Effect of 7E's Constructivist Strategy on Performance of Senior Secondary School Physics Students' in Interaction between Magnetic Field and Current-Carrying Conductor in Rivers State

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Abstract

This study investigated the effect of 7E's constructivist strategy on senior secondary school physics students' performance in interaction between magnetic field and current-carrying conductor in Rivers State. The study adopted a non-randomized pre-test posttest control group quasi-experimental design. Two hundred and seventy (270) physics students in nine public secondary schools in Gokana local government area formed the population of the study. Fifty-eight (58) physics students in four intact classes selected from two schools constituted the sample for the study. One research question and one hypothesis was posed and formulated respectively to guide the study. The instrument used in data collection was titled "Interaction between Magnetic Field and Current-Carrying Conductor Performance Test'. Face and content validity of the instrument were carried out by experts in physics education and measurement and evaluation. Test-retest and Kuder-richardson-20 methods of reliability were employed. A reliability coefficient of 0.81 and 0.78 respectively were obtained. Item analysis was done to determine the psychometric features of each test item. The research questions were answered using descriptive statistics of mean and standard deviation and the corresponding null hypotheses were tested using Analysis of Covariance at 0.05 level of significance. Results from the study revealed that the mean score of the experimental group was higher than the mean score of the control group. The study also revealed that there was a statistically significant difference between the mean scores of the experimental and the mean scores of the control group. Therefore, it was recommended that teachers should use 7Es constructivist instructional strategy in teaching interaction between magnetic field and current-carrying conductor. Also, students should be engaged in student-centered and active process of learning such as discoveries, hands-on and minds-on activities.

Keywords: *7Es constructivist instructional strategy; magnetic field; current-carrying conductor, performance.*

Introduction

The magnetic field is an invisible field around a magnetic object, in which magnetic force is exerted. The magnetic field around a magnetic object can pull up or push away another magnetic object. Moving electric charges generates magnetic fields. A magnetic field can be produced when electrons, which have negative charges, moves about in a certain direction. Magnetic fields can be represented by a continuous line of forces that emerge from the north pole of the magnet and enter into the south pole of the magnet. The density of the lines shows the magnitude of the magnetic field at any point.

Electric energy is transmitted by current, which is basically the flow of electrons, which are the sub-particles of the atom. The movement of electrons via a conductor from one points to another power our lights, computers, appliances, and other equipments. According to Evwaraye, Mgbenu and Okeke as cited in Naade, Alamina and Okwelle (2018) mechanical energy can be converted into electrical energy, thus producing electricity without a battery. This conversion is possible when there is a relative motion between the current-carrying conductor and the magnetic field.

Interaction between magnetic field and current-carrying conductor is a topic taught in senior secondary school three (SS3) physics curriculum. Studies have shown that students performed relatively poor in field and conservation principle (an aspect of electromagnetism) which is a unit in which this topic is been taught (Adolphus, Onwioduokit & Dike, 2015). Other studies have also posited that students seem to have difficulties in understanding this concept, which were attributed to the abstract nature of the concept (Naade et al, 2018). Some scholars are of the view that these difficulties and poor performance could be because of improper pedagogical approach to teaching this concept (Madu, 2004). Hence, there is need for science teachers to use a carefully designed and innovative teaching strategy that are minds-on and hands-on to ameliorate this problem. This has to be learning experiences that will be hinged on what students can do to reflect their understanding and create their knowledge themselves. Studies have proven that constructivist based strategies are more propitious as reported by Naade et al. (2018) and its auspicious impact have been noted for both students' achievement and motivation.

Constructivist teaching is an instructional strategy in which the learner assumes the active role in learning. In a constructivist classroom emphasis turns away from the teacher and the content towards the learner. This is quite different from the traditional teaching. According to Naade et al. (2018), constructivist teaching is typically student-centered learning instead of teacher-based 'fact dissemination'. In constructivist teaching approach, the students participate in hands-on and minds-on activities and extent to construct their own knowledge. According to Vygotsky as cited in Kajuru and Kauru (2014) constructivism as its name implies emphasis the building (i.e. construction) of knowledge that occurs in the students' mind when they learn. Constructivism represents a paradigm shift from education based on behaviorism at education based on cognitive theory (Amineh & Asl, 2015).

