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EFFECT OF GUIDED PRACTICAL ACTIVITIES ON LEARNERS'PROCESS SKILLS ACQUISITION AND ACADEMIC PERFORMANCE IN SELECTED TOPICS IN ELECTRICITY

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DECLARATION

Student's Declaration

I, EBENEZER MAWULORM KUATSIKOR, hereby declare that, this thesis with the exception of quotations and references contained in published work which have all been identified and duly acknowledged, is entirely my own original work, and that no part of it has been submitted for another degree in this university or elsewhere.

Signature………………………………….

Date……………………………………….

Supervisor's Declaration

I, hereby declare that, the preparation and presentation was supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba.

Supervisor's Name: DR. MICHAEL GYAN

Signature………………………………….

Date……………………………………….

DEDICATION

This thesis is dedicated to my wife, Mrs. Patience Kuatsikor, my daughter, Edna Elorm Kuatsikor and my son, Ed Enam Kuatsikor for their unflinching support.

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God bless you.

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ABSTRACT

This study examined the impact of guided practical activities on the development of science process skills, conceptual understanding, attitudes, and academic achievement in selected electricity topics among Form Two science students at Winneba Senior High School in the Effutu Municipality of Ghana. The research adopted an action research design and involved a purposively selected sample of fifty (50) physics students. Data were gathered through pre- and post-intervention achievement tests, observation checklists, and structured Likert-scale questionnaires. Results from the pre-intervention phase indicated that students demonstrated low to moderate academic performance and limited proficiency in key science process skills, including experimental setup, precise measurement, graph construction, data analysis, and interpretation of findings. To address these deficiencies, guided practical activities were implemented over a six-week period, during which students participated in systematically structured, hands-on laboratory exercises under teacher supervision. Post-intervention findings revealed marked improvement in academic performance, with the mean post-test score increasing to 6.90, reflecting a 68.31% gain relative to the pre-intervention results. Substantial enhancements were also observed in science process skills, including apparatus setup (96%), accurate measurement (98%), graph plotting (94%), appropriate scale selection (90%), and interpretation of results (96%). Additionally, students reported more positive attitudes toward physics, evidenced by increased motivation (M = 4.54), improved confidence in undertaking assessments (M = 2.98), greater classroom engagement, and stronger recognition of the subject's educational relevance (M = 4.38). Learners further demonstrated improved conceptual understanding and an enhanced capacity to apply electricity-related concepts to practical, real-world contexts. The study concludes that guided practical activities constitute an effective pedagogical strategy for enhancing students' academic achievement, inquiry competencies, and attitudes toward physics. It is therefore recommended that such activities be systematically incorporated into physics instruction, supported by well-equipped laboratory facilities and sustained professional development initiatives for teachers.
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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter provides the background to the study, outlining the central themes underpinning the research. It further presents the statement of the research problem, the purpose of the study, the research objectives, and the research questions. In addition, the chapter discusses the significance of the study, as well as its delimitations and limitations. Key operational definitions of terms are also provided, followed by an overview of the organisation of the study.

1.1 Background to the Study

Academic performance constitutes a central indicator of the effectiveness of instructional and learning processes within science education. At the global level, students' achievement in science subjects has received sustained scholarly and policy attention due to recurring evidence of underperformance, particularly in topics that are conceptually complex and cognitively demanding. Notwithstanding ongoing curriculum reforms and the introduction of innovative pedagogical strategies, findings from large-scale international assessments indicate that a substantial proportion of students continue to experience difficulties in developing deep conceptual understanding and transferable scientific skills required for meaningful learning (Organisation for Economic Co-operation and Development, 2022). These persistent challenges have intensified concerns among educators and policymakers regarding the effectiveness of prevailing instructional approaches and their capacity to enhance students' academic outcomes.

In many developing contexts, including sub-Saharan Africa, the problem of low academic performance in science is more pronounced. Studies consistently report that students' achievement levels in science subjects remain unsatisfactory, with teaching practices largely dominated by teacher-centred methods such as lecturing and rote memorisation (Akyeampong et al., 2020; Mensah & Nabie, 2021). Such approaches frequently constrain students' opportunities for active participation, critical inquiry, and the development of problem-solving competencies, all of which are fundamental to academic success in science. As a result, learners often demonstrate unsatisfactory performance in both internal and external assessments, underscoring the imperative for pedagogical strategies that actively engage students in the construction and application of knowledge.

In Ghana, persistent concerns remain regarding students' academic achievement in science at both the basic and secondary school levels. Reports issued in recent years by the West African Examinations Council (WAEC) highlight recurring deficiencies in students' comprehension of scientific concepts, application of knowledge, and interpretation of experimental scenarios. Empirical studies further indicate that students' underperformance is attributable not only to the abstract and cognitively demanding nature of certain scientific concepts but also to instructional approaches that insufficiently promote inquiry-based learning, exploration, and higher-order conceptual reasoning (Ampiah et al., 2019; Boateng et al., 2022). Collectively, these patterns emphasize the urgent necessity of adopting learner-centred pedagogical strategies capable of improving students' academic outcomes in science.

Guided inquiry has emerged as a promising instructional approach for improving students' academic performance in science. Rooted in constructivist learning theory, guided inquiry actively engages learners in posing questions, investigating phenomena, analysing data, and constructing explanations under the structured guidance of the teacher. Unlike open inquiry, guided inquiry provides scaffolding that supports learners' cognitive development while still promoting autonomy and deep understanding. Recent studies indicate that guided inquiry enhances students' conceptual understanding, retention of knowledge, and overall academic performance compared to traditional instructional methods (Lazonder & Harmsen, 2020; Alfieri et al., 2021).

Recent empirical studies in science education provide further evidence that guided inquiry has a significant positive effect on students' academic achievement. For example, Sadeh and Zion (2020) reported that students who received instruction through guided inquiry attained significantly higher test scores compared to those taught using conventional methods. Similarly, a meta-analysis conducted by Furtak et al. (2022) found that inquiry-based approaches, particularly guided inquiry, consistently produce moderate to substantial improvements in students' academic performance across science disciplines. Taken together, these findings suggest that guided inquiry offers an appropriate balance between structured teacher support and learner autonomy, which is essential for improving academic performance.

Despite the documented benefits of guided inquiry, its implementation in many science classrooms remains limited. In Ghanaian schools, instructional practices are still largely examination-driven and teacher-dominated, with minimal emphasis on inquiry-oriented learning experiences (Mensah et al., 2023). Consequently, there is a mismatch between recommended pedagogical practices and classroom realities, which may partly explain the persistent low levels of academic performance in science. Moreover, existing studies on guided inquiry in the Ghanaian context are relatively few and often focus on attitudes or conceptual understanding, with limited emphasis on measurable academic performance outcomes. Given the persistent poor performance trends in science and the growing call for learner-centred pedagogies, there is a compelling need to empirically examine the effect of guided inquiry on students' academic performance. Investigating guided inquiry as an instructional intervention is particularly important in determining its effectiveness in improving students' test scores and overall achievement. This study therefore seeks to address this gap by systematically examining the effect of guided inquiry on students' academic performance, thereby providing empirical evidence to inform instructional practices, curriculum implementation, and policy decisions in science education.

1.2 Statement of the Problem

Physics plays a critical role in fostering scientific literacy, enhancing problem-solving competencies, and promoting technological advancement, thereby establishing it as a core subject within the senior high school science curriculum in Ghana. Notwithstanding its recognized importance, students' academic achievement in physics has remained consistently low, particularly in cognitively demanding areas such as electricity. National examination reports issued by the West African Examinations Council (WAEC) have repeatedly identified candidates' weak performance on electricity-related items, attributing these outcomes to inadequate conceptual understanding, incorrect application of formulas, and difficulties in interpreting circuit diagrams (WAEC, 2019; WAEC, 2021).

Although these national reports provide useful general insights, they do not sufficiently capture the context-specific nature of students' learning difficulties in physics. Research has emphasized that students' performance in science subjects is strongly influenced by school-specific factors such as instructional approaches, availability of learning resources, and learners' prior knowledge (Adu-Gyamfi, Asante, & Nyarko, 2020; Taber, 2020). Consequently, relying solely on national examination statistics without situating the problem within a particular school context limits the depth of understanding of the issue.

