East African Journal of Education and Social Sciences
EAJESS January – March 2021, Vol. 2, No. 1, pp. 1-10
ISSN: 2714-2132 (Online), 2714-2183 (Print), Copyright © The Author(s)
Published by G-Card
DOI: https://doi.org/10.46606/eajess2021v02i01.0060
URL: http://eajess.ac.tz

Effect of the 5E Instructional Model on Physics Academic Achievement Based on Gender and Students' Ability: A Case of Berekum Senior High Schools in Ghana

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Abstract: *This study examined the effect of the 5E instructional model on Physics students' academic achievement based on gender and students' ability. The study employed a quasi-experimental design using the pre-test, post-test and delayed-post administered instruments to the experimental and control groups. The study involved two instructional strategies (5E instructional model and traditional teaching). Instruments known as Physics Students' Academic Achievement Test (*PSAAT*) and Delayed Post Test (*DPT*) were used to gather data for the study. Mean scores, standard deviations and normalized gains were used to analyses data while ANCOVA and independent-sample t-test were used to test the hypothesis at the 0.05 level of significance. A significant difference was found between Physics students instructed with the 5E instructional model and those taught through the traditional classroom. Similarly, a significant difference was found between Physics high-ability student in the 5E instructional group and those in the traditional group. However, a non-significant difference was found between Physics low-ability students in the experimental and the control groups. Similarly, a non-significant different was found among gender concerning pre-test and post-test means scores. However, a significant difference was found among gender in favor for the male students. The study recommended that Physics teachers wanting to improve their students learning outcomes should adopt the 5E instructional model.*

Keywords: 5E Instructional Model, Academic Achievement, Physics, Students, Ability, Gender

Introduction

Twenty-first-century Physics students need opportunity to critically think, collaborate with other students, participate in problem-solving activities and relate classroom knowledge with practical experiences outside the school setting (Lombardi, 2007). In Physics teaching, the appropriate use of effective research-based teaching strategies can help students learn fundamental concepts and improve their academic performance. Donovan and Bransford (2005) argued that if science educators accept and appreciate the value of effective and research-based instructional strategies, then the selection and adoption of such instructional strategies by science educator must be effective and supported with empirical data. The authors further add that such research-based instructional strategies should be applied consistently and widely to have the desired effect on student learning outcomes. The implication of adopting such researched-based instructional strategies in teaching Physics is that it equips students with the opportunity to learn through the student-centered instructional strategies which have been thought to have the ability to create and facilitate meaningful learning.

The fundamental principle of Physics teaching is about helping students understand scientific principles and develop scientific thinking skills. Therefore, any appropriate means to achieve this fundamental principle should be the desire of the Physics teacher. One of the means to help Physics students maximize their learning outcomes is by using appropriate instructional strategies. According to Armstrong (2020), after considering the target students, their learning needs and aspirations, teachers should select an instructional strategy that helps students to maximum the learning outcomes. Consequently, when Physics teachers are selecting strategies for their lessons, they are usually based on what, how, where and when they want their students to learn (Banner, 2017).

The implication is that the teachers' aim is to select an appropriate and useful instructional strategy needs to engage students in the lesson, motivate students to learn and guide students towards purposeful skill development. According to Hawkins and Williams (2020), it is uncommon to expect students to develop the necessary twenty-first-century skills in a traditional classroom because characteristically, lessons designed in the traditional classroom setting do not create opportunities for students to critically think, collaborate with other students or become problem-solvers, nor do they allow students to practice how to connect new information with experiences outside the classroom setting. The authors add that by using instructional strategies that promote inquiry-based teaching and learning, students can gain more autonomy in their learning and meet the high expectations for better learning outcomes.

According to the National Research Council (1999), studies over decades across various disciplines about how students learn have shown that students must be interested and engaged in what they are learning and the learning strategies employed must be useful and meaningful to them if effective learning has to take place. Furthermore, students must be actively involved in the teaching and learning process by comparing new information with previous ideas. They need to be guided to construct new ideas and consequently change their minds about how the concepts work. Finally, student needs opportunities to apply what they have learnt in new situations.

