Effects of Cooperative Learning Strategy on Secondary School Physics Students' Understanding of the Concept of Radioactivity

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Abstract
The study examined the effects of cooperative learning strategy on secondary school physics students' understanding of the concept of radioactivity in Ogba/Egbema/Ndoni Local Government Area, Rivers State, Nigeria. The research design employed in this study was the quasi-experimental; specifically, pre-test, post-test control and experimental group design. A sample of seventy five(75) Senior Secondary two (SS 2) students drawn from two intact classes in a co-educational secondary school in Ogba/Egbema/Ndoni Local Government Area Rivers State, Nigeria. Intact sampling technique was adopted in drawing the sample. Three research questions and three null hypotheses guided the study. Hypotheses 1 were rejected, hypothesis 2 was accepted and hypothesis 3 was rejected. An instrument known as Radioactivity Test that was duly validated by experts in science education with a split half reliability coefficient of 0.93 was adopted for the study. Mean and standard deviation was used to answer the research questions, while z-test was used to test the hypotheses at 0.05 level of significant. The results revealed that students taught using cooperative learning instructional strategy understand better in Radioactivity Evaluation Test than those taught using conventional lecture method of instruction. There was an interaction between methods and gender on students Radioactivity Evaluation Test. Based on the result obtained; it was therefore recommended that teachers should be encouraged to use cooperative instructional strategy to teach physics and other sciences, technology, engineering and mathematics subjects in secondary schools and male and female students should not be given equal consideration as far as the use of cooperative instructional strategy is concerned, but should not in conventional lecture method, since gender has an influence in cooperative learning but has an influence in conventional lecture method.

Introduction

Radioactivity is a nuclear phenomenon. It is the spontaneous emission of radiation from the nucleus. According to Loveland el ta (2006),Stabin &Michael (2007) and Bestet al (2013), radioactive decay is a stochastic (i.e. random) process at the level of single atoms, in that, according to quantum theory, it is impossible to predict when a particular atom will decay, regardless of how long the atom has existed. Shedding light upon the concept of radioactivity, Farinde etal (2015), explained that 'radioactivity is the spontaneous disintegration or random decay or breaking up or splitting up of radioactive elements / sample / materials with the emission of alpha particles, beta particles and gamma radiation, resulting in the release of energy. At advanced level, it has been shown that apart from these particles, other particles such as positrons, betatrons, antiprotons, antineutrino, etc. are also released in the process of radioactivity'. They further explained that, the rate of decay depends on the radioactive material and varies widely from material to material. No physical or chemical process can alter or affect the rate at which the disintegration of atoms proceeds.

Farinde et al, (2015) mused that radioactive elements radiate energy. They could be natural or artificial, light or very heavy. They gave examples of radioactive elements as: Uranium, radium, radon, polonium, thorium, actinium, etc. These according to them, continuously are emitting invisible rays known as radiation.

Radioactivity was discovered in 1896 by the French scientist Henri Becquerel, while working with phosphorescent materials. Mould& Richard,(2015) These materials glow in the dark after exposure to light, and he suspected that the glow produced in cathode ray tubes by X-rays might be associated with phosphorescence. He wrapped a photographic plate in black paper and placed various phosphorescent salts on it. All results were negative until he used uranium salts. The uranium salts caused a blackening of the plate in spite of the plate being wrapped in black paper. These radiations were given the name "Becquerel Rays".
It soon became clear that the blackening of the plate had nothing to do with phosphorescence, as the blackening was also produced by non-phosphorescent salts of uranium and metallic uranium. It became clear from these experiments that there was a form of invisible radiation that could pass through paper and was causing the plate to react as if exposed to light. At first, it seemed as though the new radiation was similar to the then recently discovered X-rays. Further research by Becquerel, Ernest Rutherford, Paul Villard, Pierre Curie, Marie Curie, and others showed that this form of radioactivity was significantly more complicated.

Rutherford was the first to realize that all such elements decay in accordance with the same mathematical exponential formula. Rutherford and his student Frederick Soddy were the first to realize that many decay processes resulted in the transmutation of one element to another. Subsequently, the radioactive displacement law of Fajans (1913) and Soddy, (1913), whereformulated to describe the products of alpha and beta decay. Marie and Pierre Curie's study of radioactivity is an important factor in science and medicine. After their research on Becquerel's rays led them to the discovery of both radium and polonium, they coined the term "radioactivity". L'Annunziata& Michael (2007). Their research on the penetrating rays in uranium and the discovery of radium launched an era of using radium for the treatment of cancer. Their exploration of radium could be seen as the first peaceful use of nuclear energy and the start of modern nuclear medicine,L'Annunziata, Michael F. (2007).
Radioactivity is taught and learnt in senior secondary school (SSS) three physics in the 6-3-3-4 system of education in Nigeria.