At Winneba Senior High School, anecdotal evidence from internal assessment records, classroom interactions, and teachers' reports indicates that science students experience persistent challenges in understanding electricity concepts, including electric current, resistance, voltage, and simple circuit analysis. These challenges often manifest in students' inability to relate theoretical explanations to practical situations, resulting in weak performance in both written tests and practical assessments. Similar findings have been reported in earlier studies, which show that traditional teacher-centred instructional methods commonly used in physics classrooms contribute to rote learning and superficial understanding of abstract concepts such as electricity (Adusei & Boateng, 2021; Ahiakwo & Siaw, 2022).

The problem is particularly pronounced among Form 2 science students, who encounter electricity as a foundational topic that underpins more advanced physics concepts taught at the senior high school level. Studies have shown that misconceptions developed at this stage tend to persist and negatively influence students' performance in subsequent topics if not addressed early (Duit et al., 2019). Focusing on Form 2 students is therefore pedagogically justified, as timely instructional intervention at this level may prevent the entrenchment of misconceptions and enhance students' readiness for final-year physics content.

Despite the documented challenges associated with teaching and learning electricity, there remains a notable gap in empirical, school-based studies that examine the effectiveness of instructional strategies designed to improve both conceptual understanding and science process skills among senior high school students in Ghana. In particular, limited attention has been given to guided and enriched instructional approaches that actively engage learners through inquiry, feedback, and process skill development such as observation, measurement, inference, and communication (Hodson, 2020; OECD, 2019).

Against this backdrop, the present study examines the effect of guided enriched instruction on Form Two science students' conceptual understanding and academic performance in selected electricity topics at Winneba Senior High School. By situating the investigation within a defined school context, the study seeks to generate context-specific empirical evidence capable of informing classroom practice and contributing to the enhancement of physics teaching and learning in Ghanaian senior high schools.

1.3 Purpose of the Study

The present study aimed to examine the impact of guided practical activities on students' attitudes and academic performance in electricity at Winneba Senior High School. By incorporating hands-on experiences into the instructional process, the research seeks to generate empirical evidence regarding the extent to which guided practical activities enhance student engagement and facilitate more effective learning outcomes.

1.4 Objectives of the Study

The objectives of the study were to:

i) identify specific science process skills do students struggle with when learning electricity.

ii) determine students' attitudes towards learning electricity in their physics courses.

iii) evaluate the impact of guided practical activities on students’ conceptual understanding of electricity.

iv) assess the difference in students' test scores and grades in electricity before and after participating in guided practical activities.

1.5 Research Questions

i) What specific science process skills do students struggle with when learning electricity?

ii) What are students' attitudes towards learning electricity in their physics courses?

iii) What is the impact of guided practical activities on students’ conceptual understanding?

iv) What are the difference in students' test scores and grades in electricity before and after participating in guided practical activities?

1.6 Significance of the Study

The outcome of the study would help:

i) Provide valuable insights into the effectiveness of guided practical activity in enhancing students’ attitude and performance in the topic of electricity.

ii) Reshape teaching techniques and practices at Winneba Senior High School and other educational institutions.

iii) Students get better understanding of electricity concepts in Physicst.

iv) Convince stakeholders to retool Physics laboratories with modern Science apparatus.

1.7 Delimitation

Intervention: Guided practical activities is used without rescores to variations which could affect the outcome.

Measurement: Self-reported survey is used to measure students' attitude and tests to measure performance.

Participants: Form two science students are the target population.

Scope: The research focus solely on impact of guided practical activities on learners' process skills acquisition and performance among physics classes.

1.8 Limitation

The study will be conducted within a single school, which may limit the generalizability of the findings to other schools or educational contexts.

Time constraints may limit the duration over which the impact of guided practical activities can be measured, potentially affecting the long-term assessment of their effectiveness.

Potential biases on the part of the researcher may affect genuineness of the outcome of the research.

1.9 Organisation of Study

The study was structured into five chapters. Chapter one provides the introduction, encompassing the background of the study, which presents a contextual overview of the research; the statement of the problem, identifying the specific issue under investigation; the purpose of the study, highlighting its significance; the objectives of the study; and the research questions, which the study seeks to answer. Additionally, this chapter outlines the delimitations and limitations, explains the organization of the study, and provides operational definitions of key terms and abbreviations.

Chapter Two presents a review of relevant literature, drawing from both primary and secondary sources, including previous research studies, academic publications, conference presentations, and pertinent documents such as the syllabus and chief examiner's reports. Key portions of these sources were critically reviewed, and proper citation of authors was ensured.

Chapter Three describes the methodology employed in the study, focusing on the research design, sampling techniques, population, and procedures for data collection and analysis.

Chapter Four is devoted to the presentation and analysis of data, as well as the discussion of the study's findings.

Chapter Five summarizes the main findings, draws conclusions in relation to the results obtained, and compares them with existing literature to confirm or contrast the outcomes. This chapter also provides recommendations aimed at addressing the challenges or gaps identified in the study.

1.10 Operational Definitions of Terms and Abbreviations

Academic performance: The extent to which students have attained their short-term educational goals.

Electricity: It is the flow of electrical charges in a material.

Scientific process skills: They are essential abilities students need to actively engage in science inquiry and critical thinking.

Guided practical activity: It is a structured instructional technique which engages learners in hands-on tasks under the guidance of the facilitator.

Student's attitudes: These are positive or negative opinions that an individual has about science.

ABT- Activity-Based Teaching

ABT-Activity-Based Teaching

CRDD – Curriculum Research and Development Division.

CTL – Cognitive Load Theory

ELT – Experiential Learning Theory

NRC-National Research Council

SHS- Senior High School

WASSCE- West African Senior Secondary Certificate Examination

ZPD – Zone of Proximal Development

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter presents a review of relevant literature related to the study. The review examines the concept of guided practical activities in science, with particular emphasis on physics. It further explores the impact of guided practical activities on student achievement, teacher competency, and learners' attitudes toward physics. Identified gaps in the existing literature underscore the necessity of the present study. The review is organized to provide a comprehensive analysis of the theoretical frameworks, conceptual foundations, and empirical evidence pertaining to guided practical activities.

2.1 Theoretical Review

This section provides an overview of the principal theoretical frameworks underpinning the study. It examines learning theories including constructivist learning theory, experiential learning theory, and cognitive load theory, all of which are pertinent to the guided practical activity teaching approach. Each theory is critically discussed, with particular emphasis on its implications and relevance for science education practice.

2.1.1 Constructivist Theory

Constructivist Learning Theory is a foundational framework in educational psychology, asserting that learners actively construct knowledge through experience and reflection. Its prominence in education stems from its focus on student engagement, knowledge construction, and the integration of real-world experiences (Chen & Lertamornsak, 2023). Influenced significantly by Jean Piaget and Lev

Vygotsky, this theory emphasizes that learners develop understanding through active participation rather than passive reception of information (Dumasari et al., 2024).

Piaget's theory of cognitive development highlights the learner's active role in knowledge construction. According to Piaget, cognitive growth occurs in stages, with learners assimilating new information into existing schemas and accommodating these schemas when encountering conflicting information. This dynamic process of equilibration drives cognitive development and fosters deeper understanding, as learners continually adapt their thinking to integrate new experiences (Zajda, 2021). Piaget's focus on equilibrium underscores the importance of designing learning environments that challenge students and support their cognitive adjustments.

Building on Piaget, Vygotsky introduced the concept of the Zone of Proximal Development (ZPD), which distinguishes between what learners can achieve independently and what they can accomplish with guidance from a more knowledgeable individual (Ilmiah, 2019). This concept emphasizes the critical role of social interaction and scaffolding in cognitive development, suggesting that learning is enhanced through collaboration, cultural tools, and interpersonal communication (Latson, 2022).

In science education, Constructivist Learning Theory informs teaching practices by promoting active engagement and hands-on exploration. Strategies such as experiments, problem-solving activities, and discussions allow learners to construct scientific knowledge actively, fostering critical thinking and inquiry (Chen & Lertamornsak, 2023). This approach contrasts with traditional lecture-based methods, where students passively receive information without meaningful engagement. Moreover, the theory aligns with Jigsaw cooperative learning principles, which encourage students to interact, discuss concepts, and teach peers, thereby enhancing their understanding of complex topics such as electrical energy. Through such collaborative methods, learners navigate their ZPD with support from teachers and peers, achieving higher levels of comprehension and conceptual mastery.

