Effect of Experiential Learning on Junior High School Students' Performance, And Retention of Electricity and Electronics in Tarkwa

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Abstract

Physics is noted as one of the most difficult subjects among the science subjects taught at the junior high school level. This study, therefore, investigated the effect of experiential learning approach on students' performance, and retention of electricity and electronics concepts among selected junior high schools in the Tarkwa, Western Region of Ghana. A two-group pre-test - post-test randomized control group design, a quasi-experimental quantitative method was used to collect quantitative data from 50 students from two public junior High Schools in the Western Region of Ghana. Random sampling techniques were used to select 50 students. The Academic Achievement Test (AAT) was developed to determine students' performance in electricity and electronics and was used to collect participant data. The AAT was in the form of a pre-test, a post-test, and a delayed post-test. The reliability coefficients for the pre-test and the post-test were 0.71 and 0.78 respectively. The data was analyzed using an independent-samples t-test and a dependent-samples t-test. The findings from the study showed the experiential learning approach improved students' conceptual understanding of electricity and electronics concepts. The findings also revealed that the experiential learning approach was effective in enhancing students' performance in electricity and electronics. The study's findings also indicated that female students performed better than their male counterparts with the experiential learning method. Students were able to retain the concepts due to the experiential learning approach. The study concludes that experiential learning approach with proper implementation is an effective learning paradigm that improves students' performance and retention of electricity and electronics concepts. It is recommended that both teachers and students in the selected junior high schools within the Western region should adapt the experiential learning approach as they teach and learn physics in their respective schools.

Keywords: Experiential Learning, Students', AAT, Electricity and Electronics

Introduction

The importance of electricity and electronics in modern society cannot be overstated. From powering homes and businesses to driving technological advancements, these concepts are foundational in our daily lives. However, teaching these subjects can be challenging, especially in junior high schools where students are still developing their understanding of complex scientific principles.

One of the main challenges in teaching electricity and electronics is the abstract nature of the concepts involved. Unlike more tangible subjects, such as biology or chemistry, electricity and electronics are invisible forces that require a deep conceptual understanding to grasp fully (Brown *et al*., 2018) [8]. Traditional lecture-based approaches often struggle to convey these concepts effectively, leading to poor student engagement and comprehension (Smith & Johnson, 2016) [26].

Experiential learning offers a promising solution to this challenge. By providing students with hands-on experiences, experiential learning helps bridge the gap between theory and practice, making abstract concepts more tangible and accessible (Kolb, 1984) [20]. This approach is grounded in the belief that learning is most effective when students are actively engaged in the learning process and can apply their knowledge in real-world contexts. Experiential learning is a dynamic educational approach that emphasizes learning through experience. It is rooted in the idea that individuals learn best when they actively engage in real-world experiences, reflect on those experiences, and apply their learning to new situations (Kolb, 1984) [20].

Experiential learning can be applied in a variety of educational settings. In classrooms, experiential learning can take the form of hands-on activities, simulations, and role-playing exercises. These activities help make abstract concepts more tangible and understandable (Wurdinger & Carlson, 2010) [27]. Outdoor education programs offer students opportunities to learn through outdoor activities such as hiking, camping, and team-building exercises. These activities not only enhance academic learning but also promote personal and social development (Priest & Gass, 2005) [24]. Internships and service-learning projects enable students to apply their classroom learning in real-world settings, gaining valuable experience and skills (Eyler & Giles, 1999) [13].

Experiential learning offers several benefits to learners. Firstly, it promotes active engagement, which has been shown to enhance learning outcomes (Helle *et al*., 2006) [17]. Actively engaging in the learning process helps students develop a deeper understanding of the subject matter and retain knowledge better.

Secondly, experiential learning helps develop critical thinking, problem-solving, and decision- making skills. By applying theoretical concepts in real-world settings, learners gain practical skills that are transferable to various contexts (Kolb, 1984) [20]. Experiential learning fosters a sense of responsibility, independence, and self-confidence. Through hands-on experiences, students learn to take initiative, make informed decisions, and work effectively in teams (Moon, 2004) [23].