In a study conducted by Akpan, (1999) as cited by Adolphus et al, (2015), the physics students performed very poor in Quants (where Radioactivity is taught). The study also reported that teachers did worst in the same and related concept (quanta and conservation principles). Studies have shown that the major cause of difficulty in the understanding of physics concepts and the performance of learners in physics at the secondary school level has been the improper teaching of the subject Dayal (2007).Several studies in different countries have investigated students' perception of radioactivity and its misconception (Colclough et al., 2011, Rego& Peralta, 2006, Nakiboglu&Tekin, 2006; Prather, 2005; Sesen et al, 2012).Most science education research related with radioactivity has shown that students have difficulty in understanding the concept and so they have lots of misconception (Henriksen&Jorde, 2001; Huestis, 2002; Eijkelhof, 1996) and continue to have the difficulty and misconception even after instructions (Eijkelhof, 1990, as cited inHenriksen, 1996).In attempting to explain students' difficulties in understanding the concept of radioactivity and other difficult concepts, Guisasola et al, 2013, as cited in Adolphus et al, (2015), opined that students make meaning of current learning tasks by a combination of formal and informal everyday experiences. They argued further that "while everyday experience makes an impact on some alternative conceptions, some areas of physics have no obvious parallels in everyday experience".Radioactivity is considered as one of the concepts in physics where everyday prior experience does not make a reasonable impact. Galili et al, (2006) attributed the challenge or difficulty in students' understanding of some concepts in physics like electromagnetic induction amongst others to the use of ambiguous terminologies in explaining the concepts. They mentioned the use of the terms 'area change' and 'change in orientation' that are used in many textbooks as ambiguous. They also argued that the 'unclear relation between Faraday's law and Maxwell's equation for the electric field circulation' as a challenge in the teaching of some concepts in physics mostly in electromagnetic induction. It is now clear that science educators and all the custodians in the teaching and learning of science are seriously questing for better teaching and learning strategies and methods that will enable physics students gain proper understanding and application of physics concepts and principles. In the conventional lecture method, the teacher is seen as a 'knowledge dispenser' given out information and instructions to passive students with its accompanying drill, rehearsal and practice is no longer needed for effective teaching and learning of science at the secondary school level. According to (Windschitl, 1999), teachers and instructors would need to 'develop a new, well-articulated rationale for teaching and learning experiences for much help in shaping their choice of teaching methods and strategies'. The inherent nature of this is to produce students that can criticallythink and make sense out of their classroom learning experiences. Hence, the interest of the researchers here is to identify an effective teaching strategy that will promote the teaching and learning of radioactivity in secondary school physics. Adolphus et al, (2015), mused that, several science educators have outlined methods of teaching science. Some of the methods they mentioned include lecture, question-answer problem solving, play-way, discovery, field trip, demonstration, project method; Computer Assisted Instruction (CAI) and cooperative learning strategy. In the view of (Alamina, 2008), the choice of any or some of these methods in science teaching depends on the age, content ,availability of resources, previous knowledge and the teacher's versatility. The researchers shall compare the relative effects of cooperative learning strategy and conventional lecturemethod on student understanding of the concept of radioactivity. Cooperative learning is a teaching strategy where students work together in a limited team and group to achieve learning objectives under the counseling and supervision of an instructor or the teacher (Lin, 2006). The three main reasons for the use of cooperative learning are: to increase student's tolerance and acceptance of diversity, communication and social skills and to enhance student's academic performance (Lin, 2006). To contrast, the conventional lecture method is teacher centered with the teacher as the only source of the knowledge of the student and in lecture method students are inactive receivers that must cram information (Mahira& Azamat, 2013).

In cooperative learning strategy, all students are divided into smaller groups ranging from three to seven. Every group and team is assigned an objective and the achievement of that objective calls on all the students in a particular group to help one another in a peaceful way. The cooperative learning strategy is a student centered teaching method while the conventional teaching method is teacher centered and dominated. in cooperative learning settings, learners assists one another study and learn task material or the subject matter and they make positive contributions to the group in general, (Theodora, 2008).

Mohammed, (2004) observed that, cooperative learning achievement are not restricted to a specific ability level or any group but to all whom are fully engaged in the cooperative learning activity. Also, Pierce (2009) observed that, cooperative learning instructional strategy equalizes the position and regard for learners in the group, with no regard to gender difference.Fabunmi, (2004) discovered that sex proportion has an influence on academic understanding and performance of students both in the lecture method and cooperative learning strategy. Zephaniah, (2006) examined the relationship between physics test scores and measures of cultural, political and economic gender equity. He found that the gender gap in average scores is smaller in countries with greater gender equity. Hence, over the years, the influence of gender difference in physics achievement has been a matter of concern to the public. It has been shown that gender difference in performance and understanding exists with the observation that boy's dominant in the use of physics apparatus and express more confidence of handling practical equipment's. Killer, (2007) asserted that boys are ahead of girls, in every branch of science with the largest difference in mathematics and physics and practical test. The question now is, will this difference in achievement and understanding exist if appropriate and suitable strategy is used in teaching?