2.1.2 Experiential Learning Theory

Experiential Learning Theory (ELT) is a fundamental framework in educational psychology, proposing that learning is a holistic process in which knowledge is constructed through the transformation of experience. Developed by David A. Kolb, drawing on the works of John Dewey, Kurt Lewin, and Jean Piaget, ELT conceptualizes learning as a cyclical process encompassing four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb et al., 2014). This theory emphasizes the central role of experience in learning, distinguishing it from other approaches, and provides both a comprehensive model of the learning process and a multilinear perspective on human development.

In practice, learners first engage in an experience, then reflect on it from multiple perspectives, leading to the formation of abstract concepts and generalizations. These insights are subsequently tested and applied in new contexts, creating a continuous cycle of learning. Such a process underscores the importance of hands-on activities, experiments, and direct engagement in science education, as these experiences facilitate deeper conceptual understanding and practical application. Evidence from a student perception survey indicates that hands-on activities enhance understanding, stimulate curiosity, and improve receptiveness, all of which are critical to effective learning (Rodríguez-Dueñas et al., 2022).

ELT is particularly valuable in science education, where active participation and experiential engagement are essential. By involving students in experiments, observations, simulations, and other direct experiences, ELT promotes deeper comprehension and retention of scientific concepts. The theory's focus on reflection and conceptualization encourages critical thinking, problem-solving, and the ability to apply knowledge to novel situations (Sinaga et al., 2017). Moreover, ELT aligns closely with the Jigsaw cooperative learning approach, as both methods emphasize collaborative, hands-on learning. Through group experiments, demonstrations, and interactive simulations, students connect concrete experiences with theoretical knowledge, fostering enhanced understanding and more meaningful engagement with scientific concepts.

2.1.3 Cognitive Load Theory

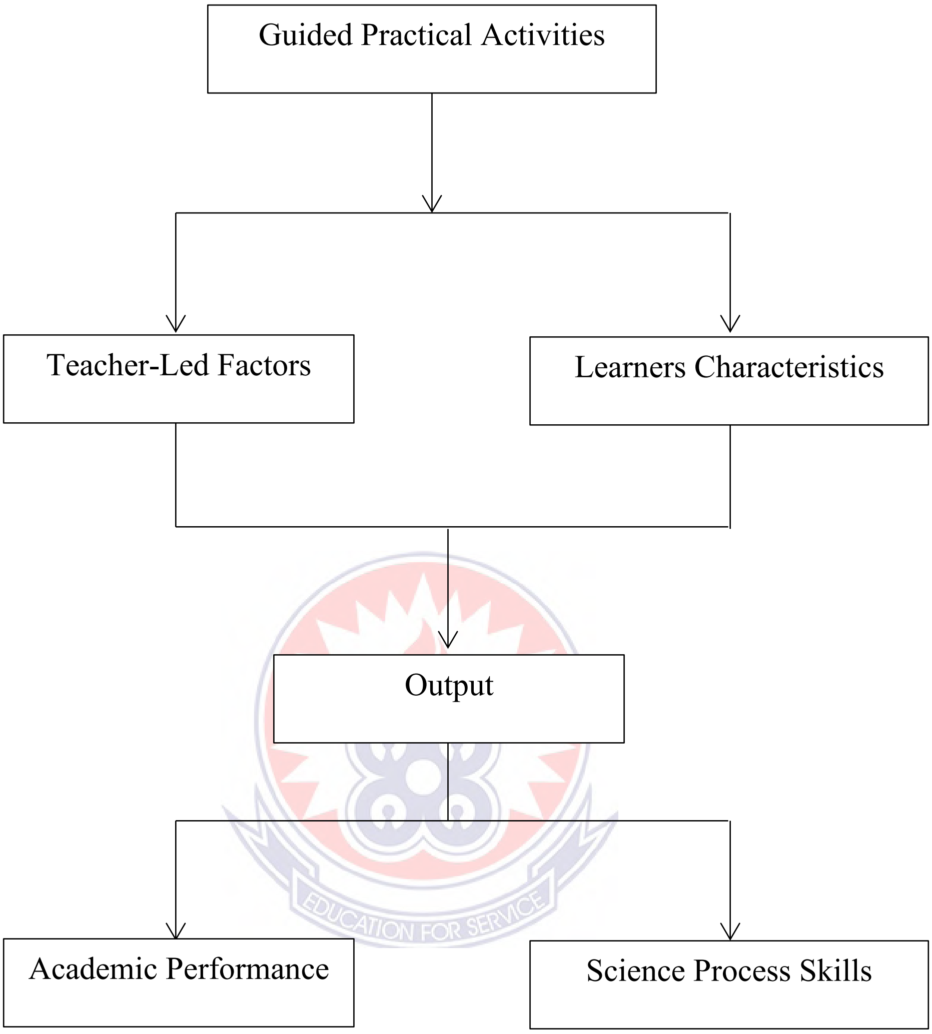
Cognitive Load Theory (CLT), developed by John Sweller in the late 1980s, is a foundational framework in educational psychology that addresses the limitations of working memory and their implications for instructional design. The theory asserts that learning is optimized when instructional materials are structured to manage the cognitive load imposed on learners' working memory (Sweller, 2020). Given the limited capacity of working memory, excessive information presented simultaneously can overwhelm learners and reduce learning effectiveness. CLT differentiates between types of cognitive load, with intrinsic cognitive load referring to the complexity of the material in relation to the learner's prior knowledge. Although intrinsic load cannot be entirely eliminated, it can be effectively managed through strategies such as careful sequencing of information and the use of scaffolding techniques. Extraneous cognitive load, on the other hand, arises from how information is presented to learners. Poorly designed instructional materials, unnecessary or confusing information can increase this type of load, distracting learners from grasping the core content. The Jigsaw method is an instructional strategy that aims to reduce extraneous cognitive load, thereby freeing up cognitive resources for learning. Research has shown that collaborative note-taking, for example, may reduce the extraneous cognitive burden on individual students, as sharing the task among group members lightens the load on each person (Fanguy et al., 2023) In educational settings, cognitive load theory helps to design instructional materials that align with learners' cognitive capacities by segmenting information, using worked examples, and reducing extraneous details. These approaches enhance students' ability to process and retain information, leading to improved learning outcomes. In the Jigsaw method, these CLT principles are applied by breaking content into manageable segments, assigning each segment to each student, and allowing the students to teach each other, which reduces cognitive overload and enhances understanding. The Cognitive Load Theory (CLT) aligns perfectly with Jigsaw cooperative learning principles by focusing on effective cognitive load management. The Jigsaw method segments complex topics into smaller, more manageable parts, helping prevent cognitive overload and allowing students to focus on essential information. Additionally, by having students teach each other, the method distributes cognitive tasks and reduces individual strain. This approach supports CLT by managing intrinsic load through breakdown of material and minimizing extraneous load through simplified peer explanations, enhancing overall understanding.

2.2 Conceptual Framework

The conceptual framework serves as a guide to explore the effect the guided practical activity teaching method on the form two students’ understanding of electricity concepts in physics.

Figure 1

Concept map of guided practical technique



2.3 Empirical Review

2.3.1 Concept of Guided Practical Activity

The ability to conduct hands-on practical work in the science laboratory is recognized as a critical scientific process skill and a key objective of science curricula (Kapici et al., 2019). Practical work is broadly defined as any teaching and learning activity that involves manipulating and observing real objects (Abrahams et al., 2013). In the context of this study, practical work refers to hands-on and minds-on scientific activities in which students engage actively, either individually or in small groups, to observe physical phenomena (Fadzil & Teknologi, 2013). This approach emphasizes learning through inquiry and discovery, enabling students to explore and understand phenomena in their environment, thereby facilitating the acquisition of scientific knowledge and conceptual understanding (Fadzil & Teknologi, 2013).

