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Effects of Hybrid Active Learning Strategy on Secondary School Students' Understanding of Direct Current Electricity Concepts in Nigeria

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Abstract. This study examined the effects of Hybrid Active Learning Strategy (HALS) on secondary school students' understanding of direct current electricity concepts (DCEC) in Nigeria. The study used a pretest-posttest control group as the design. Proportionate stratified random sampling method and table of random numbers were used to select four co-educational senior secondary schools in Kaduna Educational Zone, Kaduna State from which 172 physics students were also sampled. Randomly, the students were assigned to the experimental (n=86) and control (n=86) groups. Using HALS, the experimental group was taught DCEC while the conventional lecture approach was used to teach the same concepts to the control group. The Written Concept Test (WCT) and the Direct Current Electricity Practical Test (DCEPT) developed by the researchers with reliability coefficients 0.81 and 0.83 respectively were used to collect data. The validity of these instruments was established by experts. Employing SPSS software, data analysis was done using t-test and effect size based on Cohen's d. The findings of this study showed that the performance levels of both experimental and control groups before treatments were low with no significant difference in their understanding of DCEC. The results further showed that students taught using HALS performed significantly better than their counterparts taught with conventional lecture approach. Furthermore, the result revealed that gender and school type had no effect on students' performance when taught using HALS. The researchers concluded that the use of HALS package promotes students better understanding of concepts translating to optimal performance in physics examinations.

Keywords: Active Learning Strategy; Concepts; Direct Current Electricity; Hybrid; Understanding.

Introduction

Over the years, it has been found that physics is the bedrock of scientific and technological developments worldwide. The technologies associated with physics, especially space and nuclear science, determine the economic and military powers of nations. Thus, at the senior secondary school level in Nigeria, physics has been identified as one of the core science courses as stated in the National Policy on Education (FRN, 2004). The Nigerian government in recognition of the importance of science and technology, especially physics has taken a number of steps towards its improvement. These steps included the implementation of the Science and Technology Education Post Basic project with support from the World Bank which focuses on the production of adequate and quality science and technology graduates. Furthermore, the inclusion of Physics in Technology in the recently reviewed Senior Secondary School Physics Curriculum was a significant step towards the improvement of science and technology in Nigeria. This curriculum came into effect in September 2011. Despite the efforts of the Nigerian government, researchers generally observed students' low enrolment and poor performance in physics (Mankilik & Umaru, 2011; Erinosho, 2013; Aina & Olanipekun, 2014). The students' low enrolment and poor performance in physics is indicative of a serious variance between the expectations of the Nigerian Government as spelt out in the National Policy on Education (NPE) and the actual situation of physics in our schools and this calls for a review of the strategies teachers adopt in the teaching and learning of physics (WAEC, 2008). Generally, the way physics lessons are delivered in senior secondary schools in Nigeria is by expository method. The expository teaching method is a teacher-centered, student-peripheral approach where the teacher with or without the use of instructional materials delivers a pre-planned lesson to the students (Akinbobola, 2009).

In agreement with the low enrolment of students in physics, the analysis of the West African Examinations Council (WAEC) results shows that on the average between 2006 and 2014 in Nigeria, about 35% of the total number of students that registered for West African Senior School Certificate Examinations (WASSCE) entered for physics. In terms of performance, the WAEC Chief Examiner's reports (2005-2013) in physics indicated poor performance of students generally despite the favourable standards of the paper and the moderate severity of the marking scheme. In line with this, the analysis of the WAEC and National Examinations Council (NECO) results of candidates' performance in physics for the May/June 2006-2013 SSCE in Nigeria indicated general poor performance. For WAEC, in 2011 for example, 43% of the 12,123 physics candidates that sat for the examination in Kaduna State had credit passes and above, out of which about 1% passed with distinction. In the same year for NECO and in Kaduna State, 16% of the 24,498 candidates that sat for the examination had credit passes and above, out of which less than 0.1% passed with distinction. Also, in 2013, for WAEC, the case is even worse as 0.05% of the 38,738 candidates that sat for physics in the State had distinction. It is to be noted that a performance level of less than 1% pass with distinction is grossly inadequate for Nigeria's quest for rapid scientific and technological development.