Research has shown that experiential learning can have a profound impact on students' understanding and retention of scientific concepts. For example, a study by Brown *et al*. (2018) [8] found that students who participated in hands-on electronics projects not only demonstrated better understanding of electrical concepts but also showed improved problem-solving skills. Similarly, Smith and Johnson (2016) [26] reported that students who engaged in experiential learning activities retained more information and were more motivated to learn.

Despite these benefits, experiential learning is not widely implemented in Ghanaian schools, particularly in rural areas like the Tarkwa Nsuaem Municipality. Limited resources, inadequate teacher training, and a focus on exam-oriented teaching methods are some of the challenges that hinder the adoption of experiential learning approaches (Archer, 2019) [4]. This study seeks to address these challenges by investigating the feasibility and effectiveness of implementing experiential learning in junior high schools in the Tarkwa Nsuaem Municipality.

By providing empirical evidence on the effectiveness of experiential learning in improving students' conceptual understanding, performance, and retention of electricity and electronics concepts, this study aims to inform educational policy and practice in Ghana. Ultimately, the goal is to enhance the quality of science education in the country and better prepare students for future careers in science and technology.

1.1. Statement of the Problem

The traditional teaching methods employed in classrooms often rely heavily on theoretical explanations, diagrams, and rote memorization, which may not effectively engage students or promote deep conceptual understanding (Adu-Gyamfi, 2019) [2]. Consequently, many students struggle to apply their knowledge to real-world situations, leading to lower academic performance and retention rates (Adom, 2021) [1].

Moreover, the lack of practical, hands-on experiences in learning about electricity and electronics further limits students' ability to connect theory with practice (Boateng, 2016) [6]. The Chief examiners' report from 2011-2021 indicates the following problems students faced in the Basic Education Certificate Examination Council Exams in electricity and electronics, only very few students could state that fuse box contains thin wires which melts and cut off current when the current passing through it is too large, students could not identify live, neutral and earth wire in an electric plug, even though some students could state the type of transistors, they could not draw and label their circuit symbols, students were not able to state the effect of illegal connection and distinguished between electrical conductors and insulators, most students could not mentioned the junctions of transistors such as emitter, base and collector and could not also draw the circle round the circuit diagram, most students had problems in labelling the part of electrical circuits and cannot also state their functions. However, in the Tarkwa Nsuaem Municipality of Ghana, junior high school students face significant challenges in understanding and retaining concepts related to electricity and electronics and they are not exception from the problems outlined from Chief Examiner's report. Teachers should take students through practical lessons and guide them to experience the concepts through learning by practice (Chief Examiner's Report, 2021) [9]. This gap between theoretical learning and practical application not only hinders students' academic success but also their ability to pursue future opportunities in STEM fields (Doe, 2020) [12].

The existing literature highlights the urgent need to explore alternative teaching approaches that can enhance students' conceptual understanding, performance, and retention of electricity and electronics concepts. One such approach is experiential learning, which emphasises learning through direct experience and reflection (Amankwaa, 2018) [3]. By engaging students in hands-on activities, experiments, and real-world applications, experiential learning has shown promise in making abstract concepts more tangible and accessible, thereby improving learning outcomes (Gyamfi & Owusu, 2017) [16].

Therefore, the primary problem addressed by this study is the inadequacy of traditional teaching methods in fostering deep conceptual understanding, performance, and retention of electricity and electronics concepts among junior high school students in the Tarkwa Nsuaem Municipality. By investigating the effectiveness of the experiential learning approach, this study aims to provide valuable insights into how teaching practices can be improved to better support student learning in these critical STEM subjects.

1.2. Purpose of the Study
The purpose of this study was to investigate the effect of the experiential learning approach on Junior high school students' performance and retention of electricity and electronics in selected junior high schools in the Takwa Nsuaem Municipality of Ghana.

1.3. Research Objectives
The following research objectives guided the study.

1. To determine the effect of the experiential learning approach on students' performance in electricity and electronics in the experimental group.
2. To determine the effect of the experiential learning approach on students' retention of electricity and electronics in the experimental group.

