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Research Article

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Effects of Collaborative Learning Strategy on Physics Students' Conceptual Understanding of Electromagnetic Induction in Secondary Schools in Rivers State, of Nigeria

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Abstract The study investigates the effect of gender and collaborative learning approach on students' conceptual understanding of electromagnetic induction in Secondary Schools in Nigeria. Two research questions and 2 hypotheses were formulated to guide the research. The research design adopted for this study is the quasi-experimental design. In particular, the design is the non-randomized, pretest-posttest, control group design. The population of the study is made up of the 323 Senior Secondary III physics students in all 6 public co-educational Senior Secondary schools in Ogba/Egbema/ Local Government Area, Rivers State. A sample of 90 students, comprising of 60 male and 30 females were selected for the study. The research instrument developed and used for this study is the Test on Electromagnetic Induction (TOEI). The instrument is composed of objective test 20 questions covering the content area and testing the various levels of understanding. Z-test was used for analyses and testing of the hypotheses. The study concluded that, collaborative learning approach significantly affects students' understanding of electromagnetic induction whereas gender does not significantly affect students' understanding of the concept. Based on the findings, it was recommended that, Teachers on their part should understand the various aspects of the physics curriculum that students can learn better by collaborative learning and use all available resources to support and facilitate students' participation and government should as a matter of urgency, provide adequate laboratories and physics teaching and learning resources in all schools to support student-centered guided discovery and collaborative learning among secondary school students.

Keywords Collaborative Learning, Electromagnetic Induction; Conceptual Understanding

Introduction

Electromagnetic induction is the creating electromotive force (EMF) by means of a moving magnetic field placed near an electric conductor and, in other words, it is the creation of current by moving an electric conductor through a static magnetic field. Electromagnetic interference (EMI) can also be referred to as electric current and electromagnetic induction may also be called magnetic induction, as the principle remains the same whether the process is carried out through electromagnet or static magnet.

Electromagnetic induction is an event where-by an electromotive force (E.M.F) is produced and/or transmitted into a conductor as a result of the relative motion between a magnetic field and a conductor. According to Breithaupt, [1] 'Electromagnetic induction is the creation of an E.M.F when the magnetic flux linked to a conductor cuts across magnetic field lines. To Illustrate the concept of electromagnetic induction, Floyd, [2] clarified that, 'when a straight conductor is perpendicular to a magnetic field, there is a relative motion between the conductor and the magnetic field. Likewise when a magnetic field is moved past a static conductor, there will also be a relative motion. The relative motion in this case results in an induced voltage across the electric conductor. This principle is called Electromagnetic induction'. The principle of electromagnetic induction is applied in graphics tablet, electric generators, current clamp, electromagnetic formation, graphics tablet, hall effect meters, induction motors, induction cooking, transfer and wireless energy transfer, solenoids, transitional magnetic stimulation, pickups, mechanically powered flashlight, magnetic flow meters, inductors, inductive charging induction welding and induction sealing. Electromagnetic induction was discovered by Michael Faraday in 1831 and, independently and almost simultaneously, by Joseph Henry in 1832 Ulaby, [3] and Steve, [4].

Faraday instigated the magnetic field around an electric conductor carrying a Direct Current (DC) and found the basis for the electromagnetic field concept in the study of physics. Faraday discovered the concept (of electromagnetic induction) and demonstrated it with a gauge-based device to show current (a galvanometer), a magnate and a copper coil around a toroidal. When the magnet was moved towards the coil, an electromotive motive force (E.M.F) was generated moving the gauge on the galvanometer. If the north pole of the magnet that is drawn closer, electric current flows one way; if the south pole of the magnetic is drawn closer, then current flows in the opposite direction according to Perry, [5]. Joseph Henry discovered the electromagnetic phenomenon of self-inductance and mutual inductance independently of Michael Faraday, but did not publish his findings until Faraday published his results Perry, [5]. This is the reason the discovery of electromagnetic induction is credited to Michael Faraday.

The discovery of the concept of electromagnetic induction was a basic principle in harnessing and understanding electricity. James Clerk Maxwell formulated the mathematical equations described as *Faraday's Law of induction*, later known as the *Maxwell-Faraday Equation*, one of the four Maxwell equations in his theory of electromagnetism.

Electromagnetic induction is taught in senior secondary school (SSS) three physics in the current 6-3-3-4 system of education in Nigeria [6].