Physics, as one of the natural sciences has been recognized as the foundation for advancement in technology and development. It is against this background that science educators are increasingly seeking ways of enhancing the quality of teaching and learning of physics in our secondary schools. Twoof the general objectives of the physics curriculum in line with the curriculum document are to: "Provide basic literacy in physics for functional living in the society and to stimulate and enhance creativity" (FME, 2009).Adolphus et al, (2015), opinedthat, it is very important to bear these objectives in mind, so that what we teach, how we present it and to whom, can only be decided when we know what we are trying to achieve. In line with the objectives, we recognize the role of physics in the nation and capacity building. They further explained that, the teaching of physics should show how facts are established by experiment and observation, how generalizations are built upon this knowledge and concepts developed. When this is achieved, our secondary school leavers should be able to adapt to the rapid and drastic changes in technology and social culture.

Theoretical Approaches to Cooperative Learning

The theoretical background of cooperative learning according to
Conway (1997) anchors on the work of psychologists like Jean Piaget, Levi Vygotsky, and Jerome Bruner among others who propose that children actively construct knowledge and this construction of knowledge happens in a social context, Conway cited Vygotsky that all learning takes place in the zone of proximal development. This zone is the difference between what a child can do alone and what he/she can do with others' assistance. Thus, the child does not learn in isolation therefore the teacher should create room for cooperation amongst students for effective cross-fertilization of ideas and knowledge. Cooperative learning is based on the principle that knowledge is co-constructed through interactions with others. This is in line with Nwachukwu, (2008) who opines that when learners exchange ideas with peers and the teacher, they develop shared meanings that allow group members to communicate effectively with one another. Hence, the theoretical framework of this study is anchored on the Piaget's Socio-Cognitive Theory.

Statement of the Problem

Physics, the foundation of other science subjects in senior secondary school which deals with the promotion of scientific literacy is one of the perceived difficult subjects by both students and teachers in senior secondary school in Nigeria. Maduabum (1992) highlighted the factors militating against the teaching and learning of science to include the teaching approach. How students understand physics and the methods used in presenting it to them moves in regular procession all through their time in school. This implies that, the teaching method used by the teacher in presenting physics to the students all the years of schooling most affect and influence the students understanding and mastering of the subject matter and how they understand science generally. There is considerable evidence in the literature to show that traditional physics instruction is predominantly based on conventional lectures and manipulation of formulae, to teach concepts is ineffective. In typical classroom setting, if students are involved

in only passive learning, it would lead to limited knowledge retention, let alone engaging them in critical thinking or promoting functional understanding. Research works have shown that involving students directly and actively in the learning process promotes meaningful learning. Good performance of students in physics is very eminent and necessary as it prepares the students for advanced scientific studies and economic development of the country.
Unfortunately, the current trend in the teaching and learning of physics, where materials for teaching are not available in public schools (Onwioduokit, 2001), has forced most teachers to use the traditional lecture method in teaching physics . This has made it difficult to realize the importance of physics in our national development. From the foregoing therefore, the difficulty students have in understanding concepts in physics and the quest for better ways of effectively teaching the concepts in physics was the drive for this study. This research work therefore explores cooperative teaching strategy, particularly, student's team achievement division cooperative learning strategy in enhancing students' understanding in physics. For teaching to be effective in promoting learning and enhancing students' understanding of physics, it must involve interaction between teachers and students and between students. The interaction should be such that it encourages students to get involved in working and forming meaning from experiences themselves.

The problem of this study therefore is to find out whether cooperative learning strategy compared to conventional lecture method could enhance physics students' conceptual understanding and application of radioactivity.

Purpose of the Study

The purpose of the study is to compare the effect of cooperative learning strategy and conventional lecture method on the conceptual understanding of the concept of radioactivity in secondary school physics in Ogba/Egbema/Ndoni Local Government Area, Rivers State, Nigeria. Specifically, the study intends to:

1.2 Purpose of the Study

The purpose of the study is to compare the effects of cooperative learning strategy and conventional lecture method on the academic performance of secondary school physics student' understand of the concept of radioactivity in Ogba/Egbema/Ndoni Local Government Area, Rivers State. Specifically, the study intends to:

1) Find out the mean academic performance of physics students taught radioactivity with cooperative learning strategy and those taught with conventional lecture method.
2) Find out the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy.
3) Find out the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics students taught radioactivity with conventional lecture method.

Research Questions

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(2) What is the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy?

(3) What is the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics student taught radioactivity with conventional lecture method?

Hypotheses

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

(1) There is no significant difference between the mean academic performance of physics students taught radioactivity with cooperative learning strategy and those taught with conventional lecture method.

(2) There is no significant difference between the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy.

(3) There is no significant difference between the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics students taught radioactivity with conventional lecture method.

Significance of the Study

There is no doubt that proper teaching and learning of physics in our schools will lay a solid foundation for the Nigerian quest for scientific and technological advancement. This research work was carried out to evaluate effects of cooperative learning strategy on physics students' understanding of the concept of radioactivity in Ogba/Egbema/Ndoni Local Government Area, Rivers State.