One of such instructional strategies that engage, motivate and promote students' critical thinking is the 5E instructional model which provides research-based learning cycles in five phases which are engagement, exploration, explanation, extension and evaluation (Hawkins & Williams, 2000). Physics teachers' adoption of the 5E instructional model in their teaching allows students to engage in the learning of new content through meaningful learning experiences. The 5E instructional model further provides opportunities for students to construct their knowledge through exploration and enhances students' higher-order thinking through discourse, discussion and explanations (UkEssays, 2018, Hawkins & Williams, 2000).

While there have been several research findings which have highlighted on the effectiveness of the 5E instructional model towards maximized learning outcomes (Ayvaci et al., 2015, Guzel, 2016 & Cakir 2017), this study sought to establish the effect of the 5E Instructional Model on Senior High School Physics Students' Academic Achievement, Based Ability and Gender Differences. The study was guided by the following research questions:

1. What is the effect of 5E instructional model and the traditional teaching method on Physics students' academic achievement?
2. What difference exits between pre-test, post-test and the delayed post-test achievement test scores of male and female students instructed with 5E instructional model?
3. Is there any difference in achievement test scores between high ability Physics students taught with 5 E instructional model and those taught with the traditional classroom teaching method?
4. Is there any difference in achievement test scores between low ability Physics students taught with 5 E Instructional Model and those taught with the traditional classroom teaching method?

The research questions raised four hypotheses as appears below:

H_{o1}: There is no significant effect of 5E instructional model and the traditional teaching method on students' achievement test scores in Physics.

H_{02}: There is no significant difference in the pre-test, post-test and the delayed post-test achievement test scores after instructed student with 5E instructional model.

H_{03}: There is no significant difference between the high ability Physics students taught with 5E instructional model and those taught with the traditional classroom teaching method.

H_{04}: There is no significant difference between low ability Physics students taught with 5E instructional model and those taught with the traditional classroom teaching method.

Literature Review

This section presents literature on various concepts including the theoretical underpinning of the 5E instructional model, the teaching phases of the 5E instructional model and research based empirical evidence of the 5E instructional model.

Theoretical Underpinnings of the 5E Instructional Model

This study was underpinned by the Constructivism Learning Theory (CLT). In classrooms where constructivist approach underpins the teaching and learning processes, the value of the teachers' instruction is not measured by the repetition of information as is common in traditional classrooms, but it is characterized by learners' ability to transfer knowledge, the adaptation of that knowledge to new situations and consequently, the restructuring of the knowledge by the learners (Llewellyn 2005).

The central idea of CLT is that learners actively construct new knowledge on the foundation of pre-existing knowledge (McLead, 2019). Hence, in the CLT classroom environment, learners must actively construct meaning out of a new concept by integrating it into previous experiences (Elliot, Kratochwill, Littlefield, & Travers, 2000). According to Ngussa and Makewa (2004), knowledge should be constructed by the learners under the supervision of the teachers. Therefore, in the CLT, learners are responsible for constructing their understanding which is based on their previous ideas or experiences.

Any well-designed constructivist learning environment must have the following four basic features (Tam, 2000):

1. Knowledge must be collectively shared among the teachers and the learners.
2. Both the teachers and learners should share the authority of the teaching and learning processes.
3. The teacher's principal role in the constructivist learning environment is that of a facilitator or a guide.
4. Discussion groups should consist of small numbers of heterogeneous learners.

The above four basic features have essential implications for effective classroom teaching and learning. The implication is that the CLT reinforces various student-cantered instructional methods, which are completely different from the traditional classroom teaching and learning experiences. Characteristically, in the traditional learning environment, knowledge is simple and is actively passed on to the learners from the teacher. However, in the constructivist learning environments, the teacher's principal responsibility, according to MacLeod (2019), is that of creating a collaborative problem-solving learning environment where students become active learners in their learning process.