Ivowi, (1985) as cited by Adolphus et al, [6], the physics students performed very poor in the subheading conservation principles and fields (where electromagnetic induction is taught). Many studies have shown that the major cause of difficulty in the understanding of physics concepts at the secondary school level has been the improper method of teaching subject [7-8]. In many countries across the globe the experience is the same. In Kenya, strengthening of Mathematics and Science in Secondary Education (SMASSE) project reported that 64% of teachers interviewed during the baseline survey indicated that electromagnetic induction was a difficult topic [1]. In attempt to explain students' difficulties in understanding the concept of electromagnetic induction, Floyd, [2] proposed that students should make meaning of current learning tasks by a combination of formal and informal everyday day experiences. He argued further that "while everyday experience makes an impact on some alternative conceptions, some areas of physics have no obvious parallels in everyday experience". He considered electromagnetic induction as one of the concepts in physics where everyday prior experience does not make a reasonable impact. Perry, [5] attributed the challenge or difficulty in students' understanding of electromagnetic induction to the use of ambiguous terminologies in explaining the concept. Perry, [5] 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 electromagnetic induction.

From the above, it is now clear that science teachers and students are in quest of good teaching and learning methods that will enable physics students gain proper understanding and application of physics concepts and principles. The common traditional teaching methods is strategy where the teacher is seen as a 'knowledge dispenser' dishing out facts to passive learners with its accompanying drill and practice is no longer needed for effective teaching and learning science. To Ivowi, (1983) as cited by Adolphus et al, [6], for a teachers to produce learners who can think critically and make sense out of their classroom experiences, the teacher would need to 'develop a new, well-articulated rationale for instructional decisions and cannot depend on their previous teaching or learning experiences for much help in shaping their choice of methods'. Therefore, the interest of this present work is to identify more effective teaching approach that will enhance the teaching and learning of electromagnetic induction in secondary school physics.

Many educators and researchers in science have listed out different methods of teaching science [9-10]. A Some of the methods outlined include lecture, question-answer problem solving, play-way, discovery, field trip, demonstration, project method; Computer Assisted Instruction (CAI) and collaborative approach amongst others. The choice of any these methods in teaching science depends strictly on the age, content availability of resources, previous knowledge and the teacher's versatility [6]. The researchers shall compare the effect of collaborative learning strategy and conventional lecture methods on student understanding and application of the concept of electromagnetic induction.

Collaborative learning is a situation in which two or more people learn or attempt to learn something. Collaborative learning is a constructivist strategy. Basically, collaborative learning is specified on the model that knowledge can be created within a population where members actively interact by sharing experiences and take on asymmetry roles [7].

Physics, as one of the natural sciences has been recognized as the bedrock for technological accomplishments and development. It is against this background that science educators are increasingly seeking ways of improving the quality of teaching and learning physics in our secondary schools. One of the general objectives of the physics curriculum as stated in the curriculum document is to: "Provide basic literacy in physics for functional living in the society" [11]. It is therefore 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 these objectives, we recognize the role of physics in nation building. 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.

Physics, as one of the regular sciences has been perceived as the bedrock for mechanical achievements and improvement of a given nation. It is against this foundation of this research that science instructors are progressively looking for methods for improving the nature of educating and learning physics in our auxiliary or schools. One of the general aims and objectives of the physics educational program as expressed in the physic curriculum document plan is to: "Give essential proficiency in physics to useful living in a society" [11]. It is accordingly imperative to shoulder these objectives as a primary concern, with the goal that what we teach, how we teach it and to whom, must be chosen when we realize what we are attempting to accomplish. In accordance with these objectives, we perceive the role of physics in country building. The teaching of physics should show how realities are set up by analysis and perception, how speculations are based upon this information and ideas created. At the point when this is accomplished, our secondary school leavers ought to have the option to adjust to the quick and exceptional changes in innovation and social culture.

The research work was moored on the theory of constructivism by Jean Piaget [12]. Constructivism is a theory that depends on perception and the logical investigation of how individuals learn. The theory accept that individuals build their understanding and knowledge on the world through encountering things and considering their encounters. Constructivist are dynamic makers of their own insight as they accommodate it with past thoughts and encounters, to accomplish this they should ask questions, investigate and survey what they realize constructivism urges students to utilize active techniques such as experiments, problem solving etc. to create knowledge and then reflect on what they are doing and how their understanding changes. Here the role of the teacher becomes possibly the most important factor as the educator must understanding the students' prior existing conception, and aides class activities for students to build know knowledge, along these lines empowering learning and reflection process rather than to produce a series of fact. Constructivism change students from latent beneficiary of information to active and dynamic participants in the learning process.

Different authors and researchers have different views and opinions as to the best teaching and learning strategies that enhances the conceptual understanding of learners.

Bukunola and Idowu, [13] investigated the effectiveness of collaborative learning strategies on Nigerian junior secondary school students' academic achievement in basic science. The findings revealed that students in the two collaborative learning strategy (learning together and Jigsaw II groups had higher immediate and delayed academic achievement mean scores than the students in the conventional lecture group. learning together and

Jigsaw II collaborative teaching strategies were found to be more effective in enhancing students' academic achievement and retention in basic science than the conventional-lecture.