In Kaduna State, students' low enrolment and poor performance in physics has been attributed to inadequate human and material resources as well as inappropriate presentation of materials as recorded in the analysis of the education sector conducted by Kaduna State Ministry of Education (KSMOE, 2008). The situation is further compounded as the teaching of physics (direct current electricity) in senior secondary schools, is adversely affected by problems such as perceived abstract and difficult nature of direct current electricity concepts (DCEC), lack of modern equipment and poor teaching strategies. In realization of Vision 20-2020, Nigeria must strive for optimum performance in physics not just average performance. The realization of this vision entails rapid production of the workforce that is versatile in the development of modern technologies which are based on the principles of direct current electricity.

Direct current electricity concepts (DCEC) are the underlying concepts of one of the branches of study in physics dealing with the steady flow of electrons around a circuit. The concepts include those of current, voltage, potential difference and resistance in an electric circuit. Direct current electricity is an area of physics that teachers find difficult to teach due to its abstract nature and students make a lot of mistakes in answering questions on it (Baser & Durmus, 2010). Furthermore, they stated that instructional materials should be developed to promote the development of basic scientific reasoning skills. To this end, in any teaching method, all efforts should be directed at the students' better understanding of concepts being taught (Akinbobola & Afolabi, 2010). When a concept is well understood, it is retained much longer, it can be built upon to acquire further understanding and facilitates creativity (Reigeluth, 2009). In this light, visualization of phenomena through computer simulations can contribute to students' better understanding of physics concepts (Zacharia & Olympiou, 2010). In the same vein, cooperative learning as an active learning strategy which involves students interactively working in groups to accomplish a common goal brings about deeper understanding of learned task that is relevant to life after school (Bello, 2011).

In addition, several studies on gender issues in physics education noted differing views. Gender has been identified as having significant effect on students' performance in physics at the secondary school level (Onah & Ugwu, 2010). Another study indicated that gender is not a strong determinant of students' academic achievement in physics rather the teaching approaches adopted which should not discriminate between the sexes (Akinbobola & Afolabi, 2010). Consequently, the active learning strategies for instruction could be structured to eliminate any undue effect of gender on student's performance. Furthermore, some researches in school type (public and private) showed conflicting views. For example, in a study, students from public schools lagged behind in their performance in the sciences when they were compared with those in private schools (Olatoye & Agbatogun, 2009). On the contrary, in another study, students in regular public schools performed as well as students in private schools when presented with equal learning opportunities (Lubianski

& Lubianski, 2006). It is therefore of importance that the effect of school type be properly investigated and addressed.

However, a number of lapses have been observed in the application of active learning strategies. The lapses include lack of use of a combination of active learning strategies which are recommended in order to have a better student engagement and interest (Afolabi & Akinbobola, 2009; Adeyemo, 2010). Therefore, it is necessary to critically study ways of applying a combination of active learning strategies to enhance students' understanding of physics concepts especially direct current electricity concepts at the secondary school level. In line with this, a typical computer simulation package developed and named Hybrid Active Learning Strategy (HALS) was used in teaching senior secondary two (SS2) physics students for better understanding of DCEC. This simulation package was a combination of strategies of computer simulation, cooperative learning, questioning, class discussion, manipulation, exploration and experimentation (Ofodile & Mankilik, 2015). These strategies encouraged scaffolding which refers to a learning situation where the teacher guides the students appropriately. HALS structured to be highly interactive and engaging was used to study its effects on the understanding of direct current electricity concepts by students.

Statement of the Problem

The inappropriate utilization of relevant teaching strategies and lack of application of innovative technology in teaching physics, especially, DCEC have been major concerns of physics educators. Specifically the defective methodology employed by the teachers, as well as the non-use of modern equipment during instruction generally leads to students' low enrolment and poor performance in physics (Adegoke, 2011). This implies that the way learning materials are presented to the students manifests in their non-active participation in learning, lack of interest and proper understanding of DCEC. Therefore, the broad question to be answered in this study is: What could be the effects of HALS on senior secondary school students' understanding of DCEC in Kaduna Educational Zone?