Millar and Fryer (1999) note that practical work encompasses laboratory activities performed by students as well as teacher demonstrations. Activity-based teaching, such as laboratory instruction, provides opportunities for learners to interact directly with materials, tools, and models, promoting observation, experimentation, and application of scientific theories (Jeukendrup & Killer, 2011). Physics instruction, in particular, benefits when teachers actively engage students in constructing knowledge through classroom and laboratory activities that encourage application of concepts and skill development.

Practical work has been shown to enhance academic achievement in science. For instance, Antwi et al. (2021) found a strong positive relationship between the frequency of science practical activities and student achievement in both theory and practical components, with effect sizes ranging from 26% to 50% across various science subjects. Practical activities should aim to develop higher-order cognitive skills that underpin scientific reasoning and methods. Similarly, Tsakeni (2018) highlighted that limited access to effective practical work in physical sciences classrooms can marginalize learners, emphasizing the importance of practical examinations and hands-on engagement. Laboratory experiences foster systematic reasoning, predictive ability, and problem-solving skills, bridging the gap between hands-on and minds-on learning (Scanlone et al., 2002).

According to the Science Community Representing Education [SCORE] (2009), science practical skills involve hands-on experiences that stimulate inquiry and understanding of the physical world. These skills encompass two core activity types: scientific techniques and procedures, and scientific inquiries and investigations conducted in the laboratory. Both activity types facilitate conceptual understanding, promote physical manipulation of apparatus, and enhance practical knowledge. Alkan (2016) and Woodley (2009) further emphasize that effective practical work develops problem-solving abilities, strengthens conceptual understanding, and fosters an understanding of scientific investigation processes.

Drawing on Piaget's learning theory, Karplus (1977) proposed a three-stage learning cycle to optimize science education: the exploration stage, where students connect new experiences with prior knowledge; the concept introduction stage, in which teachers guide students toward models or theories to explain observations; and the concept application stage, where students apply knowledge through problem-solving and laboratory investigations. However, many teachers focus predominantly on the final stage, neglecting exploration and guided conceptual introduction. This omission often contributes to students perceiving physics as difficult and disengaging from the subject. To foster scientific inquiry skills, teachers should implement guided practical lessons that address all three stages, ensuring active engagement, conceptual understanding, and practical application.

2.3.2 Achievement by Guided Practical Activities and Learning

Laboratory practical experiences play a crucial role in developing students' practical skills while illustrating the methods scientists use to investigate and gain insights into the physical world. Millar (2004) emphasized that laboratory work enables students to connect observable objects and events with underlying scientific concepts. Beyond knowledge acquisition, practical activities cultivate essential process skills such as measurement, recording, data analysis, and interpretation. A student-centered, activity-based approach facilitates more effective learning, as learners comprehend and retain concepts better when actively engaged in tasks (Reisman & Payne, 1987; Jenkins, 1998). In this context, practical work encompasses laboratory experiments, fieldwork, and other hands-on activities, allowing students to interact directly with materials and observe phenomena.

According to Brownell and Kloser (2015), practical work must be carefully designed and in-depth to promote the acquisition and development of intended scientific concepts. In contrast, Sotiriou et al. (2017) noted that traditional laboratory exercises often emphasize rote procedures and scientific terminology, limiting opportunities for creativity and cognitive development. Madhuri et al. (2012) further argue that "cookbook-style" laboratory exercises fail to help students translate experimental outcomes into meaningful learning. Similarly, some studies have reported limited or no impact of practical work on student achievement in science (Usman, 2010; Woolnough & Allsop, 1985; Osborne, 1993). Hodson (1990) contended that practical activities are often unproductive and confusing when implemented without a clearly defined purpose, and other studies suggest that not all laboratory activities are equally effective in fostering meaningful learning (Usman, 2010; Abrahams, 2009).

Despite these criticisms, effective practical work has been shown to enhance students' understanding of scientific investigation processes and strengthen conceptual knowledge (Woodley, 2009). Practical skills provide learners with opportunities to explore abstract concepts and generalizations through engagement with real materials, often requiring logical reasoning. These skills range from basic tasks, such as instrument identification, to more complex scientific procedures. The primary aim of practical work is to deepen understanding of scientific concepts and laboratory processes, as well as to assess students' ability to apply acquired skills. Although practical skills are best developed through sustained integration into learning, mastery requires ongoing practice over time.

2.3.3 Teacher Competency

Competence is defined as a set of behaviors that contribute to the achievement of desired outcomes (Bartram et al., 2002). It encompasses an individual's ability to effectively apply knowledge, skills, abilities, behaviors, and personal attributes to perform complex tasks in specific roles or positions. Tucker and Cofsky (1994) identify five core components of competence: (i) knowledge, referring to an individual's understanding and information; (ii) skills, denoting the ability to perform specific tasks; (iii) self-concept and values, reflecting attitudes, personal values, and self-perception; (iv) character, indicating the capacity to perform effectively within one's domain; and (v) motives, encompassing emotions, desires, and drives that prompt action. The integration of these components enables individuals to perform tasks independently and effectively, serving as critical drivers of high performance.

In the educational context, teacher competence is vital for the successful implementation of guided practical activities. Blömeke et al. (2015) suggest that teachers' pedagogical-content knowledge (PID skills) mediates the translation of teacher knowledge into instructional behaviors, which subsequently influence students' learning progression. Physics teachers' competence is particularly critical, as effective practical instruction requires a combination of subject knowledge, pedagogical skills, and the ability to design and conduct laboratory activities. While teacher recruitment in many regions emphasizes both content and pedagogical capability, in Ghana, recruitment is often based primarily on initial training rather than demonstrated classroom effectiveness.

Empirical evidence shows a positive correlation between teachers' educational and scientific background and students' achievement, with stronger effects observed in advanced science courses (Hawk et al., 1985). However, many teachers lack sufficient knowledge and skills to design and implement effective laboratory instruction. Asikainen and Hirvonen (2010) note that inadequate subject matter knowledge impedes teaching, and pre-service training often provides exposure to laboratory equipment and apparatus that teachers are unlikely to use in schools, leaving them unprepared for practical teaching demands. Many teachers also lack skills in improvisation, maintenance, and repair of laboratory apparatus. Studies by Mohamed et al. (2017) and Magidanga (2017) indicate that deficiencies in physics teachers' content knowledge are a primary contributor to students' poor understanding of physics concepts at the senior high school level.

2.3.4 Students' Attitude toward Science

Attitude is defined as a predisposition to respond favorably or unfavorably toward a given object (Oskamp & Schultz, 2004). In the context of this study, an attitude object may include the course content, the instructor, teaching resources and facilities, science lessons, specific science topics, or education research (Tesfaye & Karippai, 2009). Both teachers' and students' attitudes are important determinants of learning outcomes. Papanastasiou and Zembylas (2002) observed that individuals with positive attitudes toward science are more likely to perform effectively in physics, as students' inherent attitudes such as interest, beliefs, confidence, self-esteem, and self-efficacy shape their learning approaches including effort, problem-solving strategies, study habits, and critical thinking. Science laboratory experiences, in particular, have been shown to promote positive attitudes toward science, increase student interest, and enhance skills in using laboratory equipment (Glasman et al., 2006). Developing positive attitudes toward science is critical because attitudes often predict behavior in learning contexts.

Sidi et al. (2013) further define attitude as the way students think and behave, noting that attitudes are not fixed and can change depending on the individual. Koballa (2012) emphasizes that negative attitudes toward a subject can reduce interest, making it difficult for students to engage successfully in practical work. George et al. (1998) argue that because attitudes are learned, teachers play a pivotal role in shaping them. The manner of instruction, teacher behavior, and interactions with students can significantly influence achievement. Laboratory work provides structured experiences with school science equipment and topics, enhancing both scientific attitudes and enjoyment of learning (White, 1996; Tamir & Education, 1981). Practical work has also been shown to promote problem-solving skills, critical thinking, and meaningful learning experiences (Osman & Muir, 1994; Tobin, 1984; Tesfaye & Karippai, 2009).

