UNIVERSITY OF EDUCATION, WINNEBA

THE EFFECT OF EXPERIENTIAL LEARNING ON STUDENTS' ACADEMIC PERFORMANCE IN ELECTRONICS AT DODI PAPASE SENIOR HIGH SCHOOL

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A thesis submitted to the school of graduate studies in partial fulfilment of the requirement for the award of the degree of Master of Philosophy (Integrated Science Education)

DEPARTMENT OF INTEGRATED SCIENCE EDUCATION,
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DECLARATION

Student's Declaration

I, Richard Senyo Ewormvor declare that this thesis, with the exception of quotations and references contained in published works which have been identified and duly acknowledged, is entirely my own work, and it has not been submitted either in part or whole for another degree elsewhere.

SIGNATURE: ………..............………………

DATE: ……….........……...…………………

Supervisors' Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba.

SUPERVISOR: DR. NELLY ADJOA SAKYI-HAGAN

SIGNATURE: ………..............………………

DATE: ……….........……...…………………

DEDICATION

This thesis is especially dedicated to Ewormvor family, Sodoke family and the Akromah family for their support and encouragement throughout this course.

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Am grateful to the Lord Almighty for his protection throughout this course without him nothing would have been possible. My heartfelt gratitude also goes to Dr. Nelly Adjoa Sekyi-Hagan my supervisor for her time, dedication, suggestions and corrections that enabled me had a successful write up of this thesis.

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ABSTRACT

The study investigated the effect of structured experiential learning on Form Two students' academic performance in Electronics and their perceptions of this instructional approach at Dodi Papase Senior High School in the Oti Region of Ghana. A quasi-experimental non-equivalent control group pretest–posttest design was employed. Two intact General Arts classes were purposively selected following preliminary screening to minimise large disparities in prior achievement. However, formal pre-intervention testing revealed a statistically significant baseline difference between the groups, indicating non-equivalence consistent with quasi-experimental designs. One class served as the experimental group and received a four-week guided experiential learning intervention involving hands-on circuit construction, measurement of electrical quantities, collaborative problem-solving, and structured reflection. The control group received conventional lecture-based instruction.Pre- and post-intervention achievement tests and a structured perception questionnaire were administered. Data were analysed using descriptive statistics and independent and paired samples t-tests. The findings indicated that although the experimental group began with a lower pretest mean score, it demonstrated substantially greater improvement over the intervention period and significantly outperformed the control group in the posttest. Students exposed to experiential learning reported high levels of perceived engagement, confidence, and support in understanding Electronics concepts.The study concludes that, within the context of Dodi Papase Senior High School, structured experiential learning was associated with enhanced academic performance in Electronics. The findings provide contextual support for Kolb's Experiential Learning Theory, suggesting that guided cycles of concrete experience, reflection, abstraction, and application may facilitate conceptual restructuring in abstract science topics. It is recommended that, within similar instructional contexts, Integrated Science teachers consider incorporating structured experiential tasks into Electronics lessons, with appropriate institutional support to facilitate hands-on learning. Further research involving multiple schools and extended intervention periods is encouraged to strengthen generalisability.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter introduces the study by presenting the background, statement of the problem, purpose, objectives, research questions, and hypotheses. It further outlines the significance, delimitations, limitations, definition of key terms, and organisation of the study.

1.1 Background to the Study

Science and technology are widely recognised as foundations for socio-economic transformation and national development. Countries that have achieved sustained industrial progress have done so through deliberate investment in science education, research, and innovation, which support the development of a scientifically literate population and a skilled workforce (Tijani & Adeduyigbe, 2025; National Academies of Sciences, Engineering, and Medicine, 2018). In Ghana, the strategic importance of science education is reflected in successive educational reforms aimed at preparing learners capable of contributing to industrialisation, technological advancement, and sustainable development (Ministry of Education, 2010; NaCCA, 2020).

At the Senior High School (SHS) level, Integrated Science is a compulsory core subject designed to develop scientific knowledge, inquiry skills, and problem-solving abilities. It integrates foundational concepts from physics, chemistry, biology, and earth science to provide students with a broad scientific base. The curriculum emphasises inquiry, critical thinking, and practical application (GES, 2012; NaCCA, 2020). Despite these intentions, instructional delivery in many Ghanaian SHSs remains predominantly teacher-centred, relying heavily on lectures, note dictation, and textbook-based instruction (Amedahe & Owusu, 2020). Such practices limit opportunities for active engagement and meaningful conceptual development.

Research indicates that traditional pedagogies restrict student participation and hinder the development of higher-order thinking skills (Aisyah, 2021; Naomi, 2019). In the Ghanaian context, large class sizes, inadequate laboratory facilities, and examination-driven teaching further constrain effective science instruction (Mensah & Nyarko-Sampson, 2020). These conditions often result in superficial learning rather than deep conceptual understanding.

Since the 1987 Education Reform Programme, Ghanaian education policy has consistently promoted learner-centred pedagogy, particularly in science education. The reform marked a shift from content transmission to activity-oriented and inquiry-based instruction aimed at fostering problem-solving and practical competence (Ministry of Education, 1987). Subsequent curriculum revisions have reinforced this orientation, highlighting hands-on investigation, collaboration, and real-world application as essential components of effective science teaching (NaCCA, 2020). However, although policy frameworks advocate learner-centred methodologies, implementation has remained uneven, with many classrooms continuing to reflect teacher-dominated instructional patterns (Amedahe & Owusu, 2020). This persistent gap between policy intention and classroom practice underscores the need for structured, research-informed strategies that can operationalise learner-centred teaching in sustainable ways.

One such strategy is experiential learning. Conceptualised by Kolb (1984), experiential learning describes learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Within this framework, learners construct knowledge through direct engagement with tasks, critical reflection on those experiences, and application of concepts in new situations. Contemporary scholarship affirms the relevance of this model for science education, where structured engagement promotes deeper cognitive processing and retention (Kolb & Kolb, 2017; National Academies of Sciences, Engineering, and Medicine, 2018).

Empirical evidence further supports the effectiveness of experiential learning in improving academic performance, motivation, and the transfer of knowledge (Adnyana et al., 2022). Studies demonstrate that hands-on tasks, real-world problem solving, guided reflection, and collaborative learning strengthen conceptual understanding and critical thinking (Pedaste et al., 2015; Wurdinger & Allison, 2017). These outcomes are particularly significant in science education, where practical engagement is essential for developing experimental competence and analytical reasoning. Despite these documented benefits, experiential learning remains underutilised in many Ghanaian SHSs.

This underutilisation is especially problematic in the teaching of Electronics, a core component of the physics strand of Integrated Science. Electronics involves abstract concepts such as current, voltage, resistance, power, and circuit configurations. Without structured practical engagement, students frequently develop misconceptions and experience difficulty applying theoretical principles such as Ohm's Law (Ampiah & Adu-Yeboah, 2020; Owusu, 2021).

Reports from the West African Examinations Council consistently highlight weaknesses in candidates' performance in science practicals, particularly in areas requiring conceptual reasoning and experimental skills (WAEC, 2021). At Dodi Papase SHS, internal classroom assessments reveal similar patterns, with students encountering difficulty analysing circuits and identifying functions of basic electrical components. These learning challenges affect not only examination outcomes but also students' readiness for further scientific study.

Although some teachers have incorporated demonstrations and elements of inquiry-based instruction, implementation has often been inconsistent and insufficient to yield sustained improvement (Frimpong & Mensah, 2021). This situation calls for a structured and systematically implemented instructional approach capable of strengthening conceptual understanding in Electronics. Experiential learning provides such a framework by integrating hands-on engagement, reflection, and application within a coherent pedagogical cycle.

However, research examining experiential learning specifically in the teaching of Electronics within rural Ghanaian SHSs remains limited. Existing studies tend to address general activity-based science instruction or focus on relatively better-resourced contexts (Agsalog, 2019). There is therefore a need for context-specific empirical evidence that examines how experiential learning operates within resource-constrained school environments.

It is against this backdrop that the present study investigates the effect of experiential learning on students' academic performance in Electronics at Dodi Papase SHS. By focusing on this specific context, the study seeks to provide evidence that may inform instructional practice within similar rural Senior High School settings. While the findings are bounded by the study context, they offer practical insights into how structured learner-centred strategies can be implemented to enhance science teaching and learning.

1.2 Statement of the Problem

The teaching and learning of Electronics within Integrated Science at the Senior High School (SHS) level continue to pose considerable challenges in Ghana, particularly at Dodi Papase Senior High School. Evidence from end-of-semester assessments consistently shows that many students are unable to demonstrate basic proficiency in core Electronics concepts. Classroom observations further reveal that learners struggle to explain current flow, interpret resistance, and analyse simple electrical circuits. Teachers at the school have repeatedly highlighted these difficulties, noting that students often rely on memorisation rather than conceptual understanding.

A major contributor to this problem is the persistent use of teacher-centred instructional methods. Lessons frequently depend on lectures, chalkboard sketches, and note dictation, with minimal opportunities for hands-on engagement (Amedahe & Owusu, 2020; Ampiah & Adu-Yeboah, 2020). Such traditional approaches have been shown to restrict conceptual development and limit students' ability to transfer knowledge beyond classroom assessments (GES, 2019; Naeemullah & Rehman, 2022). As a result, learners often recall definitions but remain unable to apply principles such as Ohm's Law to practical situations. This challenge reflects broader national trends. The WAEC Chief Examiners' Reports repeatedly highlight weaknesses in candidates' science practicals, particularly in areas requiring circuit analysis, interpretation of measurements, and application of theoretical principles (WAEC, 2021). These recurring deficiencies contribute to low achievement in Integrated Science and impede the development of scientific reasoning and problem-solving skills that are essential for tertiary education and the world of work (Amedahe & Owusu, 2020).

Although teachers at Dodi Papase SHS occasionally incorporate demonstrations, group discussions, and aspects of inquiry-based learning, these strategies are often implemented inconsistently and do not form part of a structured pedagogical approach. As a result, they have produced limited improvements in students' understanding of Electronics. Scholars argue that addressing such entrenched difficulties requires more systematic and learner-centred instructional models that shift the classroom from passive reception to active engagement, construction of meaning, and reflection (Owusu-Agyeman & Ametepee, 2021; Mensah & Frimpong, 2021).

Experiential learning offers a promising alternative. Kolb's experiential learning theory emphasises direct engagement, guided reflection, and the application of abstract concepts through concrete tasks (Kolb, 1984). International research shows that experiential approaches enhance students' achievement, motivation, problem-solving abilities, and conceptual retention by enabling them to test ideas, observe outcomes, and revise their thinking (Adnyana et al., 2022; Kasim et al., 2024). Through activities such as assembling circuits, measuring current and voltage, and troubleshooting electrical connections, learners can overcome misconceptions that often persist in lecture-driven classrooms.

Despite these advantages, empirical research on the use of experiential learning in the teaching of Electronics in Ghanaian SHSs remains limited. Existing local studies tend to focus broadly on activity-based science instruction or on better-resourced schools, leaving rural contexts such as Dodi Papase SHS under-represented in the literature. Research also suggests that constraints such as inadequate resources, limited teacher training, and examination pressures make it difficult for rural schools to adopt experiential pedagogies effectively (Agsalog, 2019). This gap underscores the need for context-specific research that evaluates both the impact and practicality of experiential learning in improving student outcomes in Electronics

It is in light of these concerns that the present study sought to investigate the effect of experiential learning on students' academic performance in Electronics at Dodi Papase Senior High School. The study aimed to generate context-specific evidence to inform instructional practice within the school and to contribute to discussions on effective science pedagogy in similar rural and resource-constrained Senior High School settings. While the findings are limited to the study context, they provide practical insights that may guide teachers and school leaders seeking to strengthen the teaching of Electronics through structured learner-centred approaches.

1.3 Purpose of the Study

The purpose of this study was to determine the effect of experiential learning on students' academic performance in Electronics, at Dodi Papase Senior High School.

1.4 Objectives of the Study

The study sought to:

1. assess students' performance in Electronics before the implementation of experiential learning.

2. determine the effect of experiential learning on students' performance in Electronics after the intervention.

3. determine students' perceptions of experiential learning in the study of Electronics.

1.5 Research Questions

1. What is the performance of students in Electronics before the implementation of experiential learning?

2. What is the effect of experiential learning on students' performance in Electronics after the intervention?

3. What are students' perceptions of experiential learning in the study of Electronics?

1.6 Research Hypotheses

H_{01}: There is no statistically significant difference in pretest scores between the experimental and control groups prior to the implementation of experiential learning.

H_{02}: There is no statistically significant difference in mean gain scores between students taught using experiential learning and those taught using conventional methods.

H_{03}: There is no statistically significant difference between the pretest and posttest scores of students taught using experiential learning.

1.7 Significance of the Study

The study seeks to address the persistent underperformance in Electronics at Dodi Papase Senior High School by introducing and evaluating the experiential learning model as an alternative instructional approach. This study is important for several reasons because it responds directly to challenges that affect students, teachers and the broader school community.

For students at Dodi Papase SHS , experiential learning offers a more engaging way of studying Electronics compared to exclusive reliance on lectures and memorisation. By assembling circuits, taking measurements and reflecting on what they observe, students are expected to strengthen their conceptual understanding and improve their performance in areas such as current, resistance and voltage which have consistently been problematic in examinations.

For teachers at Dodi Papase SHS, the study provides practical evidence on how structured, hands on learning activities can be integrated into regular classroom instruction despite limited resources. The findings can guide teachers in the school in shifting from mainly theoretical explanations to more interactive strategies that help address misconceptions and sustain student interest in Electronics.