Constructivism can be classified in many arrays; common amongst them are cognitive constructivism and social constructivism. The latter involves the learner as active participant in their environment (Von Glassersfeld, 2008). This theory posits that for students to do better in their learning, they need to explore their environment and learn from hands-on experiences.

Cognitive constructivism views knowledge as something that is actively constructed by learners based on their existing cognitive structures. Therefore, learning is relative to their stage of cognitive development. Understanding the learner's existing cognitive framework is very paramount to understanding the learning process.

The concept of constructivism that is fundamental in the constructivist approach is that the learner is an active participant in the process of learning or classroom. The characteristics of a constructivist classroom are that the classroom is democratic, the learners are actively involved, activities are interactive and student-centered, while the teacher facilitates the process of learning in which students are guided and encouraged to be independent learners. From the social constructivist point of view, the teacher is seen as a facilitator and not as a teacher. A facilitator guides the learner to construct their own knowledge or understanding of the content as opposed to the teacher that gives a didactic approach to learning. In the constructive strategy, the teacher plays the passive role; he facilitates the learning process and helps the learner to construct their knowledge. The learner assumes the active role in learning.

Several constructivist pedagogical models or teaching strategies have been developed and adopted for use in the school curriculum, such includes; Problem-based/inquiry model, social interaction model, four phase constructivist model amongst others. The 7E's constructivist is an expansion of 5E's model in a constructivist approach to teaching that makes for a robust instructional approach. The 7E's model emphasizes eliciting prior knowledge and transfer of learning. The proposed 7E's model expands the engaging element into two components-eliciting and engage.

Also, the 7E's model expands the two stages elaborate and evaluate into three components-elaborate, evaluate and extend. These changes are not suggested to add complexity but rather to ensure instructors do not omit crucial elements of the learning cycle (Kajuru & Kaura, 2014).

7E's instructional model (Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend) is a model that emphasizes on these seven components as phases that should be adopted by science teachers in science teaching. It emphasizes "transfer of learning" and importance of "schema" which helps to engage the student in a new concept using short activities that prompt curiosity and enthusiasm. Below is the summary of 7E's's instructional model (Kajuru & Kaura, 2014).

Eliciting has to do with arousing the students' prior knowledge to ascertain what the student knows about the topic to be taught. Current research in cognitive science has shown that eliciting prior knowledge is a necessary component of the learning process (Bencze, 2015). Recognizing that students construct knowledge from existing knowledge, teachers need to find out what existing knowledge their students possess. Failure to do so may result in students developing concept very different from the ones the teacher intends (Bransford, Brown & Cooking, 2000). A straightforward means by which teachers may elicit prior knowledge is by framing a "what do you think" question at the outset of the lesson. From the student's responses, the teacher could elicit their prior knowledge and misconception would be redressed in course of the learning.

Engage is a phase of the learning cycle that the student is been engaged in a new concept using activities that prompt curiosity, enthusiasm and attention towards the new concept. It intends to capture student's mind and stimulate thinking. For example, a teacher may engage students by creating surprise or doubt through a demonstration that shows a piece of steel sinking and a steel toy boat floating. The corresponding conversation with the student may access their prior learning. The student should have the opportunity to ask and attempt to answer 'why is it that the toy boat does not sink"? These capture their attention, prompting curiosity and stimulate thinking. These short activities by the teacher excite the students; get them interested and ready to learn.

Explore is a phase of the learning cycle that provides an opportunity for students with a common base of activities within which prior knowledge, process and skills are identified and conceptual change is facilitated. That is, using prior knowledge to generate new ideas. It provides an opportunity for students to observe and record data, isolate variable, design and plan experiments, create graphs, interpret results, develop hypotheses and organize their findings (Lawson, 2011). Teachers may frame prompting questions, suggest approaches and assess understanding.