Teachers' active engagement in practical lessons through experimentation, questioning, discussion, problem-solving demonstrations, cooperative group work, and observational exercises further supports the development of scientific attitudes and academic achievement (Uvie, 2021). Field excursions provide additional opportunities for experiential learning, allowing students to observe scientific principles and phenomena in real-world contexts such as industries or well-equipped external laboratories (Hamilton-Ekeke, 2007; Omeodu & Evaluation, 2018). Such experiences reinforce learning, making concepts more tangible and memorable. Abrahams and Millar (2008) suggest that increasing the minds-on components of practical work enhances its effectiveness in developing students' conceptual understanding of scientific ideas.

2.3.5 Skills to be developed by Guided Practical Activities

Scientific inquiry skills, also referred to as science process skills, are essential competencies for students in science education. Learning through inquiry (NRC, 2005) presents challenges for both teachers and learners, as it requires students to acquire specific skills before effectively engaging with practical examination tasks. Practical skills are commonly categorized into four thematic areas: manipulation of equipment and materials, measurement and observation, presentation of data, analysis and conclusion, and planning. Students must develop the ability to handle apparatus, make accurate measurements, present data in tables and graphs, draw valid conclusions, and critically evaluate experimental procedures by identifying limitations, sources of error, and suggesting improvements (Krajcik et al., 2001). These skills are most effectively developed when students are given significant control over laboratory procedures, fostering autonomy and deeper learning.

In a broader sense, scientific inquiry refers to the diverse methods scientists use to study the natural world, propose hypotheses, and justify claims based on evidence. Inquiry-based learning allows students to act as scientists, engaging in processes of investigation, explanation, and evidence-based reasoning (Sotiriou & Bybee, 2017). Teaching science as a process of discovery or inquiry highlights the importance of practical activities in learning (Ozdem-Yilmaz & Bilican, 2020; Schwab, 1960).

Inquiry learning also promotes critical thinking, problem-solving, and the ability to connect theoretical concepts with real-world applications (Sadeh & Zion, 2009; Dillon, 2016). Practical work encourages accurate observations, supports the application of theories, maintains student interest, and fosters logical reasoning.

Laboratory activities provide opportunities for students to engage in meaningful learning and construct knowledge by actively doing science (Tobin, 1990). Hands-on engagement with materials and equipment allows learners to build understanding of phenomena and related scientific concepts. Abrahams and Millar (2008) argue that practical work should be viewed as a structured mechanism in which materials and equipment are critically used to demonstrate the validity of scientific principles. When implemented appropriately from early secondary school levels, practical work in science, particularly physics, can develop students' critical thinking and problem-solving skills, laying the foundation for effective scientific reasoning.

2.3.6 Time Allotted for Practical Lesson

According to the Ministry of Education Ghana Syllabus (2010), a total of six periods per week is allocated for physics, comprising two periods for practical work and four periods for theory. In public Senior High Schools, elective subjects generally receive a total of four hours per week on the timetable. Research indicates that students' academic attainment is closely related to the amount of time spent actively engaged in learning (Walberg et al., 2013). Fuligni and Stevenson (1995) found that children in Japan and China dedicate significantly more time to learning than their peers in other countries, which may partly explain these nations' recent advances in science and technology. Consequently, poor management of instructional time can limit coverage of the curriculum, negatively affecting student achievement. Hurd (2002) therefore recommends increasing the time allocated for active experimentation in science, as this promotes student participation, strengthens the development of scientific inquiry skills, and enhances overall achievement.

2.3.7 Students' Motivation

Motivation is defined as the drive to fulfill a need (Maslow, 1954; Murray et al., 2006). It encompasses the conditions that determine variations in the intensity, quality, and direction of ongoing behavior (Landy & Conte, 2004, as cited in Goodman et al., 2011). Motivation may arise from intrinsic factors, extrinsic factors, or an interaction between the two (Maslow, 1954). In this study, achievement motivation is considered a key aspect of intrinsic motivation. It is measured in terms of the will to succeed, the need for mastery in challenging tasks, and the perceived meaningfulness of academic performance (Tella et al., 2007). Intrinsic motivation drives active engagement and is a fundamental characteristic of human behavior (Deci & Ryan, 1985). Achievement motivation, as a personality variable, reflects a continuous concern for excellence and adherence to internalized performance standards (Sturman, 1999; McClelland, 1955). According to McClelland (1965), individuals with high intrinsic motivation tend to be more productive and perform better academically, as task mastery satisfies their internal need for achievement and fosters a sense of challenge that encourages involvement and engagement. Confidence and positive self-concept also play a significant role in intrinsic motivation. A study by Sikhwari (2007) at the University of Venda in South Africa demonstrated that students' confidence and self-perception significantly influence their motivation to achieve, leading to regular class attendance, active participation, and higher academic performance.

Extrinsic motivation, on the other hand, is influenced by external rewards and social or institutional controls over behavior (Sturman, 1999). It is largely shaped by socialization within the family and academic environment (Piotrkowski et al., 1982). Relationships with teachers and peers have a strong link to academic performance, as supportive interactions and small, interactive group settings can enhance motivation and lead to positive academic outcomes (Felner et al., 2007). Extrinsic motivators also include tangible and intangible rewards. For instance, students who excel academically may gain recognition, praise, and a positive reputation, which are considered intangible rewards (Gest et al., 2008). A supportive social environment can further foster intrinsic motivation (Muller & Louw, 2004).

The perceived value of both the task and the reward influences the effort students invest in achieving academic goals. Intrinsic and extrinsic factors often interact to strengthen overall motivation, enhancing performance outcomes (Muller & Psychology, 2004). McClelland (1985) posited that intrinsic motivators are generally more influential than extrinsic ones, such as financial or material rewards. Teacher–student relationships significantly impact motivation and achievement, including academic grades, test performance, and retention (Bernstein-Yamashiro & Noam, 2013; Cornelius-White, 2007; Kannapel et al., 2005; Lee et al., 2012; Wang, 1990; Wentzel, 2012). Wentzel (2012) further found that teacher communication, expectations, willingness to provide guidance, and emotional support positively correlate with student motivation and engagement, with effects particularly strong for low-income, underachieving, and minority students.

Teacher–student relationships are malleable and can produce changes in students' motivational and academic outcomes within a single school year. The literature provides valuable insights into the factors influencing physics education; however, it is clear that significant gaps remain. Future research should focus on: The impact of socio-economic and cultural factors on guided practical activities. Development and evaluation of targeted teacher training programs for practical work strategies to address negative attitudes toward physics. The real-world applicability of skills gained through guided practical activities, innovations in time management and curricular design to enhance practical learning. Comprehensive models of student motivation that integrate intrinsic and extrinsic factors. The researcher employs available resources and technology in guided practical activity to measure its effect on learners' skill acquisition and academic performance.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter focuses on the methodology of the study. It outlines the research design, population, sample, and sampling procedures, as well as the research instruments used for data collection. Additionally, the chapter addresses the reliability and validity of the research instruments, procedures for data collection and analysis, and details of the intervention implemented (Jongbo, 2014).

3.1 Research Design

According to Jongbo (2014), a research design is the plan or strategy employed by a researcher to investigate the research questions. This study adopted an action research design to examine the impact of guided practical activities on students' development of scientific process skills and subsequent academic performance. Spencer et al. (2024) define action research as an inquiry conducted to understand, evaluate, and improve educational practice. Cohen and Manion (2002) describe it as an emergent, on-the-spot procedure designed to address concrete problems in immediate contexts. The process involves continuous monitoring through various mechanisms such as questionnaires, diaries, interviews, and case studies, enabling the researcher to make timely modifications, adjustments, and refinements that enhance the ongoing educational process rather than future applications.

Koshy et al. (2010) characterize action research as a constructive inquiry in which the researcher develops knowledge through planning, acting, evaluating, refining, and learning from experience. It is a continuous learning process that allows the researcher to generate knowledge and share it with others who may benefit.

Rosenfield et al. (1980) define action research as the study of an instance in action, providing insights into real people in real situations and facilitating a deeper understanding of ideas than abstract theories alone can provide. Preedy et al. (2013) emphasize that action research demonstrates how theoretical principles operate in practical contexts, enhancing both student learning and teachers' professional growth (Johnson & Johnson, 1985). Unlike traditional experimental studies, action research prioritizes analytic rather than statistical generalization, offering insights into cause-and-effect relationships in real-world contexts (Robson, 2002).