For school administrators, the outcomes of the study have the potential to inform decisions about investment in simple science resources and staff development. If the experiential approach leads to better learning outcomes, school leaders may be motivated to provide affordable electronic kits and support training in activity based teaching methods.

Although this study focuses on Dodi Papase Senior High School, the findings may be relevant to other rural and under resourced schools in Ghana that face similar challenges in teaching Integrated Science. The study therefore provides a model that can be adapted to improve learning contexts across the Oti Region and beyond.

The study also contributes to academic knowledge by addressing a gap in the literature on experiential learning in the teaching of Electronics in rural Ghanaian schools. By documenting both the implementation process and its outcomes, this work lays a foundation for future research on innovative strategies aimed at improving science education.

1.8 Delimitations of the Study

This study is delimited to the use of the experiential learning approach to improve the performance of students in the topic of Electronics in Integrated Science at Dodi Papase Senior High School. It focuses solely on Form Two (SHS 2) students. The study is restricted to the topic of Electronics in the Integrated Science syllabus. The study examines students' performance in Electronics before and after the intervention, without extending to other science topics or subjects

1.9 Limitations of the Study

Although this study provides valuable insights, it was subject to several limitations that were beyond the researcher's control. Firstly, the study was confined to a single school with a relatively small sample size. This limits the extent to which the results can be generalised to other schools with different student populations or resource conditions.

Secondly, the intervention was carried out over a short period, constrained by the school calendar. This meant that only the immediate impact of the experiential learning approach could be measured, without tracking whether improvements were sustained in the long term.

Thirdly, the study was affected by resource constraints. The lack of fully equipped laboratories and reliance on improvised or limited apparatus may have influenced the extent to which students could engage in practical tasks.

Finally, several learner-related factors such as prior knowledge of science, attendance, home learning support, and personal motivation were not controlled. These factors may have affected the outcomes differently across students, introducing variability that could not be accounted for in the analysis.

Despite these limitations, the study still offers useful evidence on how experiential learning can be applied in a rural SHS setting. The constraints also highlight areas where future research could build on these findings by including larger samples, longer interventions, and a wider range of schools and science topics.

1.10 Organisation of the Study

The study consists of five chapters. Chapter One, which is the introduction, comprises the background to the study, statement of the problem, purpose of the study, significance of the study, research objectives and research questions, delimitation and limitation of the study, and definition of terms.

Chapter Two deals with the literature review. The views of researchers and educationists on experiential learning and its application in science education, particularly in the teaching of Electronics, are discussed.

Chapter Three, which focuses on methodology, presents the research design, population and sampling, research instruments, data collection procedures, and methods of data analysis.

Analysis of the results and discussion are presented in Chapter Four.The last chapter, Chapter Five, provides the summary of findings, conclusions, recommendations, and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviews literature related to the effect of experiential learning on students' academic performance in Integrated Science, with emphasis on the topic of Electronics. It begins with the theoretical framework, focusing on Kolb's Experiential Learning Theory and related perspectives. The concept of experiential learning and its application in science education are then examined, followed by a discussion of Integrated Science in Ghana and the teaching and learning of Electronics. The chapter also reviews relevant empirical studies, highlights the effect of experiential learning on academic performance, and presents the conceptual framework guiding this study.

2.1 Theoretical Framework of the Study

This study is grounded in Kolb's Experiential Learning Theory (ELT) and supported by constructivist and sociocultural perspectives. Together, these theories explain why a structured, hands-on approach is particularly suitable for teaching Electronics in Senior High Schools (SHSs), especially in resource-constrained settings such as Dodi Papase Senior High School.

Experiential learning refers to instructional approaches in which learners develop understanding through structured engagement with tasks, systematic reflection on outcomes, conceptual abstraction, and the application of newly formed ideas in novel situations. Kolb's Experiential Learning Theory (ELT), first articulated in 1984, remains the foundational framework in this field. Kolb conceptualises learning as a cyclical process involving four interrelated stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Learning becomes meaningful when individuals move through the full cycle rather than engaging in isolated activities (Kolb, 1984; Kolb & Kolb, 2017).

Kolb's ELT (1984) conceptualises learning as a cyclical process involving four interrelated stages: concrete experience, reflective observation, abstract conceptualisation and active experimentation. Learning is most effective when learners progress through all four stages, actively engaging with experience, interpreting it, forming conceptual understandings and applying these in new contexts. Later refinements of the model emphasise the importance of learning spaces and individual learning styles, which influence how students interact with different phases of the cycle (Kolb & Kolb, 2005).

In science education, and particularly Electronics, ELT predicts that conceptual mastery improves when learners assemble circuits, make measurements, compare outcomes with predictions and apply established principles such as Ohm's Law. This iterative process helps correct misconceptions by enabling students to test ideas directly. Empirical studies support ELT's relevance to science learning. For example, Fomunyam and Mji (2017) reported that experiential activities improved conceptual understanding in physical sciences, while Trundle and Bell (2010) found that guided inquiry and experiential tasks enhanced accuracy in students' scientific explanations.

However, researchers caution that experiential approaches must be guided. Kirschner, et al. and Clark (2006), through cognitive load theory, showed that unguided discovery can overwhelm novices. Meta-analyses by Freeman et al. (2014) and Furtak et al. (2012) demonstrate that structured, teacher-guided inquiry, characterised by scaffolded investigation, targeted questioning, and ongoing feedback, is more effective than minimally guided discovery, particularly for learners with limited prior knowledge. The intervention in this study therefore incorporates teacher facilitation, reflection prompts and scaffolded tasks consistent with recommended practice.

Constructivism complements ELT by emphasising that learners actively build new knowledge on the basis of prior conceptions. In science, these preconceptions can be deeply rooted and resistant to change. In Electronics, recent studies continue to identify persistent misconceptions, including the belief that electric current is consumed within circuit components or that voltage and current are interchangeable concepts (Baser & Durmus, 2016; Park & Liu, 2019). Constructivist science education encourages instructional approaches that require learners to articulate their existing ideas, confront them with empirical evidence, and reconstruct more scientifically accurate conceptions (Taber, 2017).Guided practical work, prediction-observation-explanation (POE) cycles, and peer dialogue are therefore essential components of the intervention.

Recent work from sub-Saharan Africa reinforces the persistence of these misconceptions, often attributed to limited exposure to laboratory work (Boateng & Amedahe, 2020). This further underscores the need for instructional approaches that enable students to interact physically with circuits and observe real-time outcomes.

Sociocultural theory, grounded in the work of Vygotsky (1978), adds a social dimension to learning by emphasising the roles of language, tools and interaction. The Zone of Proximal Development (ZPD) highlights that learners achieve deeper understanding with guidance from teachers or more capable peers. This perspective is highly relevant in Ghanaian SHSs, where large class sizes and inadequate equipment constrain individual experimentation.

Recent studies in Ghana and similar contexts show that collaborative learning, peer explanation and teacher scaffolding support conceptual development even where material resources are limited (Mantey, 2022; Osei-Poku & Boateng, 2023). In Electronics, tools such as circuit diagrams, multimeters, and virtual simulations function as mediating artefacts that help students bridge the gap between abstract concepts and practical application.

The integration of these perspectives provides a coherent foundation for the present study. ELT offers the structure for experiential engagement, constructivism highlights the need to confront and reorganise prior conceptions, and sociocultural theory emphasises collaboration, scaffolding and the use of mediating tools. Together, they support the adoption of experiential learning as an appropriate and theoretically grounded approach for improving students' performance in Electronics. These insights inform the present study, which implements structured sequences of hands-on activity, guided reflection, conceptual development, and re-application in the teaching of Electronics at the Senior High School level.

2.2 The Concept of Experiential Learning

Recent scholarship on experiential learning emphasises the importance of intentionally designed learning environments that support dialogue, structured questioning, and formative feedback. Effective experiential instruction requires guided movement through stages of experience, reflection, conceptual clarification, and application so that learners do not remain at the level of activity without achieving conceptual integration (Kolb & Kolb, 2017). In science education, this structured progression is particularly important because students may engage in practical tasks without fully connecting observations to underlying scientific principles.

In the context of Electronics, experiential learning may involve students assembling circuits and measuring current and voltage using multimeters. Guided discussion supports reflective analysis as students examine discrepancies between expected and observed outcomes. Conceptual understanding develops when learners relate empirical findings to formal relationships such as Ohm's Law and principles governing series and parallel circuits. Application then occurs as students redesign or modify circuits to test whether these principles hold under new conditions. Through this iterative process, practical manipulation is transformed into conceptual understanding.

A substantial body of recent research supports the effectiveness of active and experiential approaches in science education. Large-scale analyses demonstrate that active learning strategies significantly improve academic performance and reduce failure rates compared with traditional lecture-based instruction (Theobald et al., 2020). Reviews of inquiry-based and experiential designs further indicate that deeper conceptual gains occur when practical activities are accompanied by structured guidance rather than minimally supported discovery (Lazonder & Harmsen, 2016; Minner, Levy, & Century, 2019). These findings reinforce the argument that experience must be deliberately connected to conceptual development.

Contemporary studies also identify the conditions under which experiential learning is most effective. Morris (2020) highlights several essential features of high-quality experiential instruction, including active learner participation, authenticity of tasks, intellectual challenge, focused inquiry, and structured reflection linking experience to theory. Similarly, recent science education research underscores the importance of scaffolding, collaborative dialogue, and formative assessment in enabling students to convert practical engagement into conceptual change (Furtak et al., 2017; Minner et al., 2019). Without such instructional support, practical activity alone may not lead to durable understanding.

This issue is particularly significant in the domain of electricity and Electronics, where students frequently hold persistent misconceptions. Recent research continues to document misunderstandings such as the belief that current is consumed within a circuit or confusion between voltage and current (Park & Liu, 2019; Baser & Durmus, 2016). These misconceptions are resistant to change unless instruction deliberately elicits and challenges learners' prior conceptions. Guided experiential learning offers a mechanism for addressing these difficulties by linking observable circuit behaviour with formal scientific explanations through structured reflection and conceptual discussion.

Critiques of experiential learning focus primarily on the risks associated with insufficient guidance. Evidence suggests that unguided discovery can overwhelm novice learners and allow incorrect ideas to persist (Lazonder & Harmsen, 2016). However, when experiential activities are supported by targeted questioning, modelling, and feedback, learning gains are substantial and conceptually robust (Theobald et al., 2020). The effectiveness of experiential learning therefore depends less on activity itself and more on the quality of instructional design.

In science classrooms, effective experiential instruction often integrates physical experimentation with multiple representations such as diagrams, symbolic equations, and simulations. Research indicates that combining real experiments with visual simulations can enhance conceptual clarity in abstract domains such as electric circuits (Zacharia et al., 2015; Park & Liu, 2019). Such integration helps students visualise invisible processes like current flow while maintaining alignment with empirical measurement.

Overall, contemporary scholarship affirms that carefully guided experiential cycles strengthen conceptual understanding, improve academic achievement, and promote meaningful knowledge transfer.

2.3 Experiential Learning in Science Education

Science education has long been recognised as an area in which experiential approaches are particularly valuable. The discipline deals with phenomena that must be observed, tested, and applied, and therefore lends itself naturally to pedagogies that emphasise doing and reflecting rather than memorisation alone. In many countries, reforms in science curricula have increasingly recommended inquiry-based and activity-centred teaching approaches that align with the principles of experiential learning (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018; National Research Council, 2012). The aim is not only to improve academic performance but also to cultivate scientific habits of mind such as curiosity, problem-solving, and critical reflection.

International research consistently demonstrates that experiential learning strategies in science outperform traditional lecture methods. Freeman et al. (2014), in a meta-analysis covering over 200 studies in STEM education, reported that active learning approaches, including guided inquiry and experiential methods, significantly improved students' examination performance and reduced failure rates. Subsequent studies have strengthened these findings. Theobald et al. (2020), analysing over 90 STEM courses, confirmed that active and experiential methods were particularly effective in reducing achievement gaps for under-represented students, thereby improving both equity and attainment. These findings underscore that experiential learning is not merely an alternative pedagogy but one that has measurable benefits across diverse learning populations.

Design principles have also been clarified by research into science pedagogy. Furtak et al. (2012) argued that learners gain most when inquiry tasks are carefully structured to link evidence with core scientific ideas, rather than leaving students to explore without direction. Minner et al. (2010) reviewed inquiry-based learning in science and concluded that the most effective interventions combined authentic tasks with explicit guidance, targeted feedback, and opportunities for reflection. More recent work by Morris (2020) has highlighted that successful experiential science learning typically incorporates authentic contexts, multiple representations, and explicit reflection, ensuring that raw experiences are transformed into conceptual understanding.

One important feature of experiential learning in science is the use of multiple representations and tools. Studies of electricity and mechanics have shown that combining diagrams, graphs, physical apparatus, and digital simulations allows learners to coordinate abstract and concrete models, leading to more stable conceptions (Perkins et al., 2006; Zacharia & Olympiou, 2011). In resource-rich environments, this often involves high-quality laboratory experiments, digital probes, and virtual simulations. However, in resource-constrained contexts, effective practice has involved the use of improvised materials, low-cost kits, and structured group work to achieve similar conceptual goals (Amoah et al., 2023; Quansah et al., 2019).