The CLT is based on students' self-directed enquiry or research. This creates the opportunity for the learners to get actively involved in the teaching and learning process with its associated learning outcomes such as self-reliance, independence and ability to identify, investigate and enhance problem-solving skills which are needed for the twenty-first-century learning environment. Similarly, the 5E instructional model is premised on student-cantered and inquiry-based instructional methods. In the 5E instructional model, the teacher as facilitator, guides learners through questions, investigation, experiences and research. The resultant effect is that learners arrive at a deep understanding of fundamental scientific concepts. Therefore, like inquiry-based learning, the 5E instructional model fits into the CLT.

The Teaching Phases in the 5E Instructional Model

The 5E instructional model was developed by the Biological Sciences Curriculum Study (BSCS) team (Bybee et al., 2006) to expand and deepen the Science Curriculum Improvement Study (SCIS) instructional model. The team subsequently proposed a five-phase instructional model for teaching science concepts to maximize student understanding.

The five phase instructional model engages, explores, explains, elaborates and evaluates. As seen in page 4, Table 1 shows a detailed description of the 5E instructional model which includes the teacher's role, the learners' activities and possible student learning outcomes.

Empirical Evidence of 5E Instructional Model

Some studies have revealed the usefulness of the 5E instructional model in enhancing students' diverse learning outcomes. For example, the study by Guzel (2016) examined the effect of the 5E instructional model on students' academic achievement in Idil High School using the quasi-experimental research design and found that the 5E model provided an enhanced understanding for students, increased students motivation and had a positive impact on students' understanding of abstract concepts. The study specifically reported that students instructed using the 5E instructional model and the control groups were significant different ($p<0.05$), those taught using the 5E Instructional Model having better results. Based on the results, it was recommended that teachers should use the 5E instructional model to promote better learning outcomes.

Table 1: The Detailed Instructional Phases of the 5E Model

Phase	Teachers' Role	Students' Activities	Learning Outcomes/Usefulness
Engagement	Help learners to make connections to the incoming concepts using advanced organizers.	Learners ask question Curious in finding new things. Express ideas, share observations and create mental models.	Identification of the learners' prior knowledge. Identification of possible misconception held by learners prior to teaching of new concept. Motivation to contribute in class.
Exploratory	Provide the needed TMLs to learners. Provide rules and guidance for scientific instigation. Assist learners to design scientific investigation.	Test predictions and hypotheses. Conduct investigation by observing, describing and recording data. Compare data, ideas and findings with other students.	Enhances learner's researching skills. Learners' development of conceptual understandings. Ability to link, extrapolate scientific ideas to complement understanding Solidification of learners' scientific ideas as results of research-based learning.
Explanation	Initiate classroom discussion. Ask open-ended, high-order, deep-though-provoking questions to make meaning of their scientific thought/thinking	Use labels, rules, observations, generalizations and laws to communicate scientific concepts Listen attentively and critically and question explanations of other or add useful information. Report/discuss of new finding with other students.	Development of learners' scientific communication skills Logic and sequence of scientific reasoning Development of scientific thinking skills
Elaboration	Motivate learners to use scientific terms to link relevant previous knowledge and the new scientific concepts. Assist students to draw conclusions from results, findings, data or evidence.	Apply findings, definitions and new skills to similar scientific concepts. Make conceptual linkages between new and previous knowledge Critique explanations of other learners using sound scientific facts and principles.	Ability to create, organize and process new scientific concepts. Broader understanding scientific concepts. Ability to generalized scientific concepts. Processing of complex scientific content.
Evaluation	Using assessments tools to test learners' understanding	Answer questions using scientific facts and principles. Assess the progress of learning	Identification of new scientific knowledge/conceptual thinking acquired by student. Identifying learning gaps.