The study was conducted in three phases. The first phase involved pre-intervention activities, including observation of students' science process skills and pre-testing to determine their baseline competencies. The second phase consisted of the intervention, during which the researcher implemented guided practical activity lessons and assessment instruments over six weeks. The final phase involved post-intervention testing, which enabled evaluation of the intervention's impact on students' acquisition of scientific process skills.

3.2 Population and Sampling

Population refers to a group of individuals who share one or more characteristics relevant to a study and are suitable for inclusion in the research (Kahn et al., 2008). A sample, in contrast, is a subset of the population selected to represent the whole, with data and insights from the sample reflecting those of the larger group (Banerjee & Chaudhury, 2010). Sampling methods are generally categorized into probability (random) and non-probability techniques (Schofield, 2004). In probability sampling, the likelihood of each member being selected is known, whereas in non-probability sampling, the selection probability is unknown.

For this study, a purposive sampling strategy was employed to select fifty students. This approach was appropriate because the chosen class was taught by the researcher and the relevant physics topic was being covered at the time. Purposive sampling involves selecting participants based on the researcher's judgment regarding their typicality or possession of specific characteristics relevant to the study (Cohen et al., 2018). In addition to purposive sampling, convenience sampling was used to facilitate access to respondents. The appropriateness of the sampling strategy is critical to the quality and validity of research findings (Morrison, 1993).

The research was conducted at Winneba Senior High School in the Effutu Municipal of the Central Region of Ghana, which had a student population of 2,100 at the time of the study. The target population comprised 110 physics students in the Science Department. From this group, a class of fifty SHS 2 physics students was selected. These students had covered a substantial portion of the physics curriculum and were not final-year examination candidates. Winneba SHS was chosen due to the researcher's familiarity with the school, teaching position in the Science Department, and proximity, which minimized logistical, financial, and time constraints. Furthermore, the researcher was able to leverage the cooperation of the headmistress, colleagues, and students to facilitate the study.

3.3 Action Research in Theory

Action research-based inquiry in educational contexts and classrooms involves distinct participants–students, teachers, and other educational stakeholders within the system. All of these participants are engaged in activities to benefit the students, and subsequently society as a whole. Action research contributes to these activities and potentially enhances the participants' roles in the education system (Baumfield et al., 2012).

3.4 Instrumentation

This study utilized quantitative data collection instruments to investigate the impact of guided practical activities on students' acquisition of science process skills and their academic performance in electricity. The instruments included student performance tests, a science process skills observation checklist, and a structured Likert-scale questionnaire. Each instrument was carefully designed to align with the research objectives and questions, ensuring consistency and relevance. The instruments were employed systematically across the pre-intervention, intervention, and post-intervention phases of the study to collect reliable and comparable data.

3.4.1 Students' Performance Tests

The students' performance tests comprised pre-intervention tests, weekly intervention exercises, and a post-intervention test. These instruments were designed to evaluate students' conceptual understanding and academic achievement in selected electricity topics. The test items included structured and short-answer questions requiring students to apply physics concepts, perform calculations, interpret results, and explain observed phenomena.

The pre-intervention test established students' baseline performance prior to the introduction of guided practical activities. Weekly intervention exercises were administered to monitor students' progress throughout the intervention period. The post-intervention test was used to determine the overall effect of the guided practical activities on students' academic performance. Scores obtained from these assessments provided the primary data for the quantitative analysis of academic achievement.

3.4.2 Students' Science Process Skills Observation Checklist

The students' science process skills observation checklist was used to quantitatively assess students' acquisition of specific science process skills during the guided practical activities. Although the checklist involved observation, the data generated were numerical, as students' performance on each skill was recorded using frequency counts and percentages. The checklist can be found in Appendix B.

The checklist focused on key science process skills relevant to physics practical work, including setting up apparatus, following experimental procedures, taking accurate measurements, recording observations, plotting graphs correctly, and interpreting experimental results. For each practical session, the number of students who successfully demonstrated each skill was recorded, and the results were later summarised as frequencies and percentages. These quantitative results were presented in tabular form in Chapter Four to show patterns and trends in skills acquisition over time.

3.4.3 Students' Questionnaire

A structured five-point Likert-scale questionnaire was administered to collect quantitative data on students' attitudes toward physics, perceptions of guided practical activities, motivation, conceptual understanding, and perceived impact on academic performance. The questionnaire was organized into sections aligned with the study's research questions. Students rated each item on a scale from Strongly Disagree (1) to Strongly Agree (5), producing numerical data suitable for statistical analysis. The responses were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. The results of the questionnaire were presented and interpreted quantitatively in Chapter Four.

3.5 Validity and Reliability of Instrument

3.5.1 Validity

Validity refers to the degree to which an instrument accurately measures the construct it is intended to assess. In this study, both content validity and face validity were carefully considered to ensure the instruments' accuracy and relevance.

Content validity was established by aligning all items in the instruments with the research objectives, research questions, and the selected electricity topics specified in the senior high school physics curriculum. The test items, observation checklist indicators, and questionnaire statements were designed to reflect essential concepts, expected learning outcomes, and science process skills associated with guided practical activities.

To further strengthen content validity, the instruments were submitted to two experts, a physics education specialist and a research methodology expert for review. The experts examined the instruments for relevance, clarity, coverage of content, and appropriateness of difficulty level for Form Two science students. Based on their feedback, ambiguous items were reworded, irrelevant items were removed, and necessary modifications were made to improve precision and alignment with the study objectives.

Face validity was ensured by assessing whether the instruments appeared, on the surface, to measure students' academic performance, science process skills, and attitudes towards physics. A small group of students similar to the study participants reviewed the questionnaire items during the pilot testing stage to confirm that the statements were clear, understandable, and free from confusing language. This process helped to ensure that students interpreted the items as intended by the researcher.

3.5.2 Reliability of the Instruments

Reliability refers to the consistency and stability of an instrument in measuring a construct across time or items. In this study, reliability was established through pilot testing and assessment of internal consistency.

Prior to the main study, the instruments were pilot-tested with a group of students possessing similar characteristics to the study participants but who were not included in the final sample. The pilot test was conducted at Apam Senior High School. Data from this pilot were used to evaluate the reliability of the instruments. Internal consistency, particularly for the questionnaire and performance test items, was measured using Cronbach's Alpha coefficient, which assesses the degree to which items within an instrument consistently measure the same construct. The analysis yielded a Cronbach's Alpha value of 0.90, indicating a high level of internal consistency.

According to Lin et al. (2015), a Cronbach's Alpha value of 0.80 or higher is considered acceptable for educational research, while values approaching 1.00 indicate very strong reliability. The coefficient obtained in this study suggests that the instruments were highly reliable for assessing students' academic performance, science process skills, and attitudes. Additionally, the science process skills observation checklist was administered consistently across all practical sessions, with clearly defined performance indicators, further enhancing the reliability of the observational data collected (Appendix H).

3.6 Methods of Data Collection

Data collection is a technique for physically obtaining data to be analyzed in a research study (Onwuegbuzie et al., 2010). Data for this study were collected in three stages; pre-intervention stage, intervention stage and post-intervention stage. In the pre-intervention stage, the Teacher took the students through a lesson where students identify some physics equipment and their functions. The intervention exercises did not assess expected skills but performance in general. The pre-intervention exercises were marked and the data collected and presented on students' evaluation form.

Stage two of data collection was centered on students' outputs in performance and skills acquisition during the weekly intervention practical exercises. Students were made to understand that the weekly exercise (experiment) were to help them develop scientific skills. Data collected from responses to exercise were duly analyzed.

3.7 Method of Data Analysis

Data analysis is the systematic process of organizing, summarizing, and interpreting collected data to address the research questions (Jassim & Abdulwahid, 2021). In this study, quantitative data analysis methods were employed, aligning with the nature of the data collected and the objectives of the research.

Data collected from the students' performance tests, science process skills observation checklist, and Likert-scale questionnaire were analysed using descriptive statistical techniques. These methods were deemed appropriate for identifying trends, patterns, and changes in students' academic performance and science process skills before, during, and after the intervention.