Despite strong evidence of effectiveness, challenges remain in implementing experiential learning in science classrooms. One recurrent problem is the lack of infrastructure, particularly in low-income and rural schools, where laboratories are under-equipped or entirely absent. This often limits opportunities for hands-on learning. Large class sizes present additional difficulties, making it hard for teachers to manage group investigations or provide adequate feedback (Asante et al., 2022). Teacher preparedness is another critical factor. Many teachers in sub-Saharan Africa, including Ghana, have been trained primarily in traditional lecture-based approaches and may lack confidence in facilitating inquiry or experiential activities (Ampiah & Adu-Yeboah, 2020). Without sufficient professional development and support, teachers often revert to didactic methods despite being aware of the potential benefits of experiential learning.

Recent Ghanaian studies confirm both the promise and the challenges of applying experiential learning in science. Ampadu and Anane (2020) demonstrated that activity-based instruction improved senior high school students' engagement and achievement in physics, while Danso and Sarpong (2021) found that guided inquiry strategies in electricity lessons led to higher conceptual gains compared with conventional teaching. At the same time, these studies reported difficulties such as insufficient equipment, rigid exam-focused teaching schedules, and large classes that limited opportunities for meaningful experimentation. Osei-Poku and Boateng (2023) highlighted that combining physical practical work with computer-based simulations helped overcome some of these barriers, allowing students to visualise abstract processes despite limited laboratory resources.

Experiential learning has become a central theme in science education research because it links hands-on activity, guided inquiry, and reflective practice in ways that improve conceptual understanding and academic performance. International evidence shows clear gains in achievement and equity when science is taught experientially. However, practical barriers, especially in resource-constrained contexts such as Ghana, continue to limit its consistent implementation. For this reason, it is important to investigate how experiential methods can be effectively adapted to specific science topics and local conditions. The present study responds to this need by applying experiential learning to the teaching of Electronics in a rural Ghanaian SHS, where both the challenges of abstraction and the limitations of resources are especially pronounced.

2.4 Integrated Science Education in Ghana

Integrated Science occupies a central place in Ghana's Senior High School (SHS) curriculum. As a compulsory core subject, it seeks to provide all students, regardless of programme, with a scientific foundation that equips them to understand their environment, make informed decisions, and contribute to national development. Policy documents from the Ghana Education Service and the National Council for Curriculum and Assessment (NaCCA) emphasise that the subject should promote scientific literacy, practical problem-solving, and positive attitudes towards science (GES, 2012; NaCCA, 2020). The curriculum further highlights the importance of inquiry-based methods, laboratory work, and application of scientific knowledge to everyday life. These aspirations are consistent with global calls for science education to develop in learners Twenty-first-Century skills such as critical thinking, collaboration, and creativity (NASEM, 2018; UNESCO, 2020). In practice, however, the teaching of Integrated Science in many Ghanaian SHSs shows a persistent gap between policy intentions and classroom realities. Studies reveal that instruction often remains teacher-centred, with heavy reliance on lectures, rote memorisation, and note dictation (Ampiahet al., 2020). Practical activities, although emphasised in the curriculum, are often implemented infrequently or not at all, particularly in rural and under-resourced schools where laboratory facilities and instructional materials are limited (Amedahe & Owusu, 2020; Osei-Poku & Boateng, 2023). This is largely due to resource constraints, including limited or outdated laboratory facilities, insufficient materials for experiments, and high student-to-teacher ratios (Amoah et al., 2023). Even where facilities exist, inadequate maintenance and lack of consumables hinder effective use. Consequently, many lessons tend to focus narrowly on preparing students for the WASSCE rather than engaging them in sustained scientific inquiry (Mensah & Nyarko-Sampson, 2020). The consequences of this disconnect are evident in students' performance. Reports by the (WAEC, 2021) frequently highlight weaknesses in practical skills and the application of theoretical concepts. Students often demonstrate difficulty in designing experiments, interpreting data, and transferring knowledge to novel contexts. The situation is particularly acute in topics that are abstract and application-heavy, such as Electronics. Without opportunities for hands-on engagement, students struggle to understand basic concepts such as electric current, resistance, voltage, and circuit behaviour. Teachers often rely on chalkboard diagrams or textbook descriptions, which are insufficient for developing the kind of conceptual clarity required for problem solving (Danso & Sarpong, 2021; Owusu-Fordjour, 2021).

Recent Ghanaian studies confirm these challenges. Asante et al. (2022) reported that over 60 percent of SHSs surveyed lacked adequate equipment for practical science lessons, leading teachers to resort to purely theoretical instruction. Amoah et al. (2023) similarly found that while most teachers recognised the importance of practical work, resource limitations and large class sizes prevented them from carrying it out regularly. These structural issues are compounded by pedagogical factors. Many teachers have limited training in experiential and inquiry-based methods and may feel more confident using lectures, which allow them to cover syllabus content quickly in preparation for examinations (Mensah & Frimpong, 2021). As a result, the experiential and inquiry dimensions of the curriculum often remain aspirational rather than realised in practice.

Despite these challenges, there is growing recognition that experiential learning approaches could help close the gap between curriculum aims and classroom realities. Activity-based and inquiry-driven strategies have been shown to improve Ghanaian students' engagement and performance when implemented, even with improvised or low-cost materials (Ampadu & Anane, 2020; Osei-Poku & Boateng, 2023). For Electronics in particular, experiential methods such as circuit construction, measurement with multimeters, and use of simulations can provide students with concrete experiences that anchor abstract concepts. These approaches not only improve test performance but also foster scientific attitudes such as curiosity and persistence.

In summary, Integrated Science in Ghana is intended to produce scientifically literate citizens capable of applying knowledge in practical contexts. Yet implementation has been constrained by resource shortages, examination pressures, and teacher preparedness, resulting in limited opportunities for experiential learning. These recurring instructional and structural constraints, particularly in abstract and application-heavy topics such as Electronics, point to the need for structured learner-centred approaches that translate curriculum intentions into classroom practice. This provides the rationale for the present study, which applied an experiential learning model to the teaching of Electronics at Dodi Papase SHS.

2.5 Teaching and Learning of Electronics

Electronics is widely recognised as one of the most challenging units within the Senior High School (SHS) Integrated Science curriculum (Akoto, 2024; Amoah et al., 2023). It introduces students to fundamental concepts such as electric current, potential difference, resistance, power, and the arrangement of components in series and parallel circuits. These concepts form the basis for understanding many modern technologies and are essential for further studies in physics and engineering. However, both Ghanaian and international research consistently shows that Electronics is a topic in which students encounter serious conceptual and practical difficulties (Asante et al. 2022; WAEC, 2021).

A major difficulty arises from the abstract nature of electrical phenomena. Unlike other branches of science where processes are visible, the flow of current and the interaction of voltage and resistance cannot be directly observed. This invisibility often leads to persistent misconceptions. Recent international studies continue to document common alternative conceptions, including the belief that current is "used up" by components, that batteries supply constant current regardless of resistance, or that current divides equally among circuit elements irrespective of configuration (Gardner et al., 2021; Park & Liu, 2019; Baser & Durmus, 2016). Similar misconceptions have been identified among Ghanaian SHS students. Danso and Sarpong (2021) reported that many students confuse voltage with current and often struggle to apply Ohm's law correctly, while Nyarko (2022) found that weak mathematical foundations further compound students' inability to calculate resistance or current in circuits.

The challenges are not limited to conceptual understanding but extend to practical application. WAEC Chief Examiners' reports repeatedly highlight poor performance in questions requiring circuit analysis, experimental design, or interpretation of results (WAEC, 2021). Many students are unable to set up simple circuits, measure current or voltage with multimeters, or apply theoretical principles to real-life problems. In schools such as Dodi Papase SHS, resource shortages exacerbate these problems. The absence of fully equipped laboratories means that teaching is often confined to chalkboard diagrams and verbal explanations, which cannot substitute for hands-on engagement with real circuits (Amoah et al., 2023; Asante et al., 2022).

Despite these challenges, a growing body of research points to strategies that can improve the teaching and learning of Electronics. Internationally, physics education research shows that conceptual change is more likely when instruction explicitly elicits students' prior thinking, confronts misconceptions with empirical evidence, and incorporates multiple representations such as diagrams, simulations, and symbolic models (Park & Liu, 2019; Treagust & Duit, 2018; Zacharia et al., 2015).The use of prediction–observation–explanation cycles, in which students are asked to predict outcomes, test circuits, and reconcile results with formal principles, has been shown to improve understanding of current and voltage (Kibirige et al., 2016; Zacharia et al., 2015).Measurement-rich tasks that require systematic use of multimeters also help students integrate qualitative and quantitative reasoning, moving beyond rote application of formulas (Perkins et al., 2006).

In the Ghanaian context, researchers have begun adapting these strategies to local conditions. Ampadu and Anane (2020) demonstrated that activity-based instruction using locally improvised materials significantly improved students' understanding of electricity and magnetism concepts. Similarly, Osei-Poku and Boateng (2023) found that combining physical experiments with PhET simulations enabled students to visualise current flow and voltage changes, leading to measurable gains in problem-solving performance. These findings are encouraging, as they suggest that even in resource-limited settings, experiential approaches can be implemented with relatively low-cost tools and technology. Another important strategy involves collaborative learning. Sociocultural perspectives emphasise that group-based tasks, where students share roles such as building circuits, recording data, and explaining results, help distribute limited resources while also promoting peer learning. In large classes typical of rural SHSs, this approach allows for meaningful engagement despite constraints. Research in Ghana confirms that group investigations enhance participation and improve confidence in handling science equipment (Mensah & Frimpong, 2021).

In summary, Electronics remains a difficult topic because of its abstract nature, the persistence of misconceptions, and the shortage of resources in many Ghanaian schools. Students often confuse fundamental concepts and perform poorly in both theoretical and practical tasksHowever, evidence from both international and Ghanaian research suggests that targeted experiential strategies can improve learning outcomes. Studies in Ghana report that structured hands-on activities and systematic measurement tasks enhance students' conceptual understanding of Electronics concepts such as current and resistance (Akoto, 2024). Research conducted in rural science classrooms further indicates that the use of improvised materials and collaborative group work can increase engagement and improve performance, even in resource-constrained settings (Osei-Poku & Boateng, 2023). Additionally, examination reports consistently highlight that students who demonstrate stronger practical competencies and application skills tend to perform better in assessment tasks requiring circuit analysis and interpretation (WAEC, 2021). International research similarly shows that structured prediction–observation–explanation cycles and the use of simulations help students reconcile misconceptions and strengthen conceptual reasoning.

These approaches provide a pathway for bridging the gap between curriculum aspirations and classroom realities, particularly in rural schools such as Dodi Papase SHS where conventional methods have proved insufficient.

2.6 Empirical Studies on Experiential Learning

The empirical evidence on the effectiveness of experiential learning spans a range of contexts, from international studies in developed countries to more recent research conducted in African and Ghanaian settings. This section synthesises the key findings from international studies, followed by a discussion of research from Africa and Ghana, with particular attention to the teaching of Integrated Science and, where available, Electronics. By examining these studies, it can better be understood how experiential learning has been applied in science education and its impact on student performance, motivation, and conceptual understanding.

A substantial body of international research demonstrates that experiential learning improves academic outcomes in science education. Freeman et al. (2014), in a meta-analysis of 225 studies, found that active learning approaches, including experiential strategies, led to significant improvements in student performance and reduced failure rates compared to traditional lecture-based methods. This was true across physics, chemistry, and biology, where conceptual understanding and hands-on engagement are crucial. The study concluded that active learning increases student achievement by about half a letter grade. Building on Freeman's findings, Theobald et al. (2020) examined over 90 STEM courses and found that active learning not only improved student performance but also reduced achievement gaps among under-represented groups, such as low-income students and students of colour. Furtak, et al., (2012) further highlighted that the strongest outcomes occurred when inquiry-based activities were well-guided, with students receiving feedback and instructional support throughout the learning process.

Zacharia and Olympiou (2011) explored the integration of virtual and physical manipulations in physics education. Their findings show that combining digital simulations with physical experiments helped students visualise processes such as current flow and voltage changes, improving their understanding of electrical circuits. This aligns with Kolb's theory that concrete experiences paired with reflective observations lead to stronger conceptualisation of abstract concepts. In resource-limited contexts, simulations can supplement physical experiments, providing opportunities to visualise abstract ideas without expensive equipment.

In African contexts, several studies have explored experiential learning in resource-constrained environments. Okebukola (2020) demonstrated in Nigerian secondary schools that inquiry-based science instruction improved conceptual understanding and achievement, even in overcrowded classrooms. Akinbobola and Afolabi (2019) confirmed these findings, noting that hands-on experiments significantly enhanced students' ability to apply theoretical knowledge to real-world problems. In South Africa, Ndlovu (2021) examined project-based learning (PBL) and found that students engaged in extended real-world tasks showed improved problem-solving abilities and deeper scientific understanding. Kose, et al., (2022) added that technology-enhanced experiential learning in Nigerian schools improved engagement and helped students visualise abstract principles such as current and voltage, demonstrating that digital simulations can substitute for physical labs when resources are scarce.

In Ghana, recent studies have begun to explore experiential learning in Integrated Science and Electronics. Ampadu and Anane (2020) found that activity-based instruction significantly improved SHS students' performance compared to lecture-based methods, with practical tasks helping students apply theoretical knowledge. Owusu-Agyeman and Ametepee (2021) reported that inquiry-based activities in Electricity and Electronics led to higher engagement and improved performance, with students who built and measured circuits showing better understanding of current, resistance, and voltage. Amoah et al., (2023) highlighted that about 60% of rural schools lack functional science labs, limiting opportunities for hands-on teaching. Nevertheless, Osei-Poku and Boateng (2023) demonstrated that combining physical experiments with PhET simulations helped students understand complex circuits, even in resource-limited schools.