The significance of the study is derived from a number of points. Firstly, most important physics topics are abstract and difficult to understand. Efforts to teach them through the conventional methods of teaching have proved abortive. The result of this work will therefore sensitize physics teachers to use effective instructional approaches for improved students' understanding and achievement in the concept of radioactivity and other concepts in physics. It will also serve as an eye opener to teachers in other fields of learning to explore and adopt better instructional approaches in handling abstract and difficult topics and concepts in their own areas for improvement.

Secondly, the way physics is hurriedly taught in secondary schools, makes the subject irrelevant to the students resulting in their inability to transfer learning to everyday life and poor academic performance. Hence, the result of the work will help to improve on students' performance in physics and other science subjects and also ensure better quality physics candidates for the Senior Secondary School Certificate Examination. Again, the work will help to produce more qualified candidates for courses in science and technology in the tertiary institutions of learning, which in turn will boost national wealth and economic development.
Finally, it will sensitize teachers and curriculum planners about gender influence on instructional approaches. The results of the study would also contribute to the pool of research in the area of education in Physics in particular and science education in general.

Method

The quasi experimental, non- equivalent pre-test, post-test, control group research design was used for the study. A sample of seventy five (75) Senior Secondary two (SS 3) students drawn from a two intact classes in a co-educational secondary school in Ogba/Egbema/Ndoni Local Rivers State, were used for the study. Only two classes from the school were randomly sampled due to the experimental nature of the study. One of the classes was assigned to experimental treatment and the other one was assigned to control group.

The instrument used for data collection was titled Radioactivity Test (RADIT) constructed by the researchers based on the unit and topics under Radioactivity taught which is part of SS 3 physics curriculum. The validation of RADIT was done by two specialists in science education from the university who are experienced science teachers. Split half reliability technique was used to estimate the reliability of the instrument, RADIT. The scores obtained were correlated using Peason Product Moment Coefficient (PPMC) of correlation. The split half reliability coefficient was found to be 0.93.

Procedure for Administration of the Instrument
The research instrument was administered to the selected school and classes using intact classes of SS 3 A and SS 3 B, because the principal of the school did not want distortion in the normal school time table. SS3 A class was the control class and SS 3 B was the experimental class.
In this study, the researchers used standardized Radioactivity Test (RADIT) to collect data. At the commencement of the study, learners in both the experimental and control group were pre-tested using the RADIT. Learners in the experimental group were taught using cooperative instructional strategy while learners in the control group were taught using conventional teaching method. At the end of the treatment, which lasted for two weeks, learners in both the experimental and control group were tested (post-test) again using Radioactivity Test (RADIT) so as to determine the effects of the teaching strategies that was used in the study. Both the pre-test and post-test was administered under similar conditions in both the experimental and control group.

Experimental Group
In the experimental group, learners were divided into groups of four members. The decision to form groups of four members was based on research that suggested that groups larger than four presented problems, such as making it easier for unenthusiastic learners to play a smaller role in group activities (Asherson, 2008).
Each group consisted of a mixture of high-and low-ability learners with different number of male and female students. The rationale for forming heterogeneous groups was to maximize strength (Asherson, 2008). A total of ten teams (40 learners) were formed in the experimental group. The learners in each group were assigned complementary roles such as leader, recorder, resource manager or person and time keeper. The group leader facilitated group discussions and ensured that group members' discussions are relevant to the learning task. The time keeper ensured that group members stick to time during group work. The recorder kept the groups' self-assessment records as well as other written records while the resource manager or person gathered and organized materials for group activities. Complementary roles were assigned to group members in this study as a strategy to maximize cooperation and learning (Woolfolk, 2010).

In view of the assertion by Woolfolk (2010) that simply putting learners in a group is no guarantee that they would cooperate and learn. Learners in the experimental groups will be given orientation about cooperative learning and its importance. In addition, they were taught appropriate social skills needed for them to work effectively as a team. The taught skills included how to communicate effectively, how to help and support each other, and how to resolve conflicts constructively. The treatment during this study was focus on the concept of radioactivity.

Control Group
The control group consisted of 35 learners who were taught using the conventional teaching method. In this method, the teacher presented information on the topics and sub-topics to the whole class while learners listened and take notes at the end of the lesson. Learning activities was done by learners individually. The topics taught in the experimental and control group was the same. The treatment in both the experimental and control group lasted for a period of four weeks.

Result
Analysis was based on the post treatment evaluation tests titled: Radioactivity Test (RADIT) administered to two intact classes of SS 3A and SS 3B. The data generated from this measurement was shown in tables below:

4.1 Research Question 1

1) What is the mean academic performance of physics students taught radioactivity with cooperative learning strategy and those taught with conventional lecture method?

Table 4.1: Mean and SD for the experimental and control class (Male + Female)

Class	N	X	%Mean	SD
Experimental Class (SS2 A Male+ Female)	40	16.8	81.0	4.96
Control Class (SS2B Male+ Female)	35	14.2	71.0	4.63

Table 4.1 shows the mean scores of experimental class and control class regarding the mean academic performance of physics students taught radioactivity with cooperative learning strategy and those taught radioactivity with conventional lecture method. A mean of 16.8 for the experimental class and 14.2 for the control class indicate that physics students taught in the experimental class with cooperative learning strategy performed better than those in the control class taught with lecture method.