Scores from the pre-intervention test, weekly intervention exercises, and post-intervention test were analysed using frequencies, percentages, mean scores, and standard deviations. The analysis compared students' performance across the different stages of the study to determine improvements attributable to the guided practical activities. Results were presented in tables showing weekly scores, as well as summary tables highlighting overall trends in academic performance over the intervention period.

Data from the science process skills observation checklist were quantified by computing the frequency and percentage of students demonstrating each targeted skill during the practical sessions. These results were organized into tables to illustrate weekly progression in students' skills acquisition. The use of percentages allowed for straightforward comparison of skills development across the intervention period and provided clear evidence of improvement in practical competencies.

Responses from the Likert-scale questionnaire were analysed using frequencies, percentages, mean scores, standard deviations, skewness, and kurtosis. These statistical measures described students' attitudes, motivation, conceptual understanding, and perceptions of the effectiveness of guided practical activities. The analysed data were presented in tables and complemented with detailed narrative explanations to support interpretation and discussion of the findings.

3.8 Intervention

The study investigates the impact of guided practical lessons on the development of science process skills, and performance of students. The study would enhance teachers' classroom practice and student's learning. The Researcher developed lessons for the first two weeks of pre-intervention stage and pre-intervention test.

Intervention stage lessons were designed for third to fifth week and the sixth week was used for post- intervention test.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results and discussion of findings in relation to the research questions. Data collected from the administered questionnaire, pre-intervention test, and post-intervention test were analysed using both qualitative and quantitative approaches. Responses were summarized using frequencies and percentages, while descriptive statistical analyses were conducted to examine trends and patterns. The findings were discussed in the context of existing literature, allowing for comparison with similar studies. Based on the results, conclusions were drawn and recommendations provided.

4.1 Research Question 1

What specific science process skills do students struggle with when learning about electricity?

Table 1

Analysis of Students' Scores in the first Pre-Intervention Exercise for week1

Students Represented by Codes(St)	Students' Scores of week 1	Students Represented by Codes(St)	Students' Scores of week 1
St1	7	St26	3
St2	1	St27	1
St3	2	St28	5
St4	5	St29	6
St5	6	St30	2
St6	2	St31	4
St7	0	St32	2
St8	4	St33	1
St9	0	St34	2
St10	2	St35	1
St11	3	St36	0
St12	3	St37	5
St13	2	St38	8
St14	1	St39	2
St15	5	St40	2
St16	2	St41	1

Students Represented by Codes(St)	Students' Scores of week 1	Students Represented by Codes(St)	Students' Scores of week 1
St17	5	St42	5
St18	1	St43	2
St19	5	St44	3
St20	1	St45	4
St21	4	St46	5
St22	3	St47	3
St23	2	St48	3
St24	3	St49	6
St25	2	St50	4
Average Score		**2.86**	

The data presented in Table 1 indicate that students recorded very low scores in the pre-intervention exercises. An average score of 2.86 reflects overall poor performance. The pre-intervention test was administered during the second week, and Exercise 3 was conducted to assess the science process skills necessary for studying Physics effectively. Two instruments were used to measure students' baseline learning outcomes: the performance test items and the science process skills checklist.

The pre-intervention test scores, presented in Tables 6 and 8, highlight students' performance and the specific process skills demonstrated prior to the intervention. The low average score of 2.86 underscores the need for targeted interventions to improve both conceptual understanding and academic performance in electricity. The first research objective, which was to identify science process skills students were unable to demonstrate, was clearly reflected in the results. Low variability in scores suggests gaps in understanding or application of these skills, with individual scores ranging from 0 to 8. Notably, some students (e.g., St7 and St36) scored zero, indicating significant difficulties in performing foundational process skills essential for learning electricity.

These pre-intervention results reveal the challenges students face in mastering electricity, particularly regarding conceptual understanding and practical competencies. This baseline data provides a benchmark against which post-intervention outcomes can be compared, enabling the evaluation of the effectiveness of guided practical activities in enhancing students' performance and engagement.

Table 2

Analyses of Students' Scores of the Pre-intervention exercise 2 for Week2

Students Represented by Codes(St)	Students' Scores of week 2	Students Represented by Codes	Students' Scores of week 2
St1	2	St26	8
St2	6	St27	1
St3	3	St28	6
St4	2	St29	1
St5	6	St30	2
St6	5	St31	7
St7	2	St32	2
St8	3	St33	6
St9	2	St34	2
St10	5	St35	1
St11	3	St36	2
St12	3	St37	7
St13	4	St38	4
St14	3	St39	2
St15	3	St40	2
St16	4	St41	3
St17	3	St42	2
St18	3	St43	2
St19	2	St44	3
St20	2	St45	4
St21	1	St46	4
St22	5	St47	2
St23	2	St48	5
St24	1	St49	6
St25	3	St50	7
Average Score		**3.38**	

Table 2 presents the students' performance scores in the pre-intervention test conducted during the second week of the study. The average score of 3.38 out of 10 indicates that overall performance remained low. However, this represents a slight improvement compared with the average score of 2.86 recorded in the earlier pre-intervention exercises shown in Table 1. This marginal increase in performance can be attributed to the remedial tuition provided to students following the marking of the first two pre-intervention exercises. The relatively low average score, along with the variability in individual student scores, underscores the need for targeted intervention strategies to address gaps in conceptual understanding and science process skills.

Table 3

Analysis of Students' Science Process Skills Acquired in Week 2

Skills	**Frequency of Students (out of 50)**	**Percentages (%)**
Apparatus set up	42	84.00
Determination of least count	40	80.00
Follow procedure	17	34.00
Correct measurement	45	90.00
Correct drawing and labeling of axis	8	16.00
Scale choosing	5	10.00
[Plotting of graph	8	16.00
Interpretation of results	3	6.00

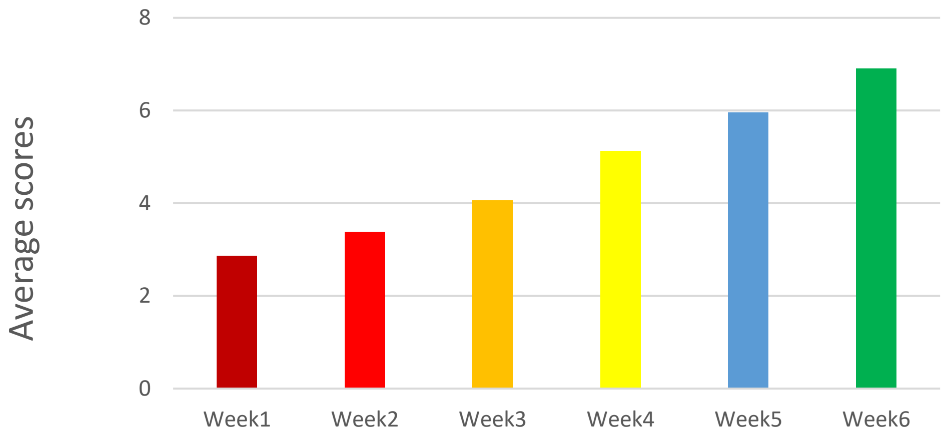
Table 3 presents an analysis of the specific science process skills expected of physics students for effective teaching and learning. The number of students who demonstrated each targeted skill during the pre-test exercise was recorded and expressed as percentages. Results show that 42 students, representing 84.00% of the sample, were able to correctly set up the apparatus. Additionally, 40 students, equivalent to 80.00% of the sample, successfully determined the least count of the ammeter and voltmeter. These findings indicate that while a majority of students could perform basic operational tasks, there remain gaps in the mastery of other essential process skills necessary for learning electricity effectively. Seventeen students (17) representing 34.00% could follow procedure and forty five students (45) making 90% took correct measurement on the ammeter and voltmeter. However, only 16.00% performed correctly drawing and labeling of graph axis as well as correct plotting of graph. Five students (5) were able to choose correct scale for the graph while three (3) students interpreted the graph correctly. In line with the first objective;

the low scores suggest that students continue to struggle with critical process skills related to electricity, even in the second week. For instance, students like St9 and St29, with scores of 2 and 1, respectively in Table 7, highlight these gaps. These scores also indicate a potential lack of engagement or understanding of electricity topics, which guided practical activities aim to improve. The data highlights specific skills where students face challenges. Low performance in result interpretation (6%), scale choosing (10%), and graph plotting (16%) require focused interventions. High performance in apparatus setup (84%) and correct measurements (90%) show proficiency in foundational skills. These insights directly fulfil the objective of identifying areas where students need support.