The empirical evidence from international, African, and Ghanaian studies consistently supports the effectiveness of experiential learning in science education. Internationally, active learning strategies improve conceptual understanding and performance across STEM subjects (Freeman et al., 2014; Theobald et al., 2020). In African contexts, inquiry-based learning and digital simulations have proven effective alternatives in resource-constrained settings (Akinbobola & Afolabi, 2019; Kose et al., 2022; Okebukola, 2020). Ghanaian studies confirm that experiential methods improve achievement and foster deeper connections between theory and practice (Ampadu & Anane, 2020; Owusu-Agyeman & Ametepee, 2021; Osei-Poku & Boateng, 2023).

However, challenges remain. Lack of infrastructure, insufficient teacher training, and overcrowded classrooms continue to hinder implementation (Amoah et al., 2023; Asante et al., 2022). Despite these obstacles, the reviewed studies provide compelling evidence that experiential learning enhances students' understanding of complex scientific concepts, including Electronics. The present study contributes to this body of research by exploring experiential learning in Electronics at Dodi Papase SHS, where these challenges are especially pronounced.

2.7 Effect of Experiential Learning on Academic Performance

Research examining the relationship between experiential learning and academic performance consistently indicates that structured, activity-oriented instruction enhances students' achievement in science and related disciplines. Rather than treating experiential learning as mere hands-on activity, contemporary scholarship emphasises its value when experience is systematically connected to reflection, conceptual clarification, and re-application. Across STEM contexts, such structured approaches have been associated with measurable gains in test performance, problem-solving ability, and conceptual understanding (Freeman et al., 2014; Theobald et al., 2020).

Large-scale evidence shows that active learning environments yield significantly higher examination scores compared to lecture-dominated instruction. Theobald et al. (2020) further demonstrate that structured engagement strategies can reduce achievement gaps, suggesting that experiential approaches support not only average performance but also broader participation in science learning. These findings reinforce the argument that carefully guided experiential designs can enhance measurable academic outcomes rather than merely increasing classroom engagement.

Within science education specifically, recent studies highlight that activity-based and inquiry-oriented instruction improves students' ability to apply theoretical principles to novel problems. Adnyana et al. (2022) report significant gains in achievement and motivation among secondary school students exposed to experiential science models. Similarly, Susiloningsih et al. (2023) found that structured experiential designs strengthened conceptual retention and improved performance in post-intervention assessments. These outcomes are particularly relevant in domains where abstract reasoning is central, such as electricity and Electronics, where learners must reconcile theoretical laws with observable circuit behaviour.

The relevance of experiential learning to Electronics lies in its capacity to make invisible processes cognitively accessible. Tasks involving circuit construction, systematic measurement, and structured explanation enable students to connect mathematical relationships with physical outcomes. Research on simulation-supported instruction indicates that combining real experiments with digital representations enhances conceptual clarity and supports application in assessment contexts (Osei-Poku & Boateng, 2023). Such approaches are especially valuable in environments where laboratory resources are limited but conceptual demands remain high.

In the Ghanaian context, empirical evidence on experiential learning and academic performance remains emerging but promising. Ampadu and Anane (2020) found that activity-based instruction in Integrated Science led to significant improvements in students' problem-solving performance compared to conventional methods. Osei-Poku and Boateng (2023) further demonstrated that integrating physical experimentation with simulation tools improved students' ability to analyse circuit configurations and apply theoretical relationships. These findings suggest that experiential strategies can enhance measurable performance outcomes even within resource-constrained settings.

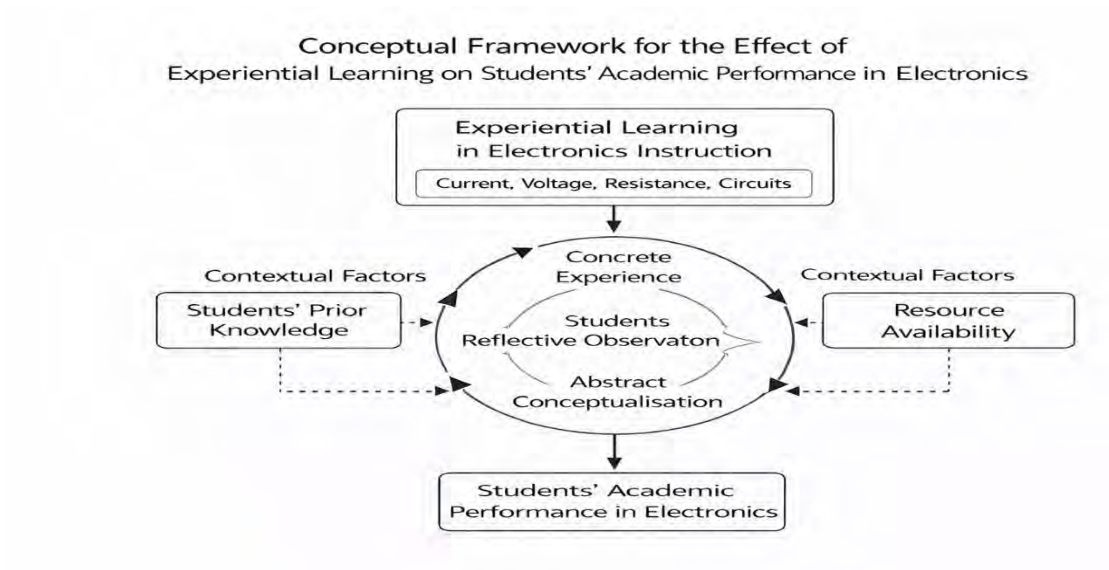
Despite this supportive evidence, important limitations remain in the literature. First, the effectiveness of experiential learning depends heavily on instructional guidance. Studies consistently indicate that unguided or minimally supported discovery does not reliably improve performance and may allow misconceptions to persist. Structured scaffolding, formative feedback, and clearly defined learning objectives are therefore critical mediators of academic gains (Theobald et al., 2020). Second, many empirical studies focus on short-term achievement measures, leaving limited insight into medium- or long-term retention. Third, relatively few investigations isolate Electronics as a distinct content domain within Integrated Science, particularly at the Senior High School level in Ghana.

Electronics presents unique instructional challenges because it requires both mathematical reasoning and conceptual understanding of non-visible processes such as current flow and voltage distribution. While broader science education research supports experiential approaches, targeted evidence examining their impact on academic performance in Electronics within rural Ghanaian SHSs remains limited.

This gap provides the basis for the present study. By examining the short- and medium-term effects of a structured experiential learning intervention on students' academic performance in Electronics at Dodi Papase SHS, the study contributes context-specific evidence to the growing body of research on learner-centred science instruction in resource-constrained environments.

2.8 Conceptual Framework

Fingure 1.



The conceptual framework for this study presents a process-based representation of how experiential learning in Electronics instruction influences students' academic performance in Electronics within a defined instructional context. As illustrated in Figure 1, the framework is organised around a central experiential learning cycle, highlighting learning as an active and iterative process driven by students' engagement with specific Electronics content.

At the top of the diagram, Experiential Learning in Electronics Instruction is positioned as the independent variable. Immediately below this, the content domain is specified as current, voltage, resistance, and circuits, making explicit that the intervention is content-specific rather than a general pedagogical approach. This placement indicates that experiential learning is deliberately applied to core Electronics concepts within the Integrated Science curriculum.

The centre of the framework is a circular structure representing Kolb's experiential learning process. The outer ring of the circle includes key phases such as Concrete Experience and Abstract Conceptualisation, while the inner section highlights students' reflective observation, placing learners at the heart of the learning process. The circular arrows indicate that the stages are interrelated and continuous, demonstrating that students move repeatedly through experiencing, reflecting, conceptualising, and applying knowledge. This cyclical arrangement visually reinforces the theoretical assumption that meaningful learning occurs through structured interaction with tasks, guided reflection, and conceptual refinement rather than through linear transmission of information.

From the experiential cycle, a downward arrow leads to Students' Academic Performance in Electronics, which constitutes the dependent variable. Its position at the base of the framework indicates that academic performance emerges as the outcome of students' participation in the experiential process. In this study, academic performance refers to students' demonstrated ability to understand and apply concepts such as current flow, resistance, and circuit relationships. It is measured using pre-test and post-test assessments that evaluate conceptual understanding, computational accuracy, and problem-solving ability. Improvements in post-test scores relative to pre-test results provide empirical evidence of the instructional effect.

Flanking the experiential cycle on both sides are labelled Contextual Factors. On the left, Students' Prior Knowledge is presented, and on the right, Resource Availability is shown. These are connected to the experiential process through dotted arrows, signifying that they influence the strength and quality of learning rather than acting as primary explanatory variables. Students' prior knowledge affects how new experiences are interpreted and integrated, while resource availability shapes the extent and effectiveness of hands-on engagement with circuit components and measurement tools. Their placement clarifies that they condition the learning environment without altering the central relationship tested in the quasi-experimental design.

Overall, the framework offers a clear visual and conceptual integration of instructional strategy, learner engagement, content specificity, contextual influences, and measurable academic outcomes. It demonstrates that experiential learning operates through a structured cyclical process involving students and Electronics content, ultimately leading to improved academic performance within the given context.

2.9 Summary

This chapter has reviewed the key literature relevant to the study of experiential learning and its potential impact on academic performance in the teaching of Electronics at Dodi Papase Senior High School (SHS). Theoretical frameworks, particularly Kolb's Experiential Learning Theory (ELT), have been explored, highlighting how experiential learning facilitates deeper understanding by engaging students in a cycle of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Complementary perspectives from constructivism and sociocultural theory further support the application of experiential learning in educational settings, emphasising the importance of active involvement, reflection, and social interaction in the learning process.

The review of experiential learning in science education has shown that active and inquiry-based methods significantly improve academic performance, particularly in STEM subjects. Studies from both international and African contexts support the effectiveness of experiential learning, demonstrating that hands-on activities, collaborative tasks, and the use of simulations lead to enhanced conceptual understanding and greater engagement. Furthermore, Ghanaian studies have demonstrated that activity-based learning can overcome some of the persistent challenges faced in schools with limited resources, as long as the learning environment is well structured and guided.

However, despite the positive outcomes, the literature also reveals certain contradictions and limitations. The success of experiential learning is highly dependent on appropriate guidance and teacher scaffolding. Without adequate support, experiential learning can sometimes overwhelm students or leave misconceptions unaddressed. Additionally, while the existing studies provide strong evidence of the benefits of experiential learning, there remains a significant gap in research, particularly regarding the teaching of Electronics in Ghanaian SHSs. Few studies have focused on Electronics specifically, and even fewer have examined the long-term impact of experiential learning on students' academic performance in this subject.

This study sought to address this gap by investigating the effect of experiential learning on the academic performance of students in Electronics at Dodi Papase SHS. By doing so, it aimed to contribute valuable insights into how experiential learning could be effectively integrated into the teaching of Electronics, particularly in resource-constrained schools, and provide evidence for the scalability of such approaches in similar context.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter outlines the research procedure and methods used in the collection of data and data analysis. It covers study design, target population, sample technique, research instruments, data processing and analysis and ethical issues.

3.1 Research Approach

This study followed a quantitative research approach, supported by descriptive and inferential statistics to examine the effect of experiential learning on students' academic performance in Electronics. Quantitative approaches are particularly suitable for studies that seek to measure change, test hypotheses, and compare outcomes between groups using structured instruments such as achievement tests (Creswell & Creswell, 2018). In this study, numerical data were collected through pre-tests, post-tests, and Likert-scale questionnaires, enabling systematic analysis of differences between the experimental and control groups.

The choice of this research approach aligned with the nature of the study, which required objective measurement of learning gains and statistical comparison of outcomes across groups. This approach also allowed the researcher to draw conclusions about the impact of experiential learning with clarity and methodological rigour.

3.2 Research Design

This study adopted a quantitative quasi-experimental research design, specifically the non-equivalent control group pretest–posttest design. A quantitative approach was appropriate because the study sought to measure changes in students' academic performance, test hypotheses, and compare mean differences between two instructional conditions using structured achievement tests. Quantitative designs are particularly suitable for examining intervention effects and determining statistical differences between groups (Creswell & Creswell, 2018; Cohen, Manion, & Morrison, 2018).

The quasi-experimental design was selected because random assignment of individual students to treatment conditions was not feasible within the natural school environment. In most educational settings, students are organised into intact classes, making full experimental randomisation impractical and potentially disruptive. Under such circumstances, quasi-experimental designs provide a rigorous alternative for evaluating instructional interventions while maintaining the integrity of existing classroom structures (Fraenkel, Wallen, & Hyun, 2019). The non-equivalent control group pretest–posttest design enables comparison between an experimental group exposed to an intervention and a control group receiving conventional instruction, while acknowledging that the groups may not be perfectly equivalent at baseline.

The study proceeded through three sequential phases. Both groups were first administered a pretest to establish baseline performance in the Electronics unit. The experimental group then received instruction through experiential learning strategies, while the control group was taught the same content using traditional lecture-based methods. Following the intervention period, a posttest was administered to both groups to measure changes in academic performance.

The pretest served two methodological purposes. It established initial levels of understanding in Electronics and enabled statistical comparison of baseline performance between the groups. Although preliminary screening was conducted to select classes with broadly comparable academic ability, the formal pre-intervention test revealed a statistically significant difference in baseline scores. Such baseline inequality is characteristic of non-equivalent group designs where intact classes are used (Cohen et al., 2018). Rather than assuming equivalence, the study accounted for this difference during analysis through gain score comparison and posttest mean analysis.