Adapted from Bybee (2006)

Ayvaci, Yildiz and Bakirci (2015) conducted a study, testing the power of the 5E instructional model on students of Karadeniz Technical University's learning outcomes using semi-experimental research design. In their study, students in the experimental group were instructed with the designed print laboratory material using the 5E instructional model, whereas students in the control group were instructed through traditional laboratory practices. The study found that students instructed with the print laboratory materials based on 5E instructional model enhanced their academic performance and their attitudes towards physics laboratory improved more than their counterparts who were instructed based on the traditional approach. Based on the results, it was recommended that print materials prepared and instructed using 5E instructional model which is grounded on the constructivist learning theory should be generalized in the Physics Laboratory courses for enhanced academic performance.

Cakir (2017) conducted a meta-analysis study on the effect of the 5E learning model on students' attitude towards the lesson as compared with the traditional teaching method between the year 2006 and 2016. Through the randomized-effects model design, the study found that the adoption of the 5E learning model is moderately effective to promote positive attitude towards the lesson compared with the traditional teaching method**.**

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Research Methodology

This section presents the methodology used to conduct the study. It includes such concepts like research design, population and sampling procedures, research instruments and the procedure of the study.

Research Design

This study used the quasi-experiment design to examine the effect of 5E instructional strategy on Senior High School students' academic achievement in Physics subject. The researchers divided the research subjects into the experimental and control groups. Specifically, a factorial pre-test, post-test control group design was employed. This design comprised two instructional groups (5E instructional group and the traditional classroom-teaching group), sex (male and female), ability (high and low Physics achievers) and repeated testing (pre-test and post-test). The main independent variables for the study were exposed to 5E instructional model, gender and ability while the dependent variables were Physics students' academic achievement and retention of Physics concepts.

Population and Sampling Procedures

The sample was drawn from the Berekum Senior High School second-year science students in the Bono Region of Ghana. From the population of 100 science students, a sample of 80 students was randomly selected. Male and female were equally represented in the sample. The sampled subjects were randomly assigned to the four classes of 20 students each. Two classes formed the experimental (sex and ability) groups, while the remaining two classes constituted the traditional teaching method group as the control group**.**

In grouping the research subjects, all the second-year science students in the high school were divided into three groups according to their baseline assessment test scores in Physics as higher, lower and middle Physics achievers. The baseline assessment test items were constructed by adopting a discrimination power index proposed by Ebel and

Frisbee (1986) who argue that test items discrimination power index of .4 and greater are considered as excellent. Hence, the authors' rule of thumb was used in the construction of the baseline assessment test for the purposes of grouping the research subjects into higher and lower Physics ability groups. In this grouping, students in the middle ability group were not used for the study because of their ability to become either high or low Physics ability students. Using the baseline assessment test items instrument, students were randomly and fairly distributed to the experimental and control group classes.

Research Instrument

Physics Students' Academic Achievement Tests (PSAAT) and Delayed Post Test (DPT) were used as research instruments to collect data for the study. The PSAAT was used to determine the effectiveness of the use of 5E instructional model on Physics students' academic achievement after students have been instructed with the 5E instructional model. The design of the 15 test items was based on the Senior High Schools Physics curriculum. The DPT was used to examine how long students could retain learned Physics concepts after they have been instructed with the 5E instructional model**.**

PSAAT and DPT were presented in a multiple-choice format. Each item having four options for the correct answer, with a maximum test score of 15 marks. Regarding the validity and reliability, the two instruments were reviewed by two Senior High School Physics Educators. Cronbach alpha of .78 and .76 for PSAAT and DPT, respectively, were established after the mini-research. Moreover, the average test difficulties for the two test instruments were .51 and .48, indicating the ability of the test instruments to differentiate between the low ability and high ability Physics students after the introduction of the 5E instructional model.

The Procedure of the Study

At the beginning of the study, the researchers grouped the research subjects into high and low Physics achievers using the baseline assessment discrimination index based on Abel and Frisbee (1986) rule of thumb with the considerations of sex. Subsequently, the researchers administered a pre-test composed of Senior High Schools Students Physics content. The experimental group (5E instructional model class) and the control group (the traditional teaching method) were instructed for six weeks.