1.4. Research Questions
The following were the questions the researcher sought to answer in this study.

1. What is the effect of the experiential learning on students' performance in electricity and electronics in the experimental group?
2. What is the effect of the experiential learning approach on students' retention of electricity and electronics in the experimental group?

1.5. Research Hypotheses
The following null hypotheses were tested at a 0.05 level of significance. Research question two was answered by testing null hypothesis one and research questions three and four were answered by testing null hypotheses two and three respectively.

H01: The experiential learning approach has no significant effect on the students' performance in electricity and electronics in the experimental group.

H03: The mean scores of the post-test and the delayed post-test in the experimental group will not change significantly due to the effect of the experiential learning approach.

Research Methodology
This study employed a quasi-experimental design, specifically the pretest-posttest randomized control group design. This approach aligns with positivist principles, emphasizing systematic observation and measurement to establish cause-and-effect relationships (Creswell & Creswell, 2018) [11]. The population for the study consisted of students from two randomly selected Junior High Schools. A total sample of 50 students was chosen, with 25 students each in the control and experimental groups. Stratified random sampling ensured an equal representation of male and female students in both groups, with each group consisting of 13 males and 12 females. This technique involved dividing the population based on gender and then randomly selecting an equal number of participants from each stratum to maintain a representative sample (Fraenkel, Wallen, & Hyun, 2019) [15].

To measure students' performance in electricity and electronics, an Academic Achievement Test (AAT) was developed. The AAT comprised practical tasks and problem-solving questions designed to assess students' understanding of electricity and electronics concepts. The test was administered before and after the intervention to both groups. Additionally, a Retention Test (RT), created by selecting 10 random questions from both the pre-test and post-test of the AAT, was administered six weeks after the intervention to evaluate students' retention of knowledge. Both the researcher and the class teacher conducted the RT, which followed a similar format to the AAT but focused on long-term retention.

To ensure the reliability and consistency of both the Academic Achievement Test (AAT) and the Retention Test (RT), Cronbach's alpha was used to measure internal consistency. Cronbach's alpha provides a reliability estimate based on the average correlation among test items. For this study, a Cronbach's alpha value of 0.71 was recorded for the AAT instrument, indicating acceptable internal consistency. A value of 0.7 or higher is generally considered sufficient for reliability. The AAT was administered to both the control and experimental groups to establish baseline data on students' understanding of electricity and electronics. The pre-test results were crucial for evaluating students' initial knowledge and skills in these areas. This allowed the study to identify whether any significant differences observed after the intervention were due to the teaching methods rather than pre- existing disparities.

Over six weeks, both groups were taught the same topics in electricity and electronics but through different teaching methods. The experimental group engaged in an experiential learning approach, while the control group received traditional lecture-based instruction. The topics covered included basic electrical components, circuit construction, and the use of measuring instruments. In the experimental group, students participated in hands-on, experiential learning activities. They went on field trips to electrical shops and repair centers, where they observed real-world electrical components and circuits in action. During these visits, students interacted with electricians and technicians, gaining insights into the practical applications of diodes, transistors, earth wires, switches, and other components.

This approach allowed students to bridge the gap between theoretical concepts and practical skills by actively engaging with real-world scenarios. The control group, in contrast, followed a more traditional lecture-based method. The teacher explained the functions and properties of electrical components, such as diodes, transistors, resistors, and earth wires, using diagrams and verbal explanations. Students learned about these components' theoretical aspects and how they are used in electrical circuits. While the teacher introduced the construction and analysis of series and parallel circuits, the learning process was largely passive, relying on note-taking and listening to explanations.

Although students may have observed demonstrations of using measuring instruments like voltmeters and ammeters, they did not engage in as much hands-on practice as the experimental group. After the six-week instructional period, both the control and experimental groups completed the post-test. This AAT post-test was designed to measure any changes in students' understanding and performance in electricity and electronics after the intervention. The results were analyzed to determine whether the experiential learning activities significantly impacted the experimental group's comprehension compared to the traditional lecture-based instruction of the control group.

Results and Discussion
Research question one

What is the effect of the experiential learning approach on students' performance in electricity and electronics in the experimental group?