The pretest–posttest structure strengthened internal validity by allowing measurement of change over time within each group and comparison of differential improvement between instructional conditions. However, because individual randomisation was not implemented, the design does not support absolute causal claims. Instead, it permits cautious interpretation of the relationship between experiential learning and observed changes in students' academic performance (Fraenkel et al., 2019).

The study was conducted within a single institutional context, Dodi Papase Senior High School. The school functioned as the research setting rather than representing a separate case study design. The methodological orientation remained strictly quantitative and quasi-experimental, focused on testing the effectiveness of an instructional intervention through systematic comparison of measurable outcomes.

3.3 Population

In research methodology, the population refers to the entire group of individuals who share defined characteristics relevant to a study and to whom the findings may reasonably be generalised (Creswell & Creswell, 2018; Cohen, Manion, & Morrison, 2018).

For this study, the population comprised all Form Two (SHS 2) students enrolled at Dodi Papase Senior High School during the 2024/2025 academic year. At the time of the study, the school had a total enrolment of 2,408 students, of whom 811 were in Form Two. This broader population provided the institutional context within which the study was situated.

3.3.1 Target Population

The target population refers to the subgroup within the broader population that possesses the specific characteristics relevant to the research objectives (Fraenkel, Wallen, & Hyun, 2019).

In this study, the target population consisted of all Form Two General Arts students studying Integrated Science, numbering 383. This group was selected because the Electronics unit, which formed the focus of the intervention, is taught to General Arts students at this level during the academic year. Therefore, they represented the category of learners for whom the findings of the study would be most directly applicable.

3.3.2 Accessible Population

The accessible population comprises members of the target population who are practically reachable by the researcher within the limits of time, logistics, and institutional access (Cohen et al., 2018).

For this study, the accessible population included all nine intact Form Two General Arts classes offering Integrated Science during the intervention period. These classes constituted the sampling frame from which the study sample was selected. By distinguishing the accessible population from the sample itself, the study maintained conceptual clarity and methodological precision.

3.4 Sample and Sampling Procedure

The study employed a purposive sampling strategy to select intact Form Two General Arts classes offering Integrated Science at Dodi Papase Senior High School. Purposive sampling was appropriate because the intervention focused specifically on the Electronics unit within Integrated Science, and only students studying this unit during the intervention period were eligible for inclusion.

To minimise substantial pre-existing academic disparities between classes, a preliminary screening test in Electronics was administered across the accessible Form Two General Arts classes. This screening instrument was distinct from the formal pre-intervention test used in the quasi-experimental design. Its purpose was to identify two classes with broadly comparable levels of prior knowledge in key Electronics concepts such as current, voltage, resistance, and Ohm's Law. The screening results were analysed to ensure that extreme differences in performance were reduced at the selection stage.

Following this process, two intact classes were selected from the accessible population. Assignment of instructional condition was conducted at the class level. One class was designated as the experimental group and received instruction through structured experiential learning strategies, while the other class served as the control group and received conventional lecture-based instruction. The assignment was implemented at the intact class level to preserve the natural classroom structure and avoid disruption of the school timetable.

The final sample consisted of 82 students: 42 students in the experimental group (General Arts 2) and 40 students in the control group (General Arts 1).

Both groups were taught by the same Integrated Science teacher to control for instructor-related variation. In addition, both groups received equal instructional time and covered the same curriculum content. The instructional method therefore constituted the primary systematic difference between the two groups.

Although the preliminary screening test was used to select classes with broadly comparable academic performance, the formal pretest administered at the beginning of the intervention revealed a statistically significant difference in baseline mean scores between the two groups. This indicates that full equivalence was not achieved.

Baseline inequality is characteristic of non-equivalent control group designs in which intact classes, rather than randomly assigned individuals, are used. The presence of such differences does not invalidate the design; however, it requires cautious interpretation of findings. To address this analytically, the study employed pretest–posttest comparisons and gain score analysis to assess changes in performance over time within and between groups.

By explicitly acknowledging and statistically accounting for baseline differences, the study strengthened internal validity while recognising the inherent limitations associated with quasi-experimental research conducted in natural educational settings.

3.5 Research Instruments

To collect data for this study, two primary instruments were employed: a researcher-developed achievement test and a structured student perception questionnaire. These instruments were designed to address the research questions and evaluate the effectiveness of the experiential learning approach in improving students' academic performance and perceptions in Electronics.

The achievement test, referred to as the Students' Achievement in Electronics Concepts Test (SAECT), consisted of a pre-test and a post-test. Both tests contained 20 objective items and were parallel in structure and level of difficulty to permit direct comparison of performance over time. The pre-test (Appendix A) was administered prior to the intervention to establish baseline academic performance. It assessed students' understanding of key Electronics concepts drawn from the Integrated Science curriculum, including electrical current, voltage, resistance, Ohm's Law, series and parallel circuits, circuit components, and units of measurement. The instrument comprised two sections: Section A contained six True/False items measuring foundational conceptual knowledge, while Section B consisted of fourteen multiple-choice items assessing application, interpretation, and problem-solving abilities across the specified content areas. Each correct response attracted one mark, yielding a maximum score of 20. The post-test (Appendix B) was structured identically to the pre-test in terms of format, number of items, and content coverage in order to ensure comparability of scores and accurate measurement of learning gains. A test blueprint was developed to ensure balanced representation of the major content domains and cognitive demands of the Electronics unit.

In addition to the pre-test and post-test, formative assessments were conducted during the intervention to monitor students' progress. These included structured classroom observations, evaluation of students' responses during practical circuit construction tasks, and assessment of their use of appropriate Electronics terminology. The formative assessments informed instructional adjustments but were not included in the final quantitative analysis.

Students' perceptions of the experiential learning intervention were measured using a structured questionnaire titled Satisfaction with Experiential Learning Activities in Electronics (SELAE) (Appendix C). The questionnaire consisted of 15 Likert-scale items designed to measure four constructs associated with experiential learning: engagement (7 items), reflection (4 items), confidence (3 items), and satisfaction (1 item). The instrument began with a brief introduction explaining the purpose of the study, followed by background information items and the perception statements. Responses were recorded on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). Positively worded items were scored directly, while negatively worded items were reverse scored to ensure consistency of interpretation. Higher scores indicated more positive perceptions of the experiential learning activities.

Content validity of the achievement test was established through alignment with the Integrated Science curriculum objectives for the Electronics unit. A test specification table guided item development to ensure adequate coverage of core topics and appropriate cognitive levels. The draft items were reviewed by two experienced Integrated Science teachers and a science education specialist to evaluate clarity, relevance, and representativeness of the content. Necessary revisions were made based on their feedback. For the questionnaire, content and face validity were ensured by aligning items with recognised dimensions of experiential learning and by subjecting the instrument to expert review to confirm that each item accurately reflected its intended construct.

A pilot study was conducted in a comparable Senior High School to determine the reliability of the instruments. A test–retest procedure was employed, and reliability coefficients were computed. The reliability coefficient for the pre-test was 0.89, indicating high internal consistency. The post-test yielded a coefficient of 0.77, while the questionnaire produced a reliability coefficient of 0.80. These values fall within acceptable ranges for educational research, indicating that the instruments were sufficiently reliable for measuring students' academic performance and perceptions.

The complete pre-test and post-test instruments, including scoring rubrics, are presented in Appendices A and B respectively, while the structured questionnaire is presented in Appendix C.

3.5.1 Pilot Testing of Instruments

A pilot study was conducted prior to the main data collection to refine the research instruments and strengthen their validity and reliability. Pilot testing allows researchers to evaluate clarity of items, identify ambiguities, assess timing, and determine the reliability of instruments before they are administered in the main study.

The pilot study was conducted during the first semester of the 2024/2025 academic year at Kadjebi-Asato Senior High School (KASEC). The school was selected because it shares similar characteristics with Dodi Papase Senior High School in terms of academic level, curriculum coverage, and school category. Both institutions are Category C Senior High Schools, making the pilot context comparable to the main study setting.

The pilot sample consisted of 21 Form Two General Arts students enrolled in Integrated Science who had already been exposed to the Electronics unit. The students were not part of the main study sample. The instruments administered during the pilot included the pre-test, post-test, and the perception questionnaire.

The pilot study served three main purposes. First, it enabled the researcher to examine the clarity, readability, and comprehensibility of the test and questionnaire items. Second, it helped determine the average time required to complete each instrument under standard classroom conditions. Third, it provided data for estimating the reliability of the instruments.

Based on feedback from students and item analysis of pilot responses, minor revisions were made to improve clarity and eliminate ambiguous wording. Some items were rephrased to ensure alignment with the cognitive level of Form Two students, and instructions were refined to enhance precision. These adjustments improved the overall quality and usability of the instruments before their administration in the main study.

3.6 Validity of the Instruments

Validity refers to the extent to which an instrument measures what it is intended to measure and supports meaningful interpretation of results. This study established content and face validity for both the achievement test and the questionnaire.

Content validity of the Students' Achievement in Electronics Concepts Test (SAECT) was ensured through systematic alignment with the Form Two Integrated Science syllabus for the Electronics unit. A test specification table was developed to guide item construction and ensure balanced representation of key content areas, including electrical current, voltage, resistance, Ohm's Law, and series and parallel circuits. Items were also designed to reflect varying cognitive levels, including knowledge, understanding, and application.

To strengthen content validity, the draft instruments were reviewed by an expert panel comprising two experienced Integrated Science teachers, the Head of the Science Department at Dodi Papase Senior High School, and the research supervisor, a senior lecturer in Science Education. The reviewers evaluated the instruments for clarity, scientific accuracy, curriculum alignment, cognitive appropriateness, and representativeness of the content domain. Based on their feedback, selected items were revised to improve clarity, eliminate ambiguity, and enhance alignment with instructional objectives.

For the perception questionnaire (SELAE), content and construct validity were established by grounding the items in clearly defined experiential learning constructs: engagement, reflection, confidence, and satisfaction. Each item was deliberately mapped to one of these constructs. The expert panel reviewed the questionnaire to confirm that items accurately reflected their intended constructs and were appropriate for the student population. Face validity was further established during pilot testing by confirming that students understood the wording and response format of the items.

Through curriculum alignment, expert review, and pilot refinement, the instruments were strengthened to ensure that they adequately measured students' academic performance and perceptions related to experiential learning in Electronics.

3.7 Reliability of the Instruments

Reliability refers to the consistency and stability of measurement results when an instrument is applied under similar conditions. Reliability of the instruments was assessed using data from the pilot study conducted at Kadjebi-Asato Senior High School.

Cronbach's alpha coefficients were computed to determine the internal consistency of the pre-test, post-test, and questionnaire. The pre-test yielded a reliability coefficient of 0.89, indicating high internal consistency. The post-test produced a coefficient of 0.77, which falls within acceptable reliability standards for educational research. The perception questionnaire achieved a Cronbach's alpha of 0.80, demonstrating satisfactory internal consistency across its 15 items.

These coefficients indicate that the instruments were sufficiently reliable for measuring students' academic performance and perceptions in the main study. The reliability analysis, combined with pilot revisions and expert validation, enhanced the dependability of the data collected during the quasi-experimental intervention.

3.8 Data Collection Procedure

Data collection for this study was conducted in a structured and standardised manner to ensure consistency, fairness, and internal validity. The procedure was organised into three distinct stages: preliminary screening and baseline measurement, implementation of the instructional intervention, and post-intervention data collection. The instructional intervention and outcome assessment were treated as separate processes to avoid conflating teaching activities with measurement procedures.

The instructional intervention was implemented over a period of four consecutive weeks. During this period, both the experimental and control groups received three Integrated Science lessons per week, each lasting 60 minutes, in accordance with the school timetable. This resulted in a total of twelve instructional sessions for each group. The duration, frequency, and content coverage were kept identical across groups, with the only systematic difference being the instructional approach employed. This ensured that any observed differences in learning outcomes could not be attributed to variations in instructional time or content exposure.

The first stage involved preliminary screening and baseline assessment. A screening test in Electronics was administered to all accessible Form Two General Arts classes to identify two intact classes with broadly comparable academic performance. This screening instrument was separate from the formal pretest used in the quasi-experimental design. Its purpose was to minimise large disparities between classes prior to selection; it did not guarantee statistical equivalence. Following the screening process, two intact classes were selected for participation in the study. One class was designated as the experimental group (General Arts 2), and the other as the control group (General Arts 1).

After group selection, the formal pretest (Appendix A) was administered to both groups under identical conditions to establish baseline performance in Electronics. The pretest was conducted during regular school hours in the students' usual classrooms to maintain normal examination conditions. Both groups were supervised by the researcher and the subject teacher to ensure uniformity in instructions and monitoring. Students were not allowed to consult textbooks, notes, or peers during the assessment. The time allocated for the pretest was clearly communicated, and identical instructions were read to both groups to ensure procedural consistency. Completed scripts were collected immediately after the allotted time.

The second stage involved implementation of the instructional intervention over a four-week period. During this period, the experimental group received instruction through structured experiential learning activities grounded in Kolb's experiential learning cycle, while the control group was taught the same content using conventional lecture-based methods. Both groups were taught by the same Integrated Science teacher to control for teacher-related variation. Instructional time, syllabus coverage, and assessment exposure were kept equivalent across groups, with the only systematic difference being the instructional approach. To minimise contamination, the classes were taught separately according to the school timetable, and students were instructed not to share instructional materials across groups during the intervention period.