Explaining is a phase that focuses students' attention on a particular aspect of engagement and exploration experiences thereby providing opportunities to explain and demonstrate their conceptual understanding, process skills and behaviours. The teacher guides the student toward coherent and consistent generalization, helps the student with distinct scientific vocabulary and provides questions that help students use this vocabulary to explain the results of their exploration.

Elaborating is a phase of the learning cycle that provides the student with an opportunity to apply their knowledge in new domain hence challenge their conceptual understanding and skills through new experiences to foster deeper and broader understanding of the concept. This phase may also include related numerical problems for students to solve. The elaboration phase ties directly to the psychological construct called "transfer of learning" (Kajuru & Kaura, 2014). Transfer of learning can range from one concept to another (e.g. Newton's law of gravitation and Coulomb's law of electrostatic).

Evaluate is another phase that encourages students to assess their understanding and abilities. It provides the teacher with an opportunity to evaluate the students' progress through a formative and summative evaluation. Students are allowed to pose questions to each other to evaluate themselves as to learn from each other's understanding of the concept while the teacher moderates the section.

Extend - This is an addition to the elaboration phase. Students are challenged to extend their understanding in a new context, compare ideas, theories and concept in a relationship with knowledge gained. Also find out the real-life situation the concept could be applied (Desiree, 2009).

Problem of the Study

Research findings have consistently indicated that electromagnetism is one of the perceived difficult concepts by both students and teachers in senior secondary school physics (Adolphus et al, 2015). In Kenya the experience is the same; with the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project reporting that 64% of the teachers interviewed during a baseline survey indicated that interaction between magnetic field and current-carrying conductor was a difficult topic (SMASSE, 2005). Similarly, Omoregbe and Ewansiha (2013) highlighted the factors militating against the teaching and learning of science to include among others, the teaching approach. There is considerable evidence in the literature to show that traditional physics instruction, predominantly based on lectures and manipulation of formulae to teach a concept is ineffective (Gbamanja, 2007; Balta & Sarac, 2016). Unfortunately, the current trend in the teaching and learning of physics, where materials for teaching are not readily available in public school has forced most teachers to use the traditional lecture method in teaching physics. It is against this backdrop and quest for better ways of effective teaching of the concept that the researchers decided to embark on this study. The research work, therefore, explores the constructivist teaching strategy, specifically 7E's constructivist approach to determine its effect on student performance in interaction between magnetic field and current-carrying conductor in senior secondary schools in Rivers State, Nigeria.

Purpose of the Study

The purpose of this study is to compare the relative effectiveness of 7E's constructivist approach and lecture method on students' performance in interaction between magnetic field and current-carrying conductor in senior secondary schools in Rivers State, Nigeria. Specifically, the study intends to:

- Find out if there is any difference in the academic performance of students taught interaction between magnetic field and current-carrying conductor using 7E's constructivist approach and those taught using lecture method.

Research Question

- What is the difference in the academic performance of students taught interaction between magnetic field and current-carrying conductor using 7E's constructivist approach and those taught using lecture method.

Hypothesis

- H_{01}: There is no significant difference between the mean score of students taught interaction between magnetic field and current-carrying conductor using 7E's constructivist approach and those taught using lecture method.