By evaluating the null hypothesis, which read, "There is no significant difference in the performance of electricity and electronics between the experimental group and the control group before the experiential teaching approach," the foundation for designating one school as the experimental group and the other as the control group to ascertain the efficacy of the experiential approach was established. The pre-test results of the students in the two schools prior to the implementation of the experiential strategy were analysed using the independent- samples t-test. The findings of the independent-samples t-test for the experimental group's mean scores and the control group are shown in Table 1.

Table 1: Independent-samples t-test of the students' scores in the pre-test

Group	*N*	*M*	*SD*	*df*	*t*	*P*
Experimental	25	30.24	14.90	78	4.37	0.470
Control	25	30.73	14.03			

Significant at $p < 0.05$

The performance of the experimental group and the control group's students in electricity and electronics prior to the use of the experiential learning strategy was ascertained using Table 1 and the independent-samples t-test. The experimental group's mean scores (M = 30.24, SD = 14.90) did not differ significantly from the control group's (M = 30.73, SD = 14.03; t(78) = 0.050, p = 0.470). Consequently, the null hypothesis was approved. This result indicates that prior to the experiential learning intervention both the control group and the experimental group had the same understand and knowledge in electricity and electronic.

Table 2 presents the results of the independent-samples t-test for the mean scores of the experimental group and the control group after the experiential learning and the conventional method respectively.

Table 2: Independent-samples t-test of the students' scores in the post-test

Group	*N*	*M*	*SD*	*Df*	*t*	*p*
Experimental	25	65.24	9.40	78	3.28	0.002
Control	25	55.27	9.63			

Significant at $p < 0.05$

The independent-samples t-test of the mean scores for the experimental group and the control group is presented in Table 2. The purpose of this study was to evaluate the efficacy of the experiential learning technique by comparing the performance of the student's electricity and electronics in the experimental and control groups. The mean scores of the experimental group (M = 65.24, SD = 9.40) and the control group (M = 55.27, SD = 9.63; t(78) = 3.28, p = 0.002) differed statistically significantly. Consequently, the null hypothesis was disproved. The means' differences were quite significant. This indicates that improving students' performance in experiential learning was a better outcome of the experiential learning technique than of the traditional approach.

Based on research question one, the findings of the study revealed that the experiential learning approach had a large effect on the students' performance in electricity and electronics. It shows that the experiential learning approach was more favourable in improving students' performance in electricity and electronics than the conventional method of teaching.

Research question two

What is the effect of the conceptual learning approach on students' electricity and electronics concepts in the experimental group?

Finding out how well students retained their electricity and electronics performance following the implementation of the experiential learning technique was the aim of this study topic. This was ascertained by applying the dependent-samples t-test to compare the post-test and delayed post-test mean scores in the experimental group. The null hypothesis for this research issue was developed and evaluated at the 0.05 significance level. "The experimental group's post-test and delayed post-test mean scores will not change significantly due to the effect of the contextual learning strategy," reads the null hypothesis.

The results of the dependent-samples t-test of the post-test and the delayed post-test are presented in Table 2.

Table 3: Dependent-samples t-test of the students' scores in both the post-test and delayed post-test of the experimental group.

Test	*N*	*M*	*SD*	*df*	*t*	*p*
Post-test	25	65.24	9.40	40	0.875	0.387
Delayed Post-test	25	67.07	9.63			

Significant at $p < 0.05$

The results, as presented in Table 5, demonstrate that there was no statistically significant difference between the post-test (M = 65.24, SD = 9.40; t(40) = 0.875, p = 0.387) and delayed post-test (M = 67.07, SD = 9.63). We are unable to reject the null hypothesis as a result. The post-percentage test's score was 58.3%, while the delayed post-score tests was 67%. 9.3% was the percentage difference between the post-test and the delayed post-test. This minor difference suggests that the inclusion of the experiential learning strategy helped the students recall the concept of electricity and electronics.

Based on the post-test results, the experiential learning strategy had already had a considerable positive impact on the performance of the students in the experimental group. The fact that the post-test results showed no discernible change after a delay indicated that the students had retained the material covered in electricity and electronics. Accordingly, the study discovered that students' performance in electricity and electronics may be retained with the help of the experiential learning strategy.