The detailed instructional approach for the experimental group was as follows: The experimental group (5E instructional model class) learnt in the teaching environment by using the 5E instructional strategy phases which included the engage, explore, explain, elaborate and evaluate. In the engagement phase, students were taken through activities to stimulate their interest and were given opportunity to share what they know about the incoming topic.

After the engagement phase, students were taken through the exploratory phase, whereby they were taken through hands-on activities to interact with the teaching and learning materials which subsequently made the learning real. The importance of this phase during the intervention was to deepen students' understanding of the Physics content under consideration. After the exploratory phase, students were guided to explain what they have learnt and experienced. Specifically, they were guided to explain the concepts or terms they encountered during the exploratory phase of the lesson.

In the explanatory phase, students were consciously guided to elaborate on their understanding and apply what they had learned to new situations for deepening their skills. The final phase of the intervention for the experimental group was evaluation. Students were guided to do a reflection on and provide evidence of their new understanding of the Physics content under study.

In the control group, students were instructed using the traditional teaching approaches typically composed of lectures and teacher-led demonstration and discussion.

After the intervention, the researchers administered a post-test instrument to the experimental and control groups to assess the effectiveness of the research intervention. After two weeks of the intervention, a delayed post-test instrument was administered to students to assess the effects of the 5E instructional model on student retention of learned information.

The researchers compared the achievement test scores of the groups (the experimental, control, sex, and Physics ability groups) to determine the effect of treatment and whether or not statistically significant differences existed after the intervention.

Findings of the Study

This study sought to determine the effect of the 5E instructional model on Physics students' academic achievement based on retention, gender and ability. Average normalized gain was also used to examine the extent of the effect of the teaching methods on Physics students after the introduction of the research intervention.

Research Question One: *What is the effect of 5E instructional model and the traditional teaching method on Physics students' academic achievement?*

Table 2: Descriptive Comparison of the Experimental and the Control Group

Group	N	Pre-test Mean	Post-test Mean	Normalized Gain
Experimental	40	6.425(1.259) *	12.075(1.095)	.659
Control	40	6.450(1.413)	7.500(1.987)	.122

**SD in parenthesis*

Table 3: ANCOVA Summary Table (n=80)

Source	Type III SS	df	MS	F	Sig.	Post Hoc
Corrected Model	458.590[a]	2	229.295	109.801	.000	
Intercept	130.142	1	130.142	62.320	.000	**5E> TM**
Pre-test	39.977	1	39.977	19.144	.000	
Method*	421.026	1	421.026	201.614	.000	
Error	160.798	77	2.088			
Total	8283.000	80				
Corrected Total	**619.387**	**79**				

Methods: *5E instructional model and traditional method*

Table 2 shows that the experimental group pre-test and post-test mean scores were 6.425(SD=1.259) and 12.075(SD=1.095), respectively. Also, the control group had the pre-test mean score of 6.450(SD=1.413) and post-test scores of and 7.500(SD=1.987). The normalized gain of the experimental group was .659 whereas the normalized gain for the control group was.122. These results revealed that Physics students instructed with the 5E instructional model performed better in Physics academic achievement test scores than their counterparts instructed with traditional method of teaching Physics.

H_{01}: *There is no significant effect of 5E instructional model and the traditional teaching method on students' achievement test scores in Physics.*

Analysis of Covariance (ANCOVA) was used to test which teaching method was more effective than the other. To do this analysis, the teaching method was taken as a fixed factor, the pre-test scores as covariate and the post-test scores of the dependent variable. The results of the ANCOVA analysis are presented in Table 3.

The results in Table 3 show that the pre-test scores of the PSAAT have a significant influence on the post-test scores after the introduction of the two teaching methods ($F=19.144$, $p < .05$). Also, the teaching method has a significant influence on the post-test scores of PSAAT ($F=201.614$, $p< .05$). Specifically, the result obtained is that Physics students instructed with the 5E instructional model and the traditional teaching methods have significantly different effectiveness on students' academic achievement.