4.2 Research Question 2

2) What is the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy?

Table 4.2: Mean and SD for the experimental class only (male and female)

Class Experimental	N	X	%Mean	SD
(Male)	24	16.95	84.79	2.05
(Female)	16	16.56	82.81	2.91

Table 4.2 shows the mean scores of male and female physics students in the experimental class regarding the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy. A mean of 16.95 for the male students in the experimental class and 16.56 for the female students in the same class indicate that both male

and female physics students taught in the experimental class with cooperative learning strategy performed better.

4.3 Research Question 3

3) What is the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics student taught radioactivity with conventional lecture method?

Table 4. 3: Mean and SD for the experimental group and control group (male and female)

Class	N	X	%Mean	SD
Experimental Class (SS2 A Male)	24	16.95	84.79	2.05
Control Class (SS2 B Female)	17	13.23	66.18	3.03

Table 4.3 shows mean scores of male physics student in the experimental class and female physics students in the control class regarding the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics students taught radioactivity with conventional lecture method. A mean of 16.95 for the male students in the experimental class and 13.23 for the female students in the control class indicate that male physics students in the experimental class perform better than female physics students taught in the control class.

4.4 Hypothesis 1

(1) There is no significant difference between the mean academic performance of physics students taught radioactivity with cooperative learning strategy and those taught with conventional lecture method.

Table 4.4: z-test analysis of significant difference between the mean scores of the control and experimental group (Male + Female).

Class	N	X	%Mean	SD	df	z-cal	z-crit	Result
Experimental Class (SS2 A Male+ Female)	40	16.8	81.0	4.96	73	2.34	1.67	Rejected
Control Class (SS 2B Male + Female)	35	14.2	71.0	4.63				

Table 4.4 shows that the experimental class with 40 students had a mean score (x) of 16.8 and standard deviation of 4.96 while the control class with 35 students had a mean score (x) of 14.2 and standard deviation of 4.63. The independent z-test was used to test the statistical difference between the two mean scores at a degree of freedom (df) of 73, the z- calculated was 2.34 and the z- critical was 1.67, at an alpha level of significant of 0.05; in view of the fact that the z-calculated value is greater than the z-critical value, the null hypothesis 1 was rejected.

4.5 Hypothesis 2

There is no significant difference between the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy.

Table 4.5: z-test analysis of significant difference between the mean scores and standard deviation of male and female students in the experimental group.

Experimental Class	N	X	%Mean	SD	df	z-cal	z-crit	Result
Male	24	16.95	84.79	2.05	38	0.55	1.68	Accepted
Female	16	16.56	82.81	2.91				

Table 4.5 shows that the experimental class with 24 male physics students had a mean score (x) of 16.95 and standard deviation of 2.05 while the 16 female physics students in the class had a mean score (x) of 16.65 and standard deviation of 2.91.The independent z-test was used to test the statistical difference between the two mean scores at a degree of freedom (df) of 38, the z-calculated was 0.55 and the z-critical was 1.68, at an alpha level of significant of 0.05; considering the fact that the z-calculated value is less than the z-critical value, the null hypothesis 2 was accepted.

4.6 Hypothesis 3

(3) There is no significant difference between the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics students taught radioactivity with conventional lecture method.

Table 4.6: z-test analysis of significant difference between the mean scores and standard deviation of male students in the experimental group and female students in the control.

Class	N	X	%Mean	SD	df	z-cal	z-crit	Result
Experimental Male	24	16.95	84.79	2.05	39	3.26	1.69	Rejected
Control Female	17	13.23	66.18	3.03				

Table 4.6 shows that the experimental class with 24 male physics students had a mean score (x) of 16.95 and standard deviation of 2.05 while the 17 female physics students in the control class had the mean score (x) of 13.23 and a standard deviation of 3.03. The independent z-test was used to test the statistical difference between the two mean scores at a degree of freedom (df) of 39, the z-calculated was 3.26 and the z- critical was 1.69, at an alpha level of significant of 0.05; for the reason that the z-calculated value is greater than the z-critical value, the null hypothesis 3 was rejected.

4.7 Discussion of Findings

The results of the data analysis are discussed below on the bases of the research questions

4.7.1 Research Question 1

(1) What is the mean academic performance of physics students taught radioactivity with cooperative learning strategy and those taught with conventional lecture Method?

Table 4.4 shows the z-test analysis of the effectiveness of students in the control and experimental groups. The experimental group had a mean score (x) of 16.8 and Sd of 4.96 while the control group had a mean score of 14.2 and the standard deviation of 4.63. The independent z-test was used to test the statistical deference between the two mean scores at a degree of freedom (df) of 73, the z-calculated was 2.34 and z-critical was 1.67, at an alpha level of 0.05 since the value of z-critical is less than z-calculated, hence the null hypothesis 1 is rejected the alternative accepted.