Purpose of the Study

The objectives of the study were to:

1. find out the performance levels of SS2 students in DCEC before exposure to HALS and the conventional lecture approach.
2. determine the performance levels of SS2 students in DCEC after exposure to HALS and the conventional lecture approach.
3. determine the effects of gender on the performance scores of students in DCEC after being exposed to HALS.
4. determine the effects of school type (public and private) on the performance scores of students in DCEC after being exposed to HALS.

Hypotheses

1. There is no significant difference between the pre-test performance mean scores of experimental group exposed to HALS and those of the control group not exposed to HALS.
2. There is no significant difference between the post-test performance mean scores of experimental group exposed to HALS and those of the control group not exposed to HALS.
3. There is no significant difference between the post-test performance mean scores of male and female students who are exposed to HALS.
4. There is no significant difference between the post-test performance mean scores of students from public and private schools exposed to HALS.

Research Methodology

This study adopted the true experimental design. It used the pretest - posttest control group design with randomization. The population for the study comprised 16 co-educational senior secondary schools in Kaduna Educational Zone that have at least 40 SS2 physics students. This presented a total population size of 1,034 students. The samples of 4 schools (2 public and 2 private) and 172 students (89 males and 83 females) were selected using proportionate stratified random sampling method and table of random numbers. The instruments, Written Concept Test (WCT) and the Direct Current Electricity Practical Test (DCEPT) developed by the researchers were used for data collection. The content validity of the instruments was established using four experts, one test and measurement expert and three physics educationists. Their comments and independent observations, corrections and suggestions were incorporated into the final form of the instruments. The instruments were trial-tested using 40 SS2 physics students that were similar in all respect to the students for the study but were not part of the study sample. The reliability coefficients for WCT and DCEPT using Cronbach Alpha were 0.81 and 0.83 respectively.

The selected students were assigned randomly to the experimental (n=86) and control (n=86) groups using table of random numbers. WCT was administered as pre-test to the students and used to measure the degree of the dependent variable before treatment. The treatment was administered to both groups for six weeks. The experimental group was exposed to HALS for DCEC while the conventional lecture approach was used to teach the same concepts to the control group. The experimental group students in smaller groups of 2 or 3 were provided with either a desktop or laptop on which the HALS package was installed. At the end of the treatment, WCT and DCEPT were administered to both groups as post-test. After scoring, the data were collated and subjected to statistical analysis using SPSS software. Using t-test at 0.05 level of significance, the four hypotheses were tested.

Results

Hypothesis One

There is no significant difference between the pre-test performance mean scores of the experimental group exposed to HALS and those of the control group not exposed to HALS. Result of the t-test analysis for independent samples is presented in Table 1.

Table 1: Pre-test Analysis Results of Scores of Students in the Experimental and Control Groups

Group	Number n	Mean $\bar{X}$	Standard Deviation SD	Degree of Freedom df	t-Cal	p value
Experimental	86	33.38	8.37	170	0.08	0.936
Control	86	33.49	8.72			

Not significant at p> 0.05

The result in Table 1 showed that the t-test failed to reveal a statistical significant difference between the pre-test performance mean scores of the experimental group exposed to HALS ($\bar{X}$ =33.38; SD=8.37) and the control group not exposed to HALS ($\bar{X}$ = 33.49; SD=8.72); $t_{(170)} = 0.080$, $p > 0.05$. The null hypothesis was retained. Therefore, prior to treatment, there was no significant difference in the performance mean scores of students from both experimental and control groups. As a result, the groups were considered the same as far as their understanding of DCEC is concerned.

Hypothesis Two

There is no significant difference between the post-test performance mean scores of the experimental group exposed to HALS and those of the control group not exposed to HALS. The result of the t-test analysis for independent samples is presented in Table 2.