Research Question Two: *What difference exits between pre-test, post-test and the delayed post-test achievement test scores of male and female students instructed with 5E instructional model?*

The result presented in Table 4 (page 8) indicates that the 20 male students who were instructed with 5E instructional model had pre-test, post-test and delayed-post-test mean scores of 6.451(SD=1.431), 9.900(SD=2.881) and 10.975(SD= 2.749), respectively. Their 20 female counterparts had pre-test, post-test and delayed-post-test mean scores of 6.425(SD=1.432), 9.675(SD=2.749 and 9.975(SD=1.493), respectively. The results indicate that after instructing with the 5E instructional model, male students slightly performed better than their female counterparts.

H_{02}: *There is no significant difference in the pre-test, post-test and the delayed post-test achievement test scores after instructed student with 5E instructional model.*

Table 4: Independent Sample t-test for Males and Females in the 5E Group

	Gender	N	Mean	SD	*T*	*df*	*Sig(2-tailed)*
Pres-test	Male	20	6.451	1.431	.084	78	.934
	Female	20	6.425	1.432			
Post-test	Male	20	9.900	2.881	.357	78	.722
	Female	20	9.675	2.749			
Dpost-test	Male	20	10.975	2.749	2.995	78	.004
	Female	20	9.975	1.493			

Table 5: Descriptive Comparison of Physics High-Ability Students Experimental and control

Group	N	Pre-test Mean	Post-test Mean	Normalized Gain
High-Ability Experimental	10	6.425(1.359) *	13.800 (.6324)	.860
High-Ability Control	10	6.451(1.419)	10.000(1.247)	.415

**SD in Parenthesis*

Table 6: Inferential Comparison of high-ability Physics students in the Experimental and Control Groups

Group	N	Mean	SD	*Df*	*t*	*Sig (2-tailed)*
High-Ability Experimental	10	13.800	.6324	18	8.593	.000
High-Ability Control	10	10.000	1.247			

Table 7: Descriptive Comparison of Low-Ability Physics Students in the Experimental and Control Groups

Group	N	Pre-test Mean	Post-test Mean	Normalized Gain
Low-Ability Experimental	10	6.200(1.241) *	6.800(1.033)	.068
Low-Ability Control	10	6.120(1.419)	6.500(1.649)	.041

**SD in Parenthesis*

The independent sample t-test revealed no significant difference in the pre-test [(78) =. 084, p>.05] and the post-test [(78) = .357, p >.05] of male and female students instructed with the 5E instructional model. Hence, the null hypothesis was retained. However, a significant difference was found in the delayed-post-test mean scores of male and female students instructed with the 5E instructional model [t (78) =2.995 p < .05], with the male counterparts slightly retaining Physics concepts after the two weeks of administration of the delayed-post-test. As a result, the null hypothesis was rejected.

Research Question 3: *Is there difference in achievement test scores between high ability Physics students taught with 5E instructional model and those taught with the traditional method*?

Table 5 shows that the Physics high-ability students in the experimental group who were instructed with 5E instructional model pre-test and post-test mean scores were 6.425(SD=1.359) and 13.800(SD=.6324), respectively. Also, the high-ability Physics in the control group who were instructed with the traditional method had pre-test mean score of 6.451(SD=1.419) and post-test scores of 10.000(SD=1.247) respectively. The normalized gain of the high-ability Physics student in the experimental group was .860 whereas the normalized gain for the high-ability Physics students in the control group was .415 These results reveal that the high-ability Physics students in the experimental group where students were instructed with 5E instructional model performed better than their high-ability counterparts instructed with traditional method of teaching Physics.

H_{03}: *There is no significant difference between Physics high ability students taught with 5E instructional model and those taught with the traditional classroom teaching method*.

The independent sample t-test as presented in Table 6 shows that there is a significant difference between the high-ability student instructed with 5E instructional model (Mean=13.800, SD= .6324) and those instructed with the traditional method (Mean=10.00, SD=1.247). [t (18) = 8.593, p<.05]. Hence, the null hypothesis was rejected.