Gokhale (1995), in Williams and Akpan, [14] in their research found that, individuals are able to achieve higher levels of learning and retain more information when they work in a group rather than individually, this applies to both the facilitators of knowledge, the instructors, and the receivers of knowledge (students).

Laal, [15] in a research concluded that, collaborative learning approach fosters learners' development of metacognition, improvement in formulating ideas, and higher levels of discussion. It also teaches learners to monitor each other, detect errors and learn how to correct their mistakes which in turn improves their participation in formative assessment.

Katie and Shank [16] in there research who asserted that there is no perfect teaching approach, however collaborative and contextual learning approach enhanced students' academic performance significantly.

Ghani, [17] in an investigation opined that gender have no significant effect on the learning approach used in learning biology and other science subjects. Aladejana, [18] also discovered that collaborative learning makes no significant difference in the performance of learners as compared to the traditional approach.

Statement of the Problem

Electromagnetism is one of the perceived difficult concepts by both students and teachers in senior secondary physics. Maduabum, (1989) as cited by Adolphus et al, [6] listed out some factors militating against the teaching and learning of science to include the teaching methods. There is impressive proof in the literature to show that traditional physics instruction predominantly based on lectures and manipulation of formulae, to teach concepts is ineffective [19-20]. In typical classroom setting, if students are involved in only passive learning, it would lead to limited knowledge retention, let alone engaging them in thinking or promoting functional understanding. Research works have shown that involving students directly and actively in the learning process promotes meaningful learning [21-22].

Lamentably, the present pattern in the instructing and learning of physics, where instrumental materials and apparatus are not available and accessible in our public schools f has constrained most science teachers to utilize the customary talk technique in teaching physics. This has made it hard to understand the significance and the important role of physics in our national advancement. From the foregoing therefore, the difficulty students have in understanding the concept of electromagnetic induction and the journey for better methods for adequately teaching the concept was the drive for this study. This research work thus, explores constructivists teaching strategy, specifically, the collaborative learning strategy in enhancing students' conceptual understanding of electromagnetic induction. For teaching to be effective in promoting learning and enhancing students' understanding of concepts, it must involve interaction between teachers and students. The interaction should be such that it encourages students to get involved in working and forming meaning of experiences themselves. The problem of this study therefore is to find out whether collaborative learning strategy compared to conventional lecture method could enhance physics students' conceptual understanding and application of electromagnetic induction in secondary schools in Ogba/Egbema/Ndoni Local Government Area of Rivers State, Nigerian.

Purpose of the Study

The general purpose of the study is to compare the effects of collaborative learning strategy on physics students' conceptual understanding of electromagnetic induction in secondary schools in Rivers state. Specifically, the study seeks to:

1. Compare the performance of male and female students in electromagnetic induction taught with collaborative learning strategy.
2. Compare the performance of students in electromagnetic induction taught with collaborative learning strategy and those taught with conventional lecture method.

Research Questions

To guide the research, the following research questions are developed:

1. What are the effects of collaborative learning strategy on male and female student's performance in electromagnetic induction?
2. What are the effects of collaborative learning strategy and conventional lecture method on students' performance in electromagnetic induction?

Research Hypotheses

The following null hypothesis guided the study:

1. There is no significant difference in the mean scores of male and female students taught electromagnetic induction with collaborative leading strategy.
2. There is no significant difference in the mean scores of students taught electromagnetic induction with collaborative leading strategy and those taught with conventional lecture method.

Methodology

The research design adopted for this study is the quasi-experimental design. In particular, the design is the non-randomized, pretest-posttest, control group design. The independent variables were the teaching approaches while students' performance is the dependent variable.

Area of the Study

The study was conducted in Ogba/Egbema/Ndoni Local Government Area of Rivers State, Nigeria. The study area has tertiary institution, private and public schools. This makes the area suitable for this study.

Population of the Study

The population of the study is made up of all 334 Physics students in SSS III. By stratified random sampling, two (2) co-educational schools located strategically in area of study were chosen for the study.

Sample and Sampling Techniques

A random sample of 90 students were selected for the study. Again, 50 students (28 male and 22 female) where randomly selected for the experimental group taught with collaborative learning strategy while 40 students (23 male and 17 female) were selected for control group taught with conventional lecture method.