This finding is in agreement with the earlier researcher, Zephaniah (2006), who carried out an investigation on the effectiveness of cooperative instructional strategy in physics on students' academic performance in senior secondary school. He found that student taught physics with cooperative instructional strategy have a mean score greater than that of their colleague that are taught physics using conventional lecture method. But not in agreement with Sahin (2010) who found cooperative instructional strategy to be ineffective in improving student's academic performance. He researched on the effect of cooperative learning method on student's academic performance in vocational studies. The results he found had no statistical difference or relationship between the mean scores of students in both lecture method and cooperative learning group.

4.7.2 Research Question 2

(2) What is the mean academic performance of male and female physics students taught radioactivity with cooperative learning strategy?

Table 4.5 shows the level of performance of male and female physics students taught radioactivity by student's team-achievements division cooperative learning strategy. Male students had the mean score (x) of 16.95 and the standard deviation of 2.05, while female student had the mean of 16.56 and standard deviation of 2.91. The mean scores of male and female student's show z-calculated to be 0.55 and z-critical to be 1.68 with the degree of freedom (df) of 38 at an alpha level of 0.05. The value of z-calculated and z-critical shows no statistical difference, since the value of z-critical is less than that of z- calculated, hence, the null hypothesis 2 is accepted but not rejected.

This finding conforms to that of the earlier researcher Mohammed (2004), who observed that cooperative learning gains, has no limit to any stipulated level or gender but to all who participated in it. The finding is also in conformity to pierce (2009), who noticed cooperative learning strategy to equate status and respect all group mates, regardless of sex. But not in line with Killer (2007), who asserted that boys are ahead of girls in every branch of science with the largest difference being in mathematics and physics and practical test.

4.7.3. Research Question 3

(3) What is the mean academic performance of male physics students taught radioactivity with cooperative learning strategy and female physics student taught radioactivity with conventional lecture method?

Table 4.6 shows the level of performance of male physics students taught radioactivity with cooperative learning strategy and female physics students taught radioactivity with conventional lecture method. Male students in experimental class had the mean score (x) of 16.95 and the standard deviation of 2.05 while female students in the control class had the mean of 13.23 and standard deviation of 3.03. The mean scores of male students in experimental class and female students in the control class shows z-calculated to be 3.26 and z-critical to be

1.69, with the (df) of 40 at an alpha level of 0.05. The value of z- calculated and z-critical shows a statistical difference, since the value of z-critical is less than that of z-calculated, hence the null hypothesis 3 is rejected, the alternative accepted.
This observation is in line with Fabunmi (2004) who in a study discovered that gender composition has a significant relationship with students' academic performance and that gender composition has a significant influence on secondary school students' academic performance in a lecture strategy.

Summary

The study seeks to investigate the effects of cooperative learning strategy on secondary school physics students' academic performance in Ogba/Egbema/Ndoni Local Government, Rivers State, Nigeria. The introduction and/or the background of the study covers the weakness of traditional lecturer method and the need for a shift to cooperative learning strategy, an innovative teaching strategy. Three research questions and three null hypotheses guided the study and all the null hypothesis were rejected, there alternatives accepted.

The study anchored on Jane Paiget cognitive development theory.
Quasi-experimental pretest – posttest experimental and control design was used for the in this study. The population of the study was 75 ss3 physics students of two intact classes from co-educational school in the area of the study using intact sampling techniques. The research data were gathered using the instrument Radioactivity Test (RADIT) that was validated by two expects in science education with a Split-half reliability coefficients of 0.93. A lesson package was administrated to the intact classes after they were pre-tested. Also, a post- test was given after the lesson and results obtained were discussed.
Mean and standard deviation was used to answer the research questions. Additionally, the z-test was used to analyze the results of the three null hypotheses. The study concluded that, there is a statically significant difference between the academic performance of male and female students taught with Students Team Achievement Division Cooperative Learning and those taught with conventional lecture method. Recommendations and suggestions for further studies were made.

Conclusion

From the findings of this study we conclude that:

1. The understanding of students taught radioactivity with cooperative learning strategy and conventional lecture method differs significantly.
2. Also, understanding of the male and female physics students taught radioactivity with the cooperative learning strategy does not differs to any extent.
3. The understanding of male students taught radioactivity with student's team-achievements division cooperative learning strategy and male students taught with conventional lecture method differs greatly.
4. There is a statistically significant difference between the understanding of students taught radioactivity with student's team-achievements division cooperative learning strategy and those taught radioactivity with lecture method.

Educational Implications

The findings of this study have implication for science teachers, guidance and counselors, and ministry of education and the understanding of students in Physics as enhanced by the use student's team-achievements division cooperative learning strategy is of significant to science teachers, as it can be adopted as a teaching method.