Methods

The research design adopted for this study was a quasi-experimental design. Precisely, the non-randomized, pretest-posttest control group design was used with teaching approaches as an independent variable, students' performance as a dependent variable. The study was conducted in Gokana Local Government Area of Rivers State, Nigeria. The area was chosen to enable the researcher to have enough time to supervise the experiment properly; the area is accessible at all time of the year. Also, most schools in the Local Government Area are co-educational hence the researcher used only co-educational schools. Two hundred and seventy (270) physics students in nine public secondary schools in Gokana local government area formed the population of the study. Two schools were purposively selected from nine secondary schools in Gokana Local Government Area of Rivers State, Nigeria. The criteria for the selection include: (1) Schools that had an adequately equipped science laboratory. (2) Schools having at least two professional physics teachers with at least five years of teaching experience. Two schools out of nine that met the criteria were purposively selected and assigned to treatment and control groups. Four intact classes were randomly selected and used in the two schools since each of the schools had two arms (SS3A & SS3B). In each school, there was an experimental class and one control class. A total of 58 Physics Students from the four intact classes in the two schools form the sample for the study. The research instrument for data collection was “Interaction between Magnetic Field and Current-carrying Conductor Performance Test” (IMCCPT). The instrument was composed of 40 questions covering the content area and testing the various level of understanding. The IMCCPT is made up of standardized objective questions adopted from past question papers of West African Examination Council (WAEC) and Joint Admission Matriculation Board (JAMB) examination in Nigeria. The instrument was subjected to face and content validation by experts in Physics education. The instrument was further subjected to item analysis to determine the item difficulty index, discrimination index, effectiveness of distracters to verify the psychometric features of each test items. The equivalent form and test-retest methods of reliability were employed. A reliability coefficient of 0.81 and 0.78 were established using Test-retest and Kuder-Richardson-20 for stability and internal consistency respectively. These values were considered good enough to use the instrument.

Two instructional methods were used for the study. 7E’s constructivist approach was used in teaching the experimental group, while the lecture method was used in teaching the control group. The pre-test was administered to the intact classes in the selected schools to establish the equivalence of the participants in the study. The teachers in the respective schools were trained for one week on how to follow the various steps in the new model (7E’s) in teaching the students. Before treatment, a pre-test was administered to the students. Thereafter, the students in the class were divided into two groups and the treatment was given. The experiment lasted for four (4) weeks; an equivalent form of the pre-test was administered by the teachers to the student as post-test. Data collected from the pre-test and post-test were kept separately for analysis. This procedure was followed in both experimental classes. The research question was answered using descriptive statistics of mean and the corresponding null hypothesis was tested using inferential statistics of t-test at $p \leq 0.05$ level of significance.

The teachers in the respective schools teaching the control classes were briefed and asked to adhere to the lesson plan strictly. Before the commencement of the class, a pre-test was administered to the students. The lecture method was employed for the control group. The class lasted for four (4) weeks. An equivalent form of the pre-test was administered to the students as post-test.

Data collected from the pre-test in both groups were subjected to a pre-test analysis to ascertain the equivalence of both groups before treatment. The result showed a significance difference in the pre-test mean scores of both groups. This justifies the use of ANCOVA in testing the hypothesis as to statistically take care of the significant difference in both groups. Mean was used in answering the research questions.

Results

Research Question

What is the difference in the academic achievement of students taught interaction between magnetic field and current-carrying conductor using 7E's constructivist approach and those taught using lecture method?

Table 1: *Mean score of students taught interaction between magnetic field and current-carrying conductor*

Groups	n	Pre-test Mean (M_1)	Post-test Mean (M_2)	Mean difference (Within)
Control	30	28.67	54.33	**25.67**
Experimental	28	24.93	68.57	**44.64**
Mean Difference (Between)		**4.74**	**14.24**	**18.98**

Result as shown in Table 1, shows an improvement in the performance of the students taught using 7E's constructivist approach. The control group had a mean score of 28.67 on the pre-test and mean score of 54.33 on the post- test with a mean difference (gain) of 25.67. The experimental group had a mean score of 24.93 on the pre-test and mean score of 68.57 on the post-test with a mean difference (gain) of 44.64. This shows that the experimental group had a higher mean difference of 44.64 as against 25.67 of the control group. The table shows a mean difference (between) of 18.98 in favour of the experimental group.

Hypothesis

H_0: There is no significant difference between the mean score of students taught interaction between magnetic field and current-carrying conductor using 7E's constructivist approach and those taught using lecture method.

Table 2: *ANCOVA for scores of students taught interaction between magnetic field and current-carrying conductor*

Source of Variance	Sum of Squares	Df	Mean Square	F	P-value	Decision
Corrected Model	6784.182	2	3392.091	38.616	.000	
Intercept	6726.568	1	6726.568	76.575	.000	
Pre-test	3848.188	1	3848.188	43.808	.000	
method	4774.147	1	4774.147	54.349	.000	Rejected
Error	4831.336	55	87.842			
Total	228900.000	58				
Corrected Total	11615.517	57				

Result from Table 2, indicate F (1, 55) = 54,349, $p < 0.05$, based on this the hypothesis was rejected. This implies that there was a significant difference between the mean score of students taught interaction between magnetic field and current-carrying conductor using 7E's constructivist approach and those taught using lecture method.