Instrument for Data Collection

The research instrument developed and used for this study is the Test on Electromagnetic Induction (TOEI). The instrument is composed of 30 questions covering the content area and testing the various levels of understanding. The TOEI is made up of standard objective questions adapted from past question papers of Senior Secondary School Certificate Examinations (SSCE), National Examination Council (NECO) and Joint Admission Matriculation Board (JAMB) Examinations. The TOEI was used for both pre-test and post-test. The TOEI is designed to measure students' understanding and performance in electromagnetic induction.

Validity of the Instrument

The validity of these instruments was confirmed by the researchers themselves and two other lecturers in the field of study.

Reliability of the Instrument

The test instrument had a reliability co-efficient of 0.70, when it was subjected to reliability test via the reliability co-efficient test, using Pearson Product Moment Correlation (PPMC).

Data Collection

Data was collected from the post test administered to the experimental and the control groups. That is, the collaborative learning strategy group and the conventional lecture method group.

Method of Data Analysis

Data was analyzed using mean and standard deviation. The hypotheses were test at alpha level of 0.05 using z-test statistics

Findings and Results

Hypothesis1

There is no significant difference in the mean scores of male and female students taught electromagnetic induction with collaborative learning strategy.

Table 1: Z-test analysis of significant difference between the mean scores of male and female students taught electromagnetic induction with collaborative learning strategy

Gender	Mean ($\bar{x}$)	SD	N	dft_{cal}		tcrit, α=0.05	Significance
Male	16.98	2.07	28	48	0.16	1.987	Not Significant
Female	16.86	2.81	22				

As illustrated in Table 1, the calculated z-value (0.16) is less than the critical z-value (1.987) at α =0.05. The hypothesis that, there is no significant difference between mean scores of male and female students taught electromagnetic induction with collaborative learning strategy is hereby accepted.

Hypothesis 2

There is no significant difference in the mean scores of students taught electromagnetic induction with collaborative learning strategy and those taught with conventional lecture method.

Table 2: Z-test analysis of significant difference between the mean scores of students taught electromagnetic induction with collaborative learning strategy and those taught with conventional lecture method

Gender	Mean ($\bar{x}$)	SD	N	dft_{cal}		tcrit, α=0.05	Significance
Experimental Group (Male + Female)	17.9	4.97	50	88	2.24	1.987	Significant
Control Group (Male + Female)	15.6	4.72	40				

As illustrated in Table 2, the calculated z-value (2.24) is greater than the critical z-value (1.987) at α =0.05.The hypothesis that, there is no significant difference between mean scores of students taught electromagnetic induction with collaborative learning strategy and those taught with lecture method is hereby rejected.

Discussion of Findings

The result of analysis presented in hypothesis one showed no significant difference between the mean scores of male and female students in the experimental group who were taught electromagnetic induction using collaborative strategy. The result of this finding agrees with the findings of Ghani, [17] who opined that, gender have no significant effect on the learning approach. Also in line with Laal, [15] who found that, collaborative learning approach fosters learners' development of metacognition, improvement in formulating ideas, and higher levels of discussion. It also teaches learners to monitor each other, detect errors and learn how to correct their mistakes which in turn improves their participation informative assessment.

The result of analysis presented in hypothesis two portrayed a significant difference between the mean scores of students in the experimental group who were taught electromagnetic induction using collaborative strategy and their contemporaries in the control group who were taught electromagnetic induction using conventional lecture method. The result of this finding is in consonant with the findings of Bukunola and Idowu, [13]. They found that, students in the two collaborative learning strategy (learning together and Jigsaw II groups had higher immediate and delayed academic achievement mean scores than the students in the conventional lecture group.

Learning together and Jigsaw II collaborative teaching strategies were found to be more effective in enhancing students' academic achievement and retention in basic science than the conventional-lecture.

Conclusion

The finding of this study is concluded that, collaborative learning approach significantly affects students' understanding of electromagnetic induction whereas gender does not significantly affect students' understanding of the concept.

Recommendations

Based on the findings of the study, it is recommended that:

1. Educational institutions, government and relevant authorities that train, recruit and monitor the professional development of physics teachers would need to ensure that teachers receive appropriate training and skills needed for the facilitation of collaborative learning in their classes. This can be achieved by the incorporation of content on collaborative learning and peer-tutoring strategies in the training and re-training of student teachers.
2. Government should as a matter of urgency, provide adequate laboratories and physics teaching and learning resources in all schools to support student-centered guided discovery and collaborative learning among secondary school students.
3. Teachers on their part should understand the various aspects of the physics curriculum that students can learn better by collaborative learning and use all available resources to support and facilitate students' participation.
4. Teaches should see the need of equipping students with necessary skills to enrich their science learning experience by collaborative learning.
5. Teachers should device appropriate teaching strategies that encourage the interaction of boys and girls in the learning process so as to drastically reduce or remove the gender gap in performance in science subjects.

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