Recommendation

From the findings of the study, the following recommendations were offered:

1. The teachers and instructors should use cooperative instructional strategy, to teach physics and other subjects in senior secondary schools.
2. Conferences, seminars and workshops should be organized by government and schools to prepare teachers on how to include cooperative learning strategy in science teaching.
3. Science teachers and curriculum planners should incorporate the innovative pedagogies like the cooperative learning strategy, concept mapping and the use of analogy into their different teacher education programmes.
4. Male and female students should be given equal consideration as far as the use of cooperative instructional strategy is concerned since gender has no influence on the academic achievement and performance of students.

Suggestions for Further Studies

At the conclusion of this study, some areas were identified for further research, thus, the following areas are suggested for further study:

1. This study was conducted using only two teaching methods; other study should be conducted testing other teaching methods.
2. This study should also be conducted in other local government areas of the state.
3. This study was conducted using only one co-educational school other study should be conducted using more than one co- educational school.
4. The study was conducted using the concept of radioactivity; other studies should be conducted using different difficult concepts in physics.
5. The study was conducted using only one cooperative learning method (student's team achievement division cooperative learning); other studies should be conducted using different cooperative learning models and more than one cooperative learning model.
6. The study was conducted in a coeducational secondary school; other studies should be conducted in other none coeducation secondary school.

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FOR COOPERATIVE LEARNING TEACHING STRATERGY (MALE)
Total number of male students (N) = 24
Total number of scores ($\sum x$) = 19+ 19 + 19 + 19 +19 + 19 + 19 + 19 + 18 + 18 + 17 +17 + 17 + 17 + 17 +17 + 1
7 + 16 + 15+ 15 + 15 + 14 + 13 + 12 = 407/24 = 16.95

S/N	X	X^2
1	19	361
2	19	361
3	19	361
4	19	361
5	19	361
6	19	361
7	19	361
8	19	361
9	18	324
10	18	324
11	17	289
12	17	289
13	17	289
14	17	289
15	17	289
16	17	289
17	17	289
18	16	256
19	15	225
20	15	225
21	15	225
22	14	196
23	13	169
24	12	144
Total	**$\sum x$ =407**	**$\sum x^2$ = 6999**

STANDARD DEVIATION (STD) $= \frac{\sum x^2 - (\sum x)^2 / N}{N-1}$

$S^2 = \frac{6999 - (407)^2/24}{24 - 1}$

$S^2 = \frac{6999 - 165649/24}{23}$

$= \frac{6999 - 6902.0416667}{23}$

$= \frac{96.9583333}{23}$

$= 4.21557971$

$S = \sqrt{4.21557971}$

S = **2.05**

FOR COOPERATIVE LEARNING TEACHING STRATERGY (FEMALE)
Total Number of Female Students (N) = 16
Total Number of Scores (∑x) = 19+ 19 +19 + 19 +18 + 18 + 18 + 17 + 17 + 16 + 16 + 16 + 15 + 14 + 12 + 12 = 265/16 = 16.56

S/N	X	X^2
1	19	361
2	19	361
3	19	361
4	19	361
5	18	324
6	18	324
7	18	324
8	17	289
9	17	289
10	16	256
11	16	256
12	16	256
13	15	225
14	14	196
15	12	144
16	12	144
Total	**$\sum x = 265$**	**$\sum x^2 = 4516$**

STANDARD DEVIATION (STD) $= \frac{\sum x^2 - (\sum x)^2/N}{N-1}$

$S^2 = \frac{4516 - (265)^2/16}{16 - 1}$

$= \frac{4516 - 70225/16}{15}$

$= \frac{4516 - 4389.0625}{15}$

$= \frac{126.9375}{15}$

$= 8.4625$

$S = \sqrt{8.4625}$

S = **2.91**

FOR CONVENTIONAL LECTURE MATHOD (MALE)
Total Number of Male Students (N) =18
Total number of scores (∑x) =18 + 17 + 17 + 16 + 16 + 16 + 16 + 16 + 15 + 15 + 15 + 15 + 15 + 14 + 13 + 13 + 13 + 12 = 272/18 = 15.11

S/N	X	X^2
1	18	324
2	17	289
3	17	289
4	16	256
5	16	256
6	16	256
7	16	256
8	16	256
9	15	225
10	15	225
11	15	225
12	15	225
13	15	225
14	14	196
15	13	169
16	13	169
17	13	169
18	12	144
Total	**∑x = 272**	**$\sum x^2$ = 4154**

STANDARD DEVIATION (STD) = $\frac{\sum x^2 - (\sum x)^2/N}{N-1}$

$S^2 = \frac{4154 - (272)^2/18}{18-1}$

$= \frac{4154 - 73984/18}{17}$

$= \frac{4154 - 4110.222222\ 2}{17}$

$= \frac{43.7777778}{17}$

$= 2.5751634$

$S = \sqrt{2.5751634}$

S= **1.60**

FOR CONVENTIONAL LECTURE METHOD (FMALE)

Total Number of Female Students (N) =17

Total number of scores (∑x) =20 + 18 + 15 + 15 + 15 + 15 + 14 + 14 + 13 + 13 + 12 + 12 + 11 + 10 + 10 + 9 + 9 = 225/17 = 13.23