Table 2: Post-test Analysis Results of Scores of Students in the Experimental and Control Groups

Group	Number n	Mean $\bar{X}$	Standard Deviation SD	Degree of Freedom df	t-Cal	p value
Experimental	86	70.02	16.57	170	12.24	0.000
Control	86	45.31	8.73			

Significant at p<0.05

The result in Table 2 showed that the t-test revealed a statistical significant difference between the post-test performance means score of the experimental group ($\bar{X}$ = 70.02; SD = 16.57) and the control group ($\bar{X}$ = 45.31; SD = 8.73); $t_{(170)} = 12.24$; $p < 0.05$. The null hypothesis was therefore not accepted. This implies that a significant difference exists between the post-test performance mean scores of experimental group exposed to HALS and those of the control group not exposed to HALS. An effect size of 1.88 was also recorded, which according to the range recorded by Becker (2000) indicated a large effect as a result of the intervention.

Hypothesis Three

There is no significant difference between the post-test performance mean scores of male and female students who are exposed to HALS. The result of the t-test analysis for independent samples is presented in Table 3.

Table 3: Post-test Analysis Results of Scores of Male and Female Students Exposed to HALS

Gender	Number n	Mean $\bar{X}$	Standard Deviation SD	Degree of Freedom df	t-Cal	p value
Male	44	70.36	17.03	84	0.194	0.847
Female	42	69.67	16.26			

Not significant at p> 0.05

The result in Table 3 showed that the t-test failed to reveal a statistical significant difference between the post-test mean scores of male ($\bar{X}$ =70.36; SD=17.03) and female students exposed to HALS ($\bar{X}$ = 69.67; SD=16.26); $t_{(84)} = 0.194$, $p > 0.05$. The decision was to retain the null hypothesis. Therefore, there is no significant difference between the post-test performance mean scores of male and female students exposed to HALS.

Hypothesis Four

There is no significant difference between the post-test performance mean scores of students from public and private schools exposed to HALS. The result of the t-test analysis for independent samples is presented in Table 4.

Table 4: Post-test Analysis Results of Scores of Students from Public and Private Schools Exposed to HALS

School Type	Number n	Mean $\bar{X}$	Standard Deviation SD	Degree of Freedom df	t-Cal	p value
Public	44	69.91	15.75	84	0.065	0.948
Private	42	70.14	17.57			

Not significant at p> 0.05

The result in Table 4 showed that the t-test failed to reveal a statistical significant difference between the post-test mean scores of students from public ($\bar{X}$ = 69.91;

SD=15.75) and private schools exposed to HALS ($\bar{X}$ = 70.14; SD=17.57); $t_{(84)}$ = 0.065, $p > 0.05$. The decision was to retain the null hypothesis as there is no sufficient ground to reject the hypothesis. Therefore, there is no significant difference between the post-test performance mean scores of students from public and private schools exposed to HALS.

Discussion

The study examined the effect of Hybrid Active Learning Strategy (HALS) and conventional lecture approach on students' understanding of Direct Current Electricity Concepts (DCEC). The analysed results disclosed that there was no significant difference between the pre-test performance mean scores of experimental and control groups in their understanding of DCEC. This outcome collaborates the research finding of Agbatogun, Ajelabi, Oyewusi and Inegbedon (2011) which indicated that the entry performance of both intervention and control groups were at par. Determining if there are any pre-existing differences between the two groups was a good starting point for the treatments. This agrees with the findings of Akinbobola and Afolabi (2010), Bello (2011) and Tebabal and Kahssay (2011) that indicated same background knowledge in pre-test for experimental and control groups in their studies. Furthermore, the analysed data showed that the performance level of the two groups before exposure to treatment was low. This confirmed WAEC Chief Examiners' reports (2005-2013) in physics that indicated poor performance of students generally. Mankilik and Umaru (2011), Udoh (2012) and Erinosho (2013) also reported poor performance of students in physics. One major factor that might have contributed to this research outcome was the fact that equivalence was maintained between the two groups of students prior to treatment using random assignment.