Discussion of Findings

The findings of this study indicate that experiential learning has a significant effect on students' performance in electricity and electronics. The results from the pre-test and post-test comparisons, and retention assessments, align with existing literature on the effectiveness of experiential learning in technical and vocational education. The discussion below provides an analysis of the findings and connects them to the literature reviewed.

Effect of Experiential Learning on Students' Performance in Electricity and Electronics

The study found that experiential learning had a positive impact on the students' performance in electricity and electronics, as demonstrated by the significant improvement in the post-test scores of the experimental group compared to the control group. Before the implementation of the experiential learning approach, there was no significant difference in the performance of students in both groups, as shown by the pre-test results ($t(78) = 0.050$, $p = 0.470$). However, after applying the experiential learning strategy, the experimental group's mean scores ($M = 65.24$, $SD = 9.40$) were significantly higher than those of the control group ($M = 55.27$, $SD = 9.63$; $t(78) = 3.28$, $p = 0.002$), indicating that experiential learning greatly improved students' performance in electricity and electronics.

This result is consistent with the study by Smith and Jones, which found that students exposed to hands-on, project-based learning in technical fields like electricity and electronics performed better in both theoretical and practical assessments than their peers in traditional lecture-based courses. High performance of students in electricity and electronics with the experiential learning approach underscores the various activities involved in the application of the experiential teaching approach. During the experiential learning approach, the concept was related to real-life examples where the concept was linked to the everyday activities within the learner's own immediate environments. The students had the opportunity to go on excursions and field trips to observe how each of the concepts taught was performed and the processes and the various stages involved. The improved understanding and application of concepts in electricity and electronics through experiential learning, as seen in the current study, reflects the real-world applications and deeper cognitive engagement that experiential learning fosters, a view supported by Brown *et al.* (2020) [8].

Retention of Concepts in Electricity and Electronics

The third research question investigated the effect of the experiential learning approach on students' retention of electricity and electronics concepts. The study found that there was no significant difference between the post-test and delayed post-test scores ($M = 65.24$, $SD = 9.40$; $t(40) = 0.875$, $p = 0.387$), suggesting that students retained the concepts learned through the experiential learning approach over time. The 9.3% difference between the post-test and delayed post-test scores further demonstrates the effectiveness of experiential learning in promoting long-term retention of knowledge.

These findings are supported by Prince and Felder (2019) [25], who demonstrated that students engaged in hands-on projects and experiments retained information more effectively than those in traditional learning environments. Bransford *et al.* (2018) [6] explain this retention phenomenon through cognitive processes, suggesting that active engagement helps students form stronger neural connections, which aids in better recall of learned concepts. This finding also echoes Lee and Kim's (2023) [22] research, which showed that students who learned through experiential methods retained information about electrical circuits and electronic systems more effectively

Conclusion

Based on the findings, it can be concluded that the experiential learning approach significantly improves students' performance in electricity and electronics, enhances retention of concepts, and has a more pronounced effect on students. The approach, which incorporates real-world applications, hands-on activities, and reflective learning, proves to be more effective than traditional teaching methods in engaging students and fostering a deeper understanding of technical subjects.

This study supports the view that experiential learning is a valuable pedagogical tool, particularly in technical and vocational education. The approach not only enhances academic performance but also promotes long-term retention of knowledge, which is essential for future learning and application in practical settings.

Recommendations

Based on the findings, the following recommendations are made

1. Implementation of Experiential Learning in Technical Education

Schools and educational institutions should incorporate experiential learning strategies, especially in technical subjects like electricity and electronics. Teachers should be trained to adopt this approach, making use of real-life examples, hands-on activities, and field

2. Support for Long-Term Retention

To enhance retention, teachers should frequently integrate revision activities, group discussions, and hands-on projects to reinforce learning. Experiential learning strategies should also be combined with continuous assessment and practice to ensure students retain knowledge over extended periods.

3. Further Research

Future research should explore the long-term impact of experiential learning on students' career readiness and technical skills. Additionally, studies could investigate how experiential learning can be tailored to suit different learning styles and how it affects

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