Discussion of Findings

The finding revealed that students taught interaction between magnetic field and current-carrying conductor using the 7E's constructivist approach performed better than those taught with the lecture method. The test of a hypothesis also showed that the difference in the test result of the students was statistically significant at 0.05 level of significance. This significant difference in the achievement of student could be because the teachers teaching experimental group took time to elicit the student's prior knowledge to ascertain student's conception of the new concept; the teacher using this as tool in the teaching could have helped the experimental group to perform better than the control group. Also, this could be attributed to the fact that the students were engaged in the new concept using short activities that prompt curiosity, enthusiasm and attention toward the new topic. Inversely, in the control group, the students were mere passive listeners and not engaging in any hands- on and minds-on activities. This result corroborates the finding of Adesoji and Idika (2015) who carried out a study to investigate the effect of 7E learning circle model and Case-based learning strategy on secondary school students' learning outcomes in chemistry in Oyo state, Nigeria and reported that 7E learning circle model and Case-based learning strategy are more effective in improving students' performance in chemistry.

Also, this result is consistent with the findings of Kajuru and Kaura (2014) who carried out studies to investigate the effect of 7E's constructivist approach on Polytechnic student's achievement and retention in trigonometry in Polytechnics in Kaduna State. The study revealed that students taught trigonometry using 7E's constructivist model did better than those taught using the conventional method in both achievement and retention.

This result also give credence to the findings of Cardak, Dikmenli and Saritas (2008) who carried out a study to investigate the effect of the 5E instructional model on a primary (sixth grade) student success on the circulatory system topic. The study showed that a significant difference occurred in favor of the experimental group because of the application.

Successful constructivist approach is hinged on a democratic setting of the classroom where the teacher is not seen as a dispenser of knowledge rather as a facilitator who ask, support from the back, provides guidelines and create appropriate environment for learners to arrive at his or her own answer and conclusion and as well engage the learner in a continuing and interactive dialogue. Students assume the active role in learning and construct their own understanding of the content as opposed to the teacher's didactic approach.

Conclusion

Based on the empirical evidence presented, the research has shown that 7E's constructivist approach is found to be more effective than the lecture method. The approach effected students' achievement more positively than the lecture method. The 7E's constructivist approach was more effective in fostering and stimulating student's interest and enthusiasm in learning than the traditional method. The interactive nature of the pedagogy employed using the 7E's constructivist approach makes the student to be highly motivated thereby arousing their interest and enhancing deeper and broader understanding of the concept.

Educational Implication of the Study

The major finding of this research is that 7E's constructivist approach was found to be more effective than the lecture method. The implication here is that teachers need to develop themselves in the use of 7E's constructivist approach in the science classroom. The approach requires that students have access to resources - books, libraries, science apparatus and so on since the learners actively construct knowledge and are encouraged to explore their world, discover knowledge, reflect on and think critically. There is also the implication for learners to be engaged in an active process of learning such as minds-on, hands-on and discovery. The approach is learner-centered as students search for knowledge, solutions, or meaning or create a product by themselves with the teacher as facilitator or guide.

Recommendations

The following recommendations are based on the findings of this study:

- Curriculum developers should incorporate constructivist strategies such as the 7E's model into the physics curriculum as an instructional model for teaching physics in secondary school.
- Physics teachers should be given adequate training on how to effectively use this pedagogical strategy. Hence, the 7E's constructivist approach should be included in course content on methods of teaching physics in all teachers' training institutions.
- Government and other stakeholders in the educational industry should provide adequate resources as 7E's constructivist approach requires that students have access to resources - books, library and science apparatus since the learners actively construct knowledge and are encouraged to explore their world, discover knowledge, reflect on and think critically.

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