Research Question Four: *Is there significant difference in achievement test scores between low ability Physics students taught with 5E instructional model and those taught with the traditional classroom teaching method*?

Table 7 shows that the Physics low-ability students in the experimental group who were instructed with 5E instructional model had pre-test and post-test mean scores of 6.200(SD=1.241) and

6.800(SD=1.033) respectively. Also, the Physics low-ability students in the control group who were instructed with the traditional method had pre-test and post-test mean score of 6.120(SD=1.419) and 6.500(SD=1.649) respectively. The normalized gain of the Physics low-ability student in the experimental group was .068 whereas the normalized gain for the Physics low-ability Physics students in the control group was .041 These results reveal that the Physics low-ability students in the experimental group where students were instructed with 5E instructional model performed slightly better their Physics low-ability counterparts instructed with traditional method of teaching Physics.

H_{04}: *There is no significant difference between low ability Physics students taught with 5E instructional model and those taught with the traditional classroom teaching method.*

Table 8: Inferential Comparison of Low-ability Physics students in the Experimental and Control Groups

Group	N	Mean	SD	*Df*	*t*	*Sig (2-tailed)*
Low-Ability Experimental	10	6.800	1.033	18	.487	.632
Low-Ability Control	10	6.500	1.649			

The independent sample t-test as presented in Table 8 shows that there is no significant difference between the low-ability Physics student instructed with 5E instructional model (Mean=6.800, SD= 1.033) and the high ability Physics students instructed with the traditional method (Mean=6.500, SD=1.649). [t (18) = .487, p >.05]. Hence, the null hypothesis was retained.

Discussion of Results

Physics students instructed with the 5E instructional model did better in Physics academic achievement test scores than their counterparts in the control group who were instructed with the traditional method. Hence, the null hypothesis (H_{o1}) was rejected. This is further confirmed with the normalized gains for the experimental group (0.659) representing above average and control group (0.122) representing below average groups base on the classifications of normalized gains. Moreover, high ability Physics students instructed with 5E instructional model performed better in the post-test scores (Mean=12.075, SD=1.095) against the high ability students instructed with the traditional method (Mean= 7.500, SD=1.987). This implies that the 5E model provided an enhanced understanding for students, increased students' motivation study and had a positive impact on students understanding (Ayvaci ,Yildiz, & Bakirci, 2015; Guzel, 2016).

Though not significant, there was a difference between pre-test and post-test of male and female students instructed with 5E instructional model, hence this aspect of the null hypothesis was retained. However, there was a significant difference between delayed-post-test of male and female students instructed with the 5E instructional model (p < .05), hence the rejection of the null hypothesis.

The normalized gains for high ability experimental (0.860=high) and high ability control (0.415=medium) groups indicates a difference in achievement test scores between high ability Physics students taught with 5E instructional model and those instructed with the traditional classroom teaching method as suggested by Guzel (2016). Also, the Inferential Comparison in Table 6 confirms a statistical significant difference between Physics high ability students taught with 5E instructional model and those instructed with the traditional classroom teaching method, hence the rejection of the null hypothesis. However, the null hypothesis was partly retained because there was no significant difference between low ability Physics students taught with 5E instructional model and those taught with the traditional classroom teaching method as shown in Table 8. Further, the normalized gains (Table 7) for low-ability experimental (0.68=medium) performed slightly better than the low-ability control (0.41= medium) group.

Conclusion and Recommendations

This part gives the conclusions of the study as informed by the findings of the study and then presents the corresponding recommendations.

Conclusion

With strong empirical support stated in this study, it is concluded that the 5E instructional model is a very viable instructional strategy that makes sense for the success of Physics students' academic achievement and retention than the traditional method of teaching Physics in senior high schools.

Recommendations

It is recommended that Physics teachers wanting to improve their students learning outcomes should use new instructional strategies, such as the 5E instructional model which have been touted as having effects on students learning outcomes.

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