The experimental group students' post-test mean scores were higher than that of the control groups. This implies that in the performance of students taught using HALS and those taught with the conventional lecture approach, there was a significant difference. This showed that HALS was effective in improving students understanding of DCEC. It was observed during the treatment that the experimental group students were actively participatory than the control group. This is in line with the findings of Tebabal and Kahssay (2011) and Bello (2011) which pointed out that a well-structured activity oriented, cooperative learning environment in physics enhanced students' performance thereby enabling them to outscore their counterparts in the other group. The findings were also in agreement with the positions of Baser and Durmus (2010), Kiboss (2011) and Gambari and Yusuf (2014) that computer simulation improves students' understanding of physics concepts through focusing on the dynamic characteristics of the simulated circuits, as well as strengthening students' domain knowledge by retrieving and explaining problem solving steps. In addition, the recorded effect sizes imply that the intervention on the experimental group resulted in the large effect on their performances as compared to the control group. Generally, this means that there is sufficient evidence to claim that the HALS instruction improved students' understanding of DCEC.

Also, this research revealed that gender had no effect on the performance of students in DCEC when taught using HALS. Hence, there was no statistically significant effect of gender on students' performance in DCEC. This is in line with the findings of Afolabi and Akinbobola (2009) and Ogunleye and Babajide (2011) that there is no significant effect of gender on students' performance in physics. The finding also is not in agreement with the findings of Onah and Ugwu (2010) where they concluded that gender differences do exist in students' achievements in physics. Researchers' differing views on gender effect on students' performance in physics suggests that if care is taken to make the classroom environment conducive for learning through the use of appropriate teaching strategy, both male and female students will perform equally well in any given task (Baser & Durmus, 2010). This suggests that HALS has been structured in such a way that it does not give one group an edge over the other. To give credence to this, Akinbobola and Afolabi (2010) observed that any good teaching approach used in teaching physics should not discriminate between sexes. It was also found that there was no statistically significant difference between the performance of students in the public and private schools taught using HALS. This means that there is no statistically significant difference between students' performance in DCEC in both school types. This finding agrees with the findings of Lubianski and Lubianski (2006) who reported that students in regular public schools do as well as students in private schools when presented with equal learning opportunities. This shows that HALS which the students were exposed to in both the public and private schools, is an effective instructional strategy that presents equal learning opportunities to the students resulting in no significant differences in their performances.

Conclusion

This study provides evidence that the use of HALS through computer simulation, cooperative learning, questioning, class discussion, manipulation, exploration and experimentation promotes students understanding of physics concepts in the classrooms. The result of this study showed that the performance level of both the experimental and control group students before treatments were low with no significant difference in their understanding of DCEC. The result further showed that students taught using HALS performed significantly better than their counterparts taught with conventional lecture approach. Furthermore, the result revealed that gender and school type had no effect on the performance of students taught using HALS indicating that HALS presents equal learning opportunities to the students. The implication of the findings of this work is that using HALS package, students can be taught abstract concepts in physics in a way that would promote their better understanding and make learning an enjoyable experience for them. This translates to optimal performance in physics examinations which can lead to the rapid production of a better workforce for the country's technological advancement.

Recommendations

The findings of this study, gave rise to the following recommendations:

1. Hybrid Active Learning Strategy (HALS) should be used in secondary schools for the teaching of direct current electricity concepts (DCEC) in physics to promote students' understanding of concepts.
2. Physics teachers should endeavor to use activity oriented mode of instructions like HALS in order to enable students participate actively in learning for better understanding.
3. Nigerian secondary schools should be equipped with technologies like computers in conjunction with relevant computer assisted instructional packages such as HALS that will be fully accessible to the students to enhance learning and improve performance.
4. Re-training of physics teachers through series of workshops and seminars on how to incorporate effectively small-size interactions using computer simulation such as HALS during physics lessons.
5. Subject inspectors should impress it on teachers to effectively use hands-on and minds-on mode of instructions as contained in HALS that will yield positive results.
6. Curriculum developers for senior secondary school physics should incorporate modern, adequate and appropriate strategies as incorporated in HALS in the teaching of physics.

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