The final stage involved post-intervention data collection. Immediately after completion of the four-week instructional period, the posttest (Appendix B) was administered to both groups under the same standardised conditions as the pretest. The posttest mirrored the pretest in structure, format, difficulty level, and time allocation. Administration procedures were identical to those used during the pretest to ensure comparability of results. Scripts were coded using identification numbers rather than student names to reduce potential marking bias. All responses were scored using a predetermined marking scheme to ensure consistency.

Following the posttest, the perception questionnaire (Appendix C) was administered to the experimental group to capture students' views regarding the experiential learning activities. Students were informed that participation was voluntary and that their responses would remain confidential. Questionnaires were completed anonymously, and students were instructed to respond independently without discussion. Completed questionnaires were collected immediately to maintain response integrity.

All quantitative data from the pretest, posttest, and questionnaire were entered into a statistical software package for analysis. Data entry was cross-checked to minimise transcription errors. Pretest and posttest scores were analysed to determine changes within and between groups, while questionnaire responses were analysed using descriptive statistics to summarise students' perceptions.

By separating instructional delivery from outcome measurement, standardising administration procedures, and maintaining consistent testing conditions across groups, the study strengthened internal validity and enhanced the reliability and credibility of the data collected.

3.9 Data Analysis Procedure

Data obtained from the pretest, posttest, and perception questionnaire were coded and analysed using the Statistical Package for the Social Sciences (SPSS), version 26. Both descriptive and inferential statistical techniques were employed to examine baseline performance, determine the effect of the intervention, and analyse students' perceptions of the experiential learning approach.

Pretest and posttest scores were first screened for completeness and accuracy before entry into SPSS. Descriptive statistics, including mean, standard deviation, minimum, and maximum scores, were computed for both the experimental and control groups. These statistics provided an overview of students' performance and variability at baseline and after the intervention.

To examine baseline comparability, an independent samples t-test was conducted on pretest scores of the experimental and control groups. This analysis was not treated as a primary test of the intervention hypothesis but was used to establish whether the groups differed significantly prior to the instructional treatment. Where baseline differences were observed, this was explicitly acknowledged and considered during subsequent interpretation of results.

To determine the effect of the experiential learning intervention, a paired samples t-test was conducted within the experimental group to assess whether the difference between pretest and posttest scores was statistically significant. A similar paired samples t-test was conducted for the control group to determine whether any improvement occurred under traditional lecture-based instruction.

Because the groups were not randomly assigned and baseline inequality was observed, gain score analysis was employed to strengthen internal validity. Gain scores were computed for each student by subtracting the pretest score from the posttest score (Gain = Posttest − Pretest). An independent samples t-test was then conducted on the mean gain scores of the experimental and control groups to determine whether the magnitude of improvement differed significantly between instructional conditions. This approach provided a more appropriate estimate of the intervention effect than relying solely on posttest comparison.

In addition to statistical significance testing, effect sizes were calculated using Cohen's d to determine the magnitude of observed differences. Effect sizes were computed for both within-group improvements (paired comparisons) and between-group differences (independent comparisons). Reporting effect sizes allowed interpretation of the practical significance of findings beyond p-values.

The level of statistical significance for all inferential analyses was set at $p < .05$. Prior to conducting parametric tests, assumptions of normality and homogeneity of variance were examined using appropriate diagnostic procedures, including inspection of distribution patterns and Levene's test for equality of variances. These checks ensured that the assumptions underlying the t-test were reasonably satisfied.

For the perception questionnaire, responses were coded on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Negatively worded items were reverse scored to maintain consistency in interpretation. Descriptive statistics, including frequency distributions, means, and standard deviations, were computed for each item. Composite mean scores were also calculated for each construct—engagement, reflection, confidence, and satisfaction by averaging the items representing each construct. An overall perception mean score was computed to summarise students' general attitudes toward the experiential learning activities.

The questionnaire analysis focused on descriptive interpretation rather than hypothesis testing, as its purpose was to explore students' perceptions rather than test causal relationships. Reliability of the questionnaire had been established during pilot testing using Cronbach's alpha, ensuring internal consistency prior to aggregation of construct scores.

By combining baseline comparison, within-group analysis, gain score comparison, effect size estimation, and structured questionnaire analysis, the data analysis procedure ensured methodological coherence, addressed potential baseline inequality, and provided a comprehensive evaluation of both cognitive outcomes and student perceptions.

3.10 Ethical Considerations

This study followed accepted ethical principles to ensure the protection of the rights, dignity and well-being of all participants involved in the research. Ethical guidelines informed the planning, data collection, analysis and reporting stages to maintain integrity and responsibility throughout the study.

Before data collection began, ethical clearance and a formal introductory letter were obtained from the Department of Integrated Science Education at the University of Education, Winneba. These documents were presented to the school administration of Dodi Papase Senior High School to secure institutional approval and permission to engage teachers and students in the research activities.

Informed consent was obtained from all participating students and teachers involved in the experiential learning intervention. The aims of the study, expected activities and the use of pre and post- performance assessments were explained clearly. Participants were assured that their involvement was voluntary, that they had the right to opt out at any point and that their decision to withdraw would not result in penalties or unfavourable treatment. Consent was documented before participation in the intervention, assessments or reflection activities.

Confidentiality and anonymity were upheld throughout the study. Personal identifiers such as student names or class identifiers were excluded from the data. Codes were used to represent participants in assessment records and reflection documents to protect their identities. All digital files were stored securely with password protection and restricted access, while printed materials were kept in a locked cabinet managed by the researcher.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results of the study and discusses their implications in relation to the research objectives. The study aimed to investigate the effect of experiential learning strategies on the academic performance of Form Two Integrated Science students in the topic of Electronics. Data collected through pre-tests, post-tests, and student perception questionnaires are presented and analysed. Descriptive and inferential statistics, including means, standard deviations, frequencies, and t-tests, are employed to summarise performance and perceptions. The discussion interprets these findings in relation to the research questions, Kolb's Experiential Learning Theory (1984), and existing literature on science education.

Research Question 1: What is the performance of students in Electronics before the implementation of experiential learning?

Table 1 Pretest Scores of Experimental and Control Groups

Group	N	Mean	Standard Deviation	Minimum	Maximum
Experimental	42	6.86	2.19	3	11
Control	40	8.13	2.43	4	13

Source: Fieldwork, 2025

The descriptive results show that before the implementation of experiential learning, the control group obtained a higher mean score (M = 8.13, SD = 2.43) than the experimental group (M = 6.86, SD = 2.19). This suggests that the two intact classes differed in their initial level of understanding of Electronics concepts such as current, voltage, resistance, and circuit construction.

To determine whether this observed difference was statistically significant, an independent samples t-test was conducted. The results are presented in Table 2.

Table 2 Independent Samples *t*-Test for Pretest Scores

Comparison	*t*	*df*	Sig. (2-tailed)
Experimental vs Control	-2.45	80	0.017*

Note: p < .05; Source: Fieldwork, 2025

The independent samples t-test revealed a statistically significant difference in pretest scores between the two groups, t(80) = -2.45, p = .017. Consequently, the null hypothesis (H_{01}), which stated that there is no statistically significant difference in pretest scores between the experimental and control groups prior to the intervention, was rejected.

This finding indicates that the groups were not fully equivalent at baseline, with the control group demonstrating stronger initial academic performance in Electronics.

Research Question 2: What is the effect of experiential learning on students' performance in Electronics?

This research question examined whether the experiential learning intervention was associated with significant improvement in students' academic performance in Electronics compared to conventional lecture-based instruction. The analysis proceeded in two stages: first, within-group improvement was examined; second, between-group differences were analysed.

Table 3 presents the descriptive statistics for the experimental group before and after the intervention.

Table 3: Descriptive Statistics for Experimental Group Pretest and Posttest Scores

Test Type	N	Mean	Standard Deviation
Pretest	42	6.86	2.19
Posttest	42	16.81	1.13

Source: Fieldwork, 2025

The results show a substantial increase in the mean score of the experimental group from 6.86 at pretest to 16.81 at posttest, representing a mean gain of 9.95 points. In addition to the increase in central tendency, the reduction in standard deviation from 2.19 to 1.13 suggests that post-intervention scores were more clustered around the mean, indicating greater consistency in performance after the intervention.

To determine whether this observed improvement was statistically significant, a paired samples t-test was conducted. The results are presented in Table 4.

Table 4: Paired Samples t-Test Comparing Pretest and Posttest Scores for the Experimental Group

Mean Difference	SD Difference	t	df	p
9.95	2.64	29.68	41	< .001

Source: Fieldwork, 2025

The paired samples t-test revealed a statistically significant difference between pretest and posttest scores for the experimental group, $t(41) = 29.68$, $p < .001$. The null hypothesis stating that there is no significant difference between pretest and posttest scores for students exposed to experiential learning was therefore rejected. This finding indicates that students in the experimental group demonstrated significant improvement over the intervention period.

To determine whether the improvement observed in the experimental group differed from that of the control group, posttest scores were compared between groups. Table 5 presents the descriptive statistics and results of the independent samples t-test.

Table 5: Posttest Descriptive Statistics and Independent Samples t-Test Comparing Experimental and Control Groups

Group	N	Mean	Std. Deviation
Experimental	42	16.81	1.13
Control	40	9.90	2.50

Independent samples t-test: $t(80) = 10.28$, $p < .001$

Source: Fieldwork, 2025

Descriptively, the experimental group achieved a considerably higher posttest mean (16.81) than the control group (9.90). The control group showed only a modest increase from its pretest mean of 8.13 to 9.90, representing a mean gain of 1.77 points. In contrast, the experimental group achieved a gain of 9.95 points.

The independent samples t-test indicated that the difference in posttest means between the two groups was statistically significant, $t(80) = 10.28$, $p < .001$. The null hypothesis (H_{02}), which stated that there is no statistically significant difference in performance between students taught using experiential learning and those taught using conventional instruction, was therefore rejected. It is important to interpret these findings in light of the baseline difference identified under Research Question 1, where the control group initially demonstrated higher pretest scores. Despite beginning at a lower baseline, the experimental group not only closed this gap but substantially outperformed the control group at posttest. The magnitude of improvement observed in the experimental group relative to the modest gains in the control group suggests that the experiential learning approach was associated with greater academic progress in Electronics.

The consistent pattern of substantial within-group improvement and significantly higher posttest performance provides strong evidence that the experiential learning intervention was associated with enhanced academic performance.

These findings are consistent with Kolb's Experiential Learning Theory (1984), which posits that learning is strengthened when students engage in concrete experience, reflective observation, abstract conceptualisation, and active experimentation. The structured hands-on activities implemented during the intervention appear to have facilitated deeper conceptual understanding compared to lecture-based instruction. The results also align with contemporary empirical research demonstrating that guided experiential and active learning strategies improve academic performance and conceptual mastery in science education (Adnyana et al., 2022; Kasim et al., 2024).

Research Question 3: What are students' perceptions of experiential learning in the study of Electronics?

To answer this question, data were obtained using the Satisfaction with Experiential Learning Activities in Electronics (SELAE) questionnaire administered to students in the experimental group after the four-week intervention. A total of 23 students completed the questionnaire, representing those present at the time of administration.

Table 6: Distribution of Students' Responses to Likert-Scale Items on Perceptions of Experiential Learning in Electronics (N = 23)

(Response scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree)

Item Statement	**SD n (%)**	**D n (%)**	**N n (%)**	**A n (%)**	**S A n (%)**
1. The lessons in Electronics were engaging and interesting	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	23 (100.0)
2. I had the opportunity to participate actively during the lessons	0 (0.0)	0 (0.0)	0 (0.0)	9 (39.1)	14 (60.9)
3. Practical activities helped me understand the concepts better	0 (0.0)	0 (0.0)	1 (4.4)	10 (43.5)	12 (52.2)
4. Real-life examples made the topic easier to understand	0 (0.0)	0 (0.0)	2 (8.7)	10 (43.5)	11 (47.8)
5. I was encouraged to explore and experiment during the lessons	0 (0.0)	0 (0.0)	2 (8.7)	13 (56.5)	8 (34.8)
6. Group discussions improved my understanding of Electronics	0 (0.0)	0 (0.0)	2 (8.7)	7 (30.4)	14 (60.9)
7. The teacher provided guidance rather than just giving answers	0 (0.0)	0 (0.0)	2 (8.7)	6 (26.1)	15 (65.2)
8. I feel more confident in my understanding after the lessons	0 (0.0)	0 (0.0)	0 (0.0)	12 (52.2)	11 (47.8)
9. Lessons showed the relevance of Electronics in real life	0 (0.0)	0 (0.0)	1 (4.4)	10 (43.5)	12 (52.2)
10. I would prefer more lessons taught using this approach	0 (0.0)	0 (0.0)	0 (0.0)	4 (17.4)	19 (82.6)
11. My academic performance improved through practical learning	0 (0.0)	0 (0.0)	0 (0.0)	9 (39.1)	14 (60.9)
12. I am confident answering Electronics questions in tests and exams	0 (0.0)	0 (0.0)	2 (8.7)	9 (39.1)	12 (52.2)
13. I remember lessons better after activities or demonstrations	0 (0.0)	0 (0.0)	0 (0.0)	15 (65.2)	8 (34.8)
14. Practical learning increased my interest in science careers	0 (0.0)	0 (0.0)	0 (0.0)	8 (34.8)	15 (65.2)
15. Experiential learning made science more enjoyable	0 (0.0)	0 (0.0)	0 (0.0)	12 (52.2)	11 (47.8)
Overall Mean = 4.52, Overall SD = 0.55					

The overall mean perception score was 4.52 (SD = 0.55). Item mean scores ranged from 4.26 to 5.00, indicating consistently high ratings across all items.