S/N	X	X^2
1	20	400
2	18	324
3	15	225
4	15	225
5	15	225
6	15	225
7	14	196
8	14	196
9	13	169
10	13	169
11	12	144
12	12	144
13	11	121
14	10	100
15	10	100
16	9	81
17	9	81
Total	**∑x=225**	**$\sum x^2$ =3125**

STANDARD DEVIATION (STD) $= \dfrac{\sum x^2 - (\sum x)^2/N}{N-1}$

$$S^2 = \frac{3125 - (225)^2/17}{17-1}$$

$$= \frac{3125 - 50625/17}{16}$$

$$= \frac{3125 - 2977.94118}{16}$$

$$= \frac{147.05882}{16}$$

= 9.1911762

$S = \sqrt{9.1911762}$

S = **3.03**

PERCENTAGE (%) MEAN ($\bar{X}$) FOR COOPERATIVE LEARNING TEACHING STRATERGY (MALE)

Maximum Score = 24 x 20 = 480

Total Score =407

$\frac{407}{480} \times \frac{100}{1} = 84.79\%$

PERCENTAGE (%) MEAN ($\bar{X}$) FOR COOPERATIVE LEARNING TEACHING STRATERGY (FEMALE)

Maximum Score = 16 x 20 = 320

Total Score =265

$\frac{265}{320} \times \frac{100}{1} = 82.81\%$

PERCENTAGE (%) MEAN ($\bar{X}$) FOR CONVECTIONAL LECTURE METHOD (MALE)

Maximum Score = 18 x 20 = 360

Total Score =272

$\frac{272}{360} \times \frac{100}{1} = 75.56\%$

PERCENTAGE (%) MEAN ($\bar{X}$) FOR CONVECTIONAL LECTURE METHOD (FEMALE)

Maximum Score = 17x 20 = 340

Total Score =225

$\frac{225}{340} \times \frac{100}{1} = 66.18\%$

PERCENTAGE (%) MEAN ($\bar{X}$) FOR EXPERIMENTAL GROUP ORCOOPERATIVE LEARNING STRATERGY (MALE + FEMALE STUDENTS)

Maximum Score = 40 x 20= 800

Total Score = 648

$\frac{648}{800} \times \frac{100}{1} = 81.0\%$

PERCENTAGE (%) MEAN ($\bar{X}$) FOR CONTROL GROUP OR CONVECTIONAL LECTURE METHOD (MALE + FEMALE STUDENTS)

Maximum Score = 35 x 20 = 700

Total Score =497

$\frac{497}{700} \times \frac{100}{1} = 71.0\%$

z–CALCULATED FOR COOPERATIVE LEARNING STRATERGY (EXPERIMENTAL GROUP, MALE + FEMALE)

z =? $\overline{X}_1$= 16.95, $\overline{X}_2$= 16.56, S_1= 2.05, S_2 = 2.91, N_1=24, N_2 = 16

$$\text{Using } t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(S_1)^2}{N_1} + \frac{(S_2)^2}{N_2}}}$$

$$= \frac{16.95 - 16.56}{\sqrt{\frac{(2.05)^2}{24} + \frac{(2.91)^2}{16}}} = \mathbf{0.55}$$

z– CALCULATED FOR CONVENTIONAL LECTURE METHOD (CONTROL GROUP)

z =? $\overline{X}_1$= 15.11, $\overline{X}_2$ = 13.23, S_1 = 1.60, S_2 = 3.03, N_1=18, N_2 = 17

$$\text{Using } z = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(S_1)^2}{N_1} + \frac{(S_2)^2}{N_2}}}$$

$$= \frac{15.11 - 13.23.18}{\sqrt{\frac{(1.60)^2}{18} + \frac{(3.03)^2}{17}}} = 2.27$$

Z– CALCULATED FOR COOPERATIVE LEARNING STRATERGY (MALE + FEMALE) AND CONVECTIONAL LECTURE METHOD (MALE+ FEMALE)

z =? $\overline{X}_1$= 16.8, $\overline{X}_2$ = 14.2, S_1 (2.05+2.91) = 4.96, S_2 (1.60+3.03) = 4.63, N_1= 40, N_2 = 35

$$\text{Using } z = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(S_1)^2}{N_1} + \frac{(S_2)^2}{N_2}}}$$

$$z = \frac{16.8 - 14.2}{\sqrt{\frac{(4.96)^2}{40} + \frac{(4.63)^2}{35}}} = 2.34$$

z– CALCULATED FOR COOPERATIVE LEARNING STRATERGYAND CONVECTIONAL LECTURE METHOD CONTROL GROUP EXPERIMANTAL GROUP(MALE AND MALE)

z =? $\overline{X}_1$= 16.95, $\overline{X}_2$= 15.11, S_1= 2.05, S_2= 75.56, N_1= 24, N_2= 18

$$z = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(S_1)^2}{N_1} + \frac{(S_2)^2}{N_2}}} = \frac{16.95 - 15.11}{\sqrt{\frac{(2.05)^2}{24} + \frac{(1.60)^2}{18}}} = 3.26$$