

Hypothesis 1 stated that there is no significant difference in the mean achievement scores of students in Physics between groups taught by using 5E learning cycle and those taught with lecture method. The mean score of the experimental group is higher than the mean score of the control group. This implies that the experimental (5E learning cycle) group achieved better than the control group. The *t*-test result (*t*-cal. (18.315) > *t*-crit (1.960), p>0.005) shows difference in performance is significant. A confirmatory test using ANCOVA (F (246) =360.591, p>0.005) also confirms that the difference is significant in favour of the experimental group. Therefore, the achievement scores of students taught by using 5E learning cycle and those taught by using the lecture method in Physics is significantly different. This result is in consonance with Cardak *et al.* (2008), Cepni, Sahin & Ipek (2010), Tuna & Kacar (2013), Ajaja & Eravwoke (2012), Qarareh (2012), Balci, Cakiroglu & Tekkaya (2006) who reported a significant difference in students' achievement in favour of 5E learning cycle.

Hypothesis 2 stated there is no significant difference in the mean achievement scores in Physics between urban and rural students taught by using 5E learning cycle. The result of the descriptive statistics showed the mean achievement for rural and urban students in pre-test which were 8.87 and 9.18 respectively differ from the post-test scores of students which were 25.32 and 25.25. The descriptive statistics showed a difference in the mean achievement scores between rural and urban students. This implies that the rural students performed better than their urban counterparts. The finding establishes the fact that rural students are not disadvantaged when the 5E learning cycle is employed. However, when subjected to ANCOVA (F (133) =0.004, p>0.005), the difference was not significant. This led to the acceptance of the null hypothesis. This implies that the achievement of rural and urban students do not differ significantly when they are taught Physics by using the 5E learning cycle. The result of Adjusted R Squared of 0.016 shows that the effect of school location on students' achievements based on 5E learning cycle is 1.6%. The result on hypothesis 2 is at variance with the results of Adesoji and Olatunbosun (2008), Adepoju (2001), Ogunleye (2002), Ndokwu (2002), Owoeye (2002), Yusuf and Adigun (2010), Ajayi (1999) and Owoeye and Yara (2011). These researchers

have observed that the achievements of students in urban and rural areas are significantly different.

In examining whether there is a significant difference in the mean achievement scores in Physics between urban and rural students taught by the lecture method, post-test scores of students showed that rural students scored 13.71; while urban students scored 15.67. On the basis of this result, it was established that there is a difference in the mean achievement scores in Physics between rural and urban students taught the use lecture method. The mean score of the urban students was higher than that of the rural students. This implies that urban students achieved better when the lecture method is employed. However, on exposure to ANCOVA (F (113) = 0.05, P> 0.05), the difference was not significant. This implies that there is no significant difference in achievement scores between rural and urban students when they are taught by the using lecture method. The result on the hypothesis is at variance with results of Adesoji and Olatunbosun (2008), Adopoju (2001), Ogunleye (2002), Ndokidu (2002), Owoeye (2002), Yusuf and Adigun (2010), Ajayi (1999) and Owoleye and Yara (2011) who reported significant difference in the achievement of students in urban and rural areas. This show with equal treatment, there will be no significant difference in the achievement between rural and urban students. Also, irrespective of the school location, the 5E learning circle improved the mean achievement of students.

The research also showed that there is no interaction effect between method and school location in students achievements in Physics. F cal (2.178) < F-cal (3.84); p>0.141 show no significant interaction effect. Graphically, a dis-ordinal interaction between the lines crossed each other. This implies that the two factors did not interact to cause the desired test scores of the students. Thus, the null hypothesis of the non-significant interaction effect is established.

5 Conclusion and Recommendation

5.1 Conclusion

On the basis of the findings of this study, it is concluded that both methods (the lecture method and the 5E learning circle) improved students' achievement in Physics. However, the group exposed to 5E learning cycle achieved significantly better than the one taught with the traditional method. This study has established that the achievement of students taught by using both the lecture and the 5E

learning circle did not differ significantly with school location (urban and rural). From the Adjusted R Square, the effect of school location on students' achievements in Physics based on the 5E learning cycle is just 1.6%. Also, there is no interaction effect between method and school location in determining the achievements of students in Physics when the 5E learning cycle is employed.

5.2 Recommendations

On the basis of the findings and conclusions of this study, the following recommendations are made:

1. The findings of the study have proved statistically the effectiveness of 5E learning cycle in enhancing better achievements in the learning of Physics. Thus, Physics teachers are encouraged to adopt the method in the teaching of the subject with a view to improving students' achievement in it. The method enables students to cooperate with one another and individual acquisition of knowledge instead of being spoon-fed. Using 5E learning cycle provides teachers with the opportunity to discover for themselves the individual problems of students and the general weakness of the students in the class.
2. Faculties of education of various institutions of higher learning should ensure that the 5E learning cycle is included as a method of teaching Physics and other science subjects. This will acquaint would-be teachers with the knowledge of the method and its advantages.

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