To interpret these scores, the study adopted a standard Likert-scale interpretation framework in which mean values between 4.21 and 5.00 are considered “very high,” 3.41–4.20 “high,” 2.61–3.40 “moderate,” 1.81–2.60 “low,” and 1.00–1.80 “very low” (Pallant, 2016; Boone & Boone, 2012). Based on this criterion, the overall mean of 4.52 falls within the very high perception category.

All 15 items recorded mean scores above the neutral midpoint of 3.00. Thirteen items recorded mean values above 4.40, indicating strong agreement, while the lowest mean (Item 5, M = 4.26) remained within the “very high” category. The highest mean was recorded for Item 1 (M = 5.00), indicating unanimous strong agreement that the lessons were engaging and interesting.

When compared to the overall mean of 4.52, six items scored above the overall average, reflecting particularly strong endorsement. These included preference for more lessons using this approach, teacher guidance, increased interest in science careers, and improved participation. The remaining nine items scored slightly below the overall mean but remained within the “very high” range, suggesting consistently positive perceptions across engagement, reflection, confidence, and satisfaction constructs.

This indicates that students’ perceptions of experiential learning were significantly positive rather than neutral.

Engagement-related items (7 items) recorded consistently high means, indicating that students perceived the lessons as interactive and stimulating. Reflection-related items (4 items) suggested that learners valued opportunities to think critically about their experiences. Confidence-related items (3 items) indicated that students felt more capable in handling Electronics concepts after the intervention. The single satisfaction item recorded strong agreement, reinforcing overall approval of the instructional approach.

While the findings indicate overwhelmingly positive perceptions, it is important to acknowledge potential response bias inherent in self-reported measures. The absence of negative responses across several items may reflect social desirability or contextual influences during questionnaire administration. Nevertheless, the consistency of responses across items and the statistically significant difference from the neutral benchmark strengthen confidence in the overall pattern observed.

Taken together, the results indicate that students perceived experiential learning in Electronics as highly engaging, supportive of conceptual understanding, confidence-enhancing, and preferable to conventional instruction. Although perception data do not in themselves establish causal impact on academic performance, they complement the achievement findings by demonstrating that the intervention was well received and positively evaluated by participating students.

4.1 Discussion of Findings

Research Question 1: What is the performance of students in Electronics before the implementation of experiential learning?

The pretest analysis revealed a statistically significant difference between the experimental and control groups, with the control group demonstrating higher baseline performance in Electronics. The experimental group obtained a mean score of 6.86, while the control group recorded a mean of 8.13. This indicates that the two intact classes did not begin the study at equivalent levels of conceptual understanding.

The finding derived from this result is that students within the same academic programme and school context can exhibit uneven prior understanding of core Electronics concepts before formal instructional intervention. Such variability suggests that exposure to foundational ideas such as current, voltage, resistance, and circuit behaviour may differ even among students following the same curriculum and taught within the same institutional environment.

The baseline disparity observed between the two classes reflects variability that is consistent with documented instructional challenges in the teaching of Electronics in Ghana. WAEC Chief Examiners' Reports (2021) consistently highlight students' difficulties in circuit analysis, experimental reasoning, and the application of Ohm's Law. Similarly, Amoah et al. (2023) and Asante et al. (2022) report that resource constraints in many Ghanaian senior high schools often limit practical engagement, resulting in instruction that emphasises theoretical explanation over experiential reinforcement. Such instructional patterns can contribute to uneven conceptual foundations across classes. However, it is important to interpret this cautiously. The pretest difference does not imply systemic weakness specific to one group; rather, it illustrates how variability in prior understanding can exist even within the same school context.

This variability also aligns with findings from physics education research showing that students frequently hold alternative conceptions about electric circuits, including confusion between voltage and current or the belief that current is "used up" within a circuit. Without structured opportunities for practical engagement and guided reflection, such misconceptions may persist and contribute to uneven baseline performance.

From a theoretical perspective, Kolb's Experiential Learning Theory (1984) conceptualises learning as a process in which knowledge is constructed through cycles of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. While the theory does not assume that students with weaker prior knowledge will automatically improve, it suggests that structured experiential engagement provides opportunities for conceptual restructuring. The observed baseline inequality therefore establishes an important analytical context for the study. It reinforces the need to evaluate change over time rather than relying solely on post-intervention scores and provides a meaningful foundation for examining whether experiential learning is associated with differential improvement among students who begin with comparatively weaker conceptual understanding.

Research Question 2: What is the effect of experiential learning on students' performance in Electronics?

The statistical analysis revealed a substantial improvement in the academic performance of students exposed to experiential learning. The experimental group's mean score increased markedly from 6.86 in the pretest to 16.81 in the posttest, whereas the control group showed only a modest increase from 8.13 to 9.90. Paired samples t-test analysis indicated that the improvement within the experimental group was statistically significant, and an independent samples t-test demonstrated that the experimental group significantly outperformed the control group in the posttest. However, beyond statistical significance, the pattern of change across the two groups provides deeper analytical insight.

The principal finding derived from these results is that structured experiential learning was associated with markedly greater improvement in students' conceptual understanding of Electronics compared to conventional lecture-based instruction. Importantly, this improvement occurred despite the experimental group beginning with a lower baseline performance. The direction and magnitude of change suggest that experiential learning may not only enhance achievement but may also help compensate for weaker prior conceptual foundations.

The size of the gain observed in the experimental group indicates more than incremental progress. The sharp increase in mean score reflects meaningful conceptual restructuring rather than surface memorisation of procedures. In contrast, the relatively modest improvement in the control group suggests that traditional instruction supported limited progression, likely reinforcing procedural familiarity without substantially transforming underlying conceptual understanding. The critical analytical point, therefore, is not merely that posttest scores differed, but that the trajectory of learning differed substantially between the two instructional conditions.

The fact that the experimental group began at a lower baseline yet surpassed the control group at posttest strengthens the interpretive weight of the finding. In quasi-experimental research, baseline differences complicate causal inference; however, when a lower-performing group demonstrates significantly greater improvement over time, the instructional approach becomes a plausible explanatory factor. While definitive causal claims cannot be made, the pattern of results provides strong empirical evidence that the experiential learning intervention was associated with differential and substantial academic gains.

This pattern aligns with conceptual change research in science education, which shows that misconceptions in domains such as electricity persist unless learners actively confront them through structured engagement. Experiential tasks involving circuit construction, measurement, troubleshooting, and guided reflection likely enabled students to test prior assumptions against observable evidence. Through this process, incorrect beliefs such as confusion between voltage and current or misconceptions about circuit behaviour could be revised in light of empirical feedback.

Kolb's Experiential Learning Theory provides a coherent theoretical explanation for these outcomes. The intervention was deliberately structured around cycles of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Students engaged directly with circuit components, measured current and voltage, compared observed results with theoretical expectations, reflected on discrepancies, and applied principles to modified circuit configurations. This iterative movement from action to reflection to abstraction represents the mechanism through which experience is transformed into knowledge. The significant gains observed suggest that this structured cycle facilitated deeper internalisation of Electronics concepts than passive, lecture-based instruction.

The findings are consistent with international evidence demonstrating the academic benefits of active learning in STEM disciplines. Freeman et al. (2014) report that active learning increases examination performance and reduces failure rates, while Theobald et al. (2020) show that such approaches can reduce achievement gaps, particularly for students with weaker prior preparation. The pattern observed in this study, in which an initially lower-performing group achieved substantial improvement, resonates with this equity dimension of active learning research. Similarly, studies on guided inquiry emphasise that the strongest gains occur when experiential tasks are accompanied by structured guidance and feedback (Minner, Levy, & Century, 2010; Furtak et al., 2012). The present intervention incorporated teacher prompts, reflection journals, and collaborative discussion, which likely prevented the cognitive overload associated with minimally guided discovery. This is particularly important given longstanding concerns that unguided experiential approaches may overwhelm novice learners (Kirschner, Sweller, & Clark, 2006).

Within the Ghanaian context, the findings reinforce emerging evidence that activity-based instruction improves understanding in abstract science topics. Ampadu and Anane (2020) report improved performance when students engage in hands-on tasks in electricity, while Osei-Poku and Boateng (2023) demonstrate that combining practical experimentation with simulations enhances conceptual clarity. The present study extends this body of evidence by showing similar gains within a resource-constrained senior high school environment, thereby suggesting that well-structured experiential learning is feasible and effective even where laboratory resources are limited.

Taken together, the findings indicate that experiential learning, when carefully structured and guided, is strongly associated with substantial improvement in students' academic performance in Electronics. The results suggest that instructional approaches integrating practical engagement, systematic measurement, guided reflection, and collaborative reasoning may be particularly effective in addressing persistent conceptual difficulties in electricity-related topics. Although the quasi-experimental design does not allow for absolute causal claims, the magnitude and direction of the observed gains provide compelling empirical support for the pedagogical value of experiential learning in this context.

Research Question 3: What are students' perceptions of experiential learning in the study of Electronics?

The questionnaire data indicate that students who experienced the intervention reported consistently positive perceptions of experiential learning in the study of Electronics. All fifteen items recorded mean scores above 4.30 on a five-point Likert scale, with the highest endorsement observed for the statement, “I would prefer more lessons taught using this approach” (M = 4.62, SD = 0.49). Given that the scale midpoint was 3.00 and values above 4.00 are commonly interpreted as indicating high agreement in educational research, the distribution of responses reflects strong and consistent approval of the instructional approach. The relatively low standard deviations across items further suggest that responses were clustered closely around agreement and strong agreement, indicating uniformity of perception among participants.

The principal finding derived from these results is that students perceived experiential learning as cognitively supportive and affectively motivating. Learners reported that practical activities enhanced their understanding of abstract concepts, collaborative work increased participation, and guided engagement strengthened their confidence in answering Electronics questions. Importantly, the data suggest that experiential learning was not merely enjoyable but was experienced as pedagogically meaningful, supporting both conceptual clarity and academic self-confidence.

These perceptions can be interpreted through the lens of experiential learning theory. Kolb’s framework proposes that meaningful learning occurs when learners actively transform experience into knowledge through structured cycles of engagement and reflection. The high endorsement of items relating to participation, experimentation, and reflection suggests that students recognised this cyclical structure within the intervention. Rather than passively receiving information, students were positioned as active constructors of knowledge, a shift that likely enhanced their sense of ownership and competence. Kolb and Kolb’s later emphasis on supportive learning spaces further illuminates this outcome, as collaborative tasks and guided questioning created conditions conducive to reflection and conceptual integration.

From a broader theoretical perspective, constructivist learning theory explains why students may have reported heightened engagement and confidence. Constructivist models posit that learners develop deeper understanding when they actively negotiate meaning through interaction with tasks and peers. The strong agreement with items related to group discussion and guided teacher facilitation suggests that the intervention aligned with sociocultural principles of collaborative knowledge construction. In this sense, the positive perceptions reported are not incidental but theoretically coherent with the pedagogical structure implemented.

The findings also resonate with empirical evidence reviewed in Chapter Two. International studies consistently report that experiential and activity-based learning enhances engagement and motivation in STEM contexts. Rather than merely replicating those findings, the present study extends them to a Ghanaian senior high school setting, demonstrating that similar affective responses can emerge even within resource-constrained environments. Ghanaian curriculum frameworks emphasise inquiry-based instruction and practical problem solving as central aims of Integrated Science education. The uniformly positive student perceptions observed here suggest that experiential learning may help bridge the persistent gap between curriculum aspirations and classroom realities.

The results demonstrate that students who experienced experiential learning viewed it positively, but they do not establish that experiential learning produces superior affective outcomes relative to traditional instruction. Nonetheless, when considered alongside the substantial cognitive gains reported earlier, the convergence of positive academic performance and favourable perceptions strengthens the overall pedagogical argument.

When synthesised across all three research questions, a coherent pattern emerges. Students reported high levels of engagement, confidence, and satisfaction with the experiential approach. Taken together, these findings provide strong evidence that structured and guided experiential learning is pedagogically valuable within the context studied. While the quasi-experimental design does not permit definitive causal claims, the consistency of cognitive and affective outcomes suggests that experiential learning is a theoretically grounded and contextually appropriate strategy for improving the teaching and learning of Electronics in Ghanaian senior high schools.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter provides a summary of the study, key findings, conclusions drawn from the results, and practical recommendations. Additionally, areas for further research are highlighted. The chapter consolidates the implications of the experiential learning intervention on students' academic performance and perceptions in Electronics, a critical topic within the Integrated Science curriculum at Dodi Papase Senior High School.

5.1 Summary of the Study

The finding revealed that students within the same academic programme and school context did not begin at equivalent levels of conceptual understanding in Electronics. The pre-intervention assessment revealed meaningful variability in prior knowledge between the two intact classes. This finding highlights the uneven conceptual foundations that may exist even within the same instructional environment and underscores the importance of measuring baseline performance in quasi-experimental research.

The experiential learning was associated with substantially greater improvement in students' conceptual understanding of Electronics compared to conventional lecture-based instruction. Although both groups showed some level of progress, the experimental group demonstrated markedly stronger gains over the intervention period. Notably, this improvement occurred despite the experimental group beginning with comparatively weaker baseline performance. This pattern suggests that experiential learning may support conceptual restructuring and enable students with limited prior understanding to make significant academic progress.

Students exposed to experiential learning perceived the instructional approach as engaging, supportive, and confidence-building. Participants consistently reported that practical activities enhanced their understanding of abstract concepts, collaborative tasks increased participation, and guided experimentation strengthened their confidence in answering Electronics questions. The convergence of improved performance and positive perceptions indicates that the intervention was not only academically beneficial but also affectively well received.

Taken together, these findings reveal a coherent pattern. Baseline conceptual disparities were present prior to intervention. Following structured experiential instruction, substantial academic gains were observed alongside strong positive learner perceptions. This convergence suggests that experiential learning may simultaneously address cognitive and motivational dimensions of learning in Electronics.

5.2 Conclusions

Based on the findings obtained at Dodi Papase Senior High School, several context-specific conclusions can be drawn.

The study demonstrated that conceptual understanding of Electronics among Form Two General Arts students at DPSHS was uneven prior to instructional intervention, even though the students were within the same academic stream and school environment. This suggests that within DPSHS, students may enter the Electronics unit with differing levels of prior knowledge and varying misconceptions about core concepts such as current, voltage, resistance, and circuit behaviour. The implication for the study area is that instructional planning in Electronics should incorporate diagnostic assessment and targeted support rather than assuming uniform conceptual readiness across classes.

Structured experiential learning appeared to be pedagogically advantageous for teaching abstract and application-intensive topics in Electronics. The substantial improvement observed in the experimental class, particularly given its comparatively weaker baseline performance, indicates that experiential strategies may be especially beneficial in addressing conceptual gaps among students in this school. When practical circuit construction, systematic measurement, guided reflection, and collaborative reasoning were integrated into instruction at DPSHS, students demonstrated markedly stronger conceptual gains than those taught through conventional lecture-based methods. While the quasi-experimental design limits definitive causal claims, the magnitude and direction of improvement provide strong contextual evidence that experiential learning was associated with enhanced academic performance in Electronics within this school.

The findings from Dodi Papase Senior High School indicated that experiential learning functioned not merely as a teaching method but as an instructional environment that integrated cognitive engagement with affective motivation. Students in the experimental class reported that hands-on activities increased their participation, strengthened their confidence in answering Electronics questions, and made the subject more meaningful. Within the study area, the convergence of improved performance and positive learner perceptions suggests that experiential learning may contribute to both academic development and increased learner motivation in Electronics.

Finally, the findings provided contextual support for Kolb’s Experiential Learning Theory within a Ghanaian Senior High School setting. The observed pattern of improvement is consistent with the theoretical proposition that knowledge constructed through structured cycles of experience, reflection, abstraction, and application is more durable and transferable than knowledge acquired primarily through passive reception. In the specific context of DPSHS, the experiential model appears to have facilitated deeper conceptual engagement with Electronics content.

5.3 Recommendations

The recommendations presented here derive directly from the study's findings and conclusions.

Integrated Science teachers at Dodi Papase Senior High School should incorporate structured experiential activities into the teaching of Electronics. Circuit construction, guided experimentation, systematic measurement, and structured reflection should form an integral part of instruction rather than serving as supplementary activities. Given the substantial gains observed among students with weaker baseline understanding, experiential learning may be particularly beneficial in classes where prior conceptual foundations are limited.

Teacher professional development programmes at Dodi Papase Senior High School should emphasise guided experiential methodologies rather than unguided discovery approaches. The effectiveness observed in this study was associated with structured facilitation, reflective prompts, and collaborative tasks. Training initiatives should therefore equip teachers with strategies for scaffolding practical work and facilitating conceptual dialogue.

School administrators at Dodi Papase Senior High School should prioritise resource allocation that supports practical science instruction. Even in resource-constrained environments, improvised materials and low-cost apparatus can support experiential learning. Investment in basic laboratory equipment and maintenance can significantly enhance the feasibility of hands-on instruction in Electronics.

Curriculum implementation at the Senior High School level should align more closely with national policy aspirations that emphasise inquiry-based and activity-oriented learning. The positive student perceptions observed in this study suggest that experiential learning may help bridge the gap between curriculum intentions and classroom practice.

5.4 Suggestions for Further Research

Future studies could extend this research by exploring experiential learning in other science subjects, across different academic levels, and in diverse school settings. Longitudinal studies tracking the sustainability of learning gains and attitudinal changes would provide valuable insights into the enduring impact of experiential learning. Additionally, research could investigate the role of digital tools, such as interactive simulations, in supplementing hands-on activities, particularly in resource-limited environments.

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APPENDIX A

PRE-TEST

PLEASE INDICATE WHETHER THE FOLLOWING STATEMENTS ARE TRUE OR FALSE BY TICKING THE APPROPRIATE BOX. TRUE/FALSE QUESTIONS (6 MARKS)

Statement	True	False
Electric current flows from the negative terminal to the positive terminal of a battery.		
All materials allow electric current to pass through them.		
Ohm's Law is used to calculate power in a circuit		
In a series circuit, the current is the same at all points.		
Insulators are materials that conduct electricity.		
The unit of electric current is the volt.		

Section B: Multiple Choice Questions (14 Marks)

Circle or tick the letter of the correct answer for each question.

7. What is the unit of electric current?

A. Ampere

B. Volt

C. Ohm

D. Watt

8. Which device is used to measure electric current?

A. Voltmeter

B. Ammeter

C. Thermometer

D. Galvanometer

9. What is the function of a resistor in a circuit?

A. Store charge

B. Provide insulation

C. Oppose current flow

D. Measure voltage

10. Which of the following is a conductor?

A. Plastic

B. Rubber

C. Copper

D. Wood

11. Ohm's Law is represented by:

A. V = IR

B. I = VR

C. R = IV

D. V = R/I

12. In a parallel circuit:

A. Current is the same in all branches

B. Voltage is different across branches

C. Voltage is the same across all branches

D. Resistance is the same across branches

13. Which material is an insulator?

A. Aluminum

B. Gold

C. Glass

D. Silver

14. Current is measured in:

A. Volts

B. Amperes

C. Ohms

D. Watts

15. Which of the following is NOT a source of electrical energy?

A. Dry cell

B. Solar panel

C. Generator

D. Light bulb

16. Which symbol represents a resistor?

A. V

B. I

C. R

D. W

17. What type of circuit has only one path for current to flow?

A. Series

B. Parallel

C. Mixed

D. Closed

18. Electric charge is carried by:

A. Protons

B. Neutrons

C. Electrons

D. Atoms

19. Which device is used to protect circuits from overload?

A. Battery

B. Transformer

C. Fuse

D. Capacitor

20. Which of these affects resistance in a wire?

A. Colour

B. Length

C. Brightness

D. Sound

APPENDIX B

STUDENTS' ACHIEVEMENT IN ELECTRONICS CONCEPTS TEST (SAECT)

Section A: True/False Questions (6 Marks)

Write T for True and F for False in the space provided.

1. The flow of electric current is from the positive terminal to the negative terminal. ______

2. A series circuit has multiple paths for current to flow. ______

3.Conductors allow electric current to pass through them easily. ______

4.Resistance decreases with an increase in wire thickness. ______

5.Ohm's Law explains the relationship between current, resistance, and voltage. ______

6.A broken wire in a circuit has no effect on the flow of current. ______

Section B: Multiple Choice Questions (14 Marks)

Circle or tick the letter of the correct answer for each question.

7.What is the SI unit of resistance?

A. Watt

B. Ampere

C. Volt

D. Ohm

8.Which component stores electric charge?

A. Resistor

B. Capacitor

C. Transformer

D. Switch

9.What does a fuse do in an electrical circuit?

A. Increases resistance

B. Regulates voltage

C. Protects appliances from excess current

D. Stores current

10.A voltmeter is used to measure:

A. Resistance

B. Current

C. Voltage

D. Power

11.In a parallel circuit, the voltage across each branch is:

A. Different

B. Zero

C. Equal to the total supply

D. Half the total supply

12.A 12V battery is connected to a resistor of 4 ohms. What is the current?

A. 3A

B. 8A

C. 0.3A

D. 48A

13.Which of the following is NOT part of an electric circuit?

A. Resistor

B. Conductor

C. Circuit breaker

D. Thermometer

14.What causes resistance in a conductor?

A. Increase in voltage

B. Collisions of electrons with atoms

C. Decrease in temperature

D. Smooth surface of wire

15.Which of these is a practical use of series circuits?

A. Home wiring

B. Christmas lights

C. Generators

D. Computers

16.What happens when a resistor is added to a series circuit?

A. Voltage increases

B. Resistance decreases

C. Current decreases

D. Nothing changes

17.Which of the following best describes Ohm's Law?

A. $V = I + R$

B. $V = I \times R$

C. $V = R/I$

D. $V = I/R$

18.The amount of current in a circuit depends on:

A. Size of the battery only

B. Resistance only

C. Voltage and resistance

D. Voltage only

19.What happens to total current in a parallel circuit when more branches are added?

A. It decreases

B. It remains the same

C. It increases

D. It becomes zero

20.Which component is essential for converting electrical energy into light?

A. Motor

B. Battery

C. Bulb

D. Resistor

APPENDIX C

STUDENT QUESTIONNAIRE ON EXPERIENTIAL LEARNING IN ELECTRONICS

Dear Student,

This questionnaire is designed to gather information about your experiences and perceptions regarding the teaching and learning of Electronics in Integrated Science. Please respond honestly. Your responses will remain confidential and will be used for academic purposes only.

Section A: Background Information

Please tick (✓) the most appropriate response.

1. Gender: ☐ Male ☐ Female

2. Age: ☐ 13–14 ☐ 15–16 ☐ 17–18 ☐ 19+

3. Class: ☐ Form One ☐ Form Two ☐ Form Three

Section B: Perceptions of Experiential Learning

Please indicate your level of agreement with the following statements by ticking the appropriate box: Statement Strongly Agree (SA) Agree (A) Neutral (N) Disagree (D) Strongly Disagree (SD)

Statement	SA	A	N	D	S
The lessons in Electronics were engaging and interesting.					
I had the opportunity to participate actively during the lessons.					
Practical activities helped me understand the concepts better.					
The use of real-life examples made the topic easier to understand.					

I was encouraged to explore and experiment during the lessons.					
Group discussions helped improve my understanding of Electronics.					
The teacher provided guidance rather than just giving answers.					
I feel more confident in my understanding of Electronics after the lessons.					
The lessons helped me see the relevance of Electronics in real life.					
I would prefer more lessons to be taught using this approach.					
I have improved my academic performance in Electronics through practical learning.					
I am confident in answering questions related to Electronics in tests and exams.					
I remember the lessons better after participating in activities or demonstrations.					
Practical learning has made me more interested in science-related careers.					
Experiential learning has made learning Integrated Science more enjoyable.					

Appendix A – Marking Scheme

Section A: True/False Questions (6 Marks)

Each correct response = **1 mark**

1. Electric current flows from the negative terminal to the positive terminal of a battery. → **True**
2. All materials allow electric current to pass through them. → **False**
3. Ohm's Law is used to calculate power in a circuit. → **False**
4. In a series circuit, the current is the same at all points. → **True**
5. Insulators are materials that conduct electricity. → **False**
6. The unit of electric current is the volt. → **False**

Total = 6 marks

Section B: Multiple Choice Questions (14 Marks)

Each correct response = **1 mark**

7. Unit of electric current → **A. Ampere**
8. Device to measure current → **B. Ammeter**
9. Function of resistor → **C. Oppose current flow**
10. Conductor → **C. Copper**
11. Ohm's Law → **A. V = IR**
12. In a parallel circuit → **C. Voltage is the same across all branches**
13. Insulator → **C. Glass**

14. Current is measured in → **B. Amperes**

15. NOT a source of electrical energy → **D. Light bulb**

16. Symbol for resistor → **C. R**

17. Circuit with one path → **A. Series**

18. Electric charge carrier → **C. Electrons**

19. Protect circuits from overload → **C. Fuse**

20. Factor affecting resistance → **B. Length**

Total = 14 marks

Appendix B – Marking Scheme

Students' Achievement in Electronics Concepts Test (SAECT)

Section A: True/False Questions (6 Marks)

Each correct response = **1 mark**

1. The flow of electric current is from the positive terminal to the negative terminal. → **True**
2. A series circuit has multiple paths for current to flow. → **False**
3. Conductors allow electric current to pass through them easily. → **True**
4. Resistance decreases with an increase in wire thickness. → **True**
5. Ohm's Law explains the relationship between current, resistance, and voltage. → **True**
6. A broken wire in a circuit has no effect on the flow of current. → **False**

Subtotal = 6 marks

Section B: Multiple Choice Questions (14 Marks)

Each correct response = **1 mark**

7. SI unit of resistance → **D. Ohm**
8. Component that stores electric charge → **B. Capacitor**
9. Function of fuse → **C. Protects appliances from excess current**
10. Voltmeter measures → **C. Voltage**
11. In a parallel circuit, voltage across each branch → **C. Equal to the total supply**

12. Current with 12V battery and 4Ω resistor (I = V/R = 12/4 = 3A) → **A. 3A**

13. NOT part of an electric circuit → **D. Thermometer**

14. Cause of resistance in a conductor → **B. Collisions of electrons with atoms**

15. Practical use of series circuits → **B. Christmas lights**

16. Adding a resistor to a series circuit → **C. Current decreases**

17. Ohm's Law → **B. V = I × R**

18. Current depends on → **C. Voltage and resistance**

19. Total current in parallel circuit when more branches are added → **C. It increases**

20. Component converting electrical energy into light → **C. Bulb**

Subtotal = 14 marks