The third, fourth, and fifth weeks of the study were devoted to the implementation of the intervention lessons and ongoing evaluation. The sixth week was allocated for the administration of the post-intervention test. During the intervention phase, the researcher designed and delivered guided practical lessons on selected topics in electricity. Students' learning outcomes were assessed in terms of academic performance and the acquisition of science process skills. These evaluations provided data to determine the effectiveness of the guided practical activities in enhancing students' conceptual understanding and practical competencies.

Figure 2

Trend of performance of Students



The graphical presentation of the weekly average performance of fifty students used for this study shows consistent improvement in the performance over the six weeks study. The first and second bars from the left show average scores of the pre-intervention stage of the study

4.2 Research Question 2

What are students' attitudes towards learning about electricity in their physics course?

Table 4

Analysis of Students' Responses on Section A of the Questionnaire

	FREQUENCY				
Likert scale point	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
1	2	5	9	7	25
2	3	2	19	19	21
3	18	33	16	21	3
4	14	7	4	1	1
5	13	3	2	2	
Total	**50**	**50**	**50**	**50**	**50**

The results indicate varying levels of students' academic performance, confidence, and attitudes toward physics.

A mean score of 2.30 (SD = 1.04) reflects moderate academic performance, with most responses clustering around the median value of 2.00. Similarly, a mean score of 2.98 (SD = 0.91) suggests that students moderately agreed that they achieved high scores, with the mode of 3.00 representing the most frequent response.

Students demonstrated relatively strong confidence in their abilities, as indicated by a mean score of 3.58 (SD = 1.01). The median value of 4.00 shows that a substantial proportion of students rated their confidence at or above this level. Homework completion also reflected a positive trend, with a mean of 3.56 (SD = 0.91) and both the median and mode at 4.00, indicating consistent engagement with assigned tasks.

The highest level of agreement was observed for the importance of physics, with a mean score of 4.38 (SD = 0.78), demonstrating that students highly value the subject within their education.

The skewness values for most variables ranged between -0.535 and 0.506, indicating approximately normal distributions. However, the variable measuring understanding of the importance of physics showed a skewness of -1.87, reflecting a negatively skewed distribution, where most students selected high agreement ratings. Kurtosis values ranged from -2.02 to 5.90. The high kurtosis value for the importance of physics indicates a peaked distribution, suggesting strong consensus among students at the upper end of the scale.

Overall, the findings suggest moderate academic performance alongside positive attitudes, confidence, and strong perceived value of physics

Students' confidence and consistent completion of homework align with the study's objectives of improving motivation through guided practical activities. The high mean score (4.38) for understanding the importance of physics supports the hypothesis that practical activities enhance students' perceptions of the subject.

Moderate scores for academic performance (2.30) and achievement in science classes (2.98) highlight areas where further interventions could be effective.

The findings suggest that guided practical activities significantly enhance students' confidence and perception of physics, as reflected in the high scores for confidence (M = 3.58) and understanding of the subject's importance (M = 4.38). While students demonstrate positive attitudes, their academic performance (M = 2.30) and self-reported high grades in science classes (M = 2.98) indicate a need for further emphasis on skill-building and knowledge retention.

The results align with the study's objectives, particularly in improving perceptions and motivation, as indicated by consistent homework completion and strong appreciation for physics in education. The findings reinforce the importance of practical activities in enhancing conceptual understanding and engagement. Teachers should integrate guided experiments into lessons to further bridge gaps in academic performance.

To sustain these improvements, stakeholders should invest in equipping physics laboratories with necessary apparatus to support hands-on learning.

Table 5 shows the results of students’ responses to five questions (Q6 to Q10) on their acquisition of science process skills, captioned section B.

Table 5

Analysis of Students' Responses on Section B of the Questionnaire

	FREQUENCY				
Likert Scale Point	Q6	Q7	Q8	Q9	**Q10**
1	2	7	6	7	6
2	5	27	21	19	13
3	16	11	11	17	20
4	21	5	9	6	6
5	6		3	1	5
Total	**50**	**50**	**50**	**50**	**50**

This analysis evaluates students' self-reported competence in key skills related to conducting physics experiments, applying the scientific method, analyzing data, formulating hypotheses, and using scientific tools and equipment. Below is a detailed summary of the findings. The mean of 1.56 (SD = 0.50) indicates a nearly balanced gender distribution, with one gender slightly predominating. The mean score of 2.52 (SD = 0.97) indicates moderate proficiency, with the most frequent response (Mode = 2.00) suggesting room for improvement in conducting experiments.

The mean score of 3.72 (SD = 0.83) reflects a strong understanding of the scientific method, with the majority of responses centered around the median and mode of 4.00. A mean score of 3.36 (SD = 1.10) suggests moderate competence in data analysis, with most students reporting scores at or above the median of 4.00. Students reported a relatively high ability in hypothesis formulation, with a mean score of 3.54 (SD = 0.97). The mode of 4.00 highlights this as a frequent response. The mean score of 3.30 (SD = 1.05) shows that students generally feel confident in using scientific tools, although the range of responses suggests variability in skill levels.

Skewness values range from -0.523 to 0.563, indicating approximately symmetric distributions, except for a slight negative skew for "Scientific Method" (-0.523), "Hypothesis Formulation" (-0.486), and "Scientific Tools Usage" (-0.207). Kurtosis values range from -0.520 to 0.244, indicating that most distributions are relatively flat (platykurtic), reflecting variability in students' responses. Students demonstrate the highest competence in understanding and applying the scientific method (M = 3.72) and formulating hypotheses (M = 3.54). These skills align with the core objectives of guided practical activities.

Moderate scores for conducting experiments (M = 2.52) and using scientific tools (M = 3.30) indicate areas requiring further development through structured practical activities. Students report moderate to high competence in data analysis (M = 3.36), reflecting the effectiveness of guided practices in developing analytical skills.

Guided practical activities effectively enhance students' understanding of the scientific method and their ability to formulate hypotheses. These findings align with the study's objectives, emphasizing conceptual understanding through hands-on learning.

Students exhibit variability in their ability to conduct experiments and use scientific tools, suggesting that additional guided sessions focusing on these aspects could further improve overall proficiency.

The findings directly address the study's objectives of improving science process skills and conceptual understanding in physics. Specifically, the high scores for the scientific method and data analysis demonstrate the impact of practical activities on critical thinking and problem-solving abilities. Practical activities should remain a central component of the physics curriculum to enhance experimental skills and bridge gaps in technical proficiency. Stakeholders should also prioritize equipping laboratories with adequate tools to support effective learning.

Table 6 shows the results of students' responses to five questions (Q11 to Q15) on the impact of guided practical work on academic performance captioned section C

Table 6

Analysis of Students' Responses on Section C of the Questionnaire

	FREQUENCY				
Likert Scale Point	Q11	Q12	Q13	Q14	Q15
1	24	34	29	12	22
2	19	12	15	20	17
3	5	3	5	12	10
4	2		1	4	
5		1		2	1
Total	50	50	50	50	50

The mean of 1.56 (SD = 0.50) indicates a nearly balanced gender distribution, with one gender slightly predominating.

The mean score of 4.28 (SD = 0.81) reflects students' strong agreement that guided practical activities enhance their understanding of physics concepts. The mode of 5.00 indicates many students rated this aspect highly.

A mean score of 4.54 (SD = 0.79) highlights students' strong belief that guided practical activities positively influence their academic performance. Engagement in Learning Physics through Guided Practical Activities: The mean score of 4.44 (SD = 0.76) shows high levels of engagement among students during guided practical activities.

Students reported moderate to high interest, with a mean score of 3.72 (SD = 1.05).

The mean score of 4.18 (SD = 0.87) indicates students generally feel capable of applying knowledge gained from guided practical activities to real-world contexts. The skewness values for most items are negative, ranging from -0.724 to -2.354, indicating that most students rated these aspects positively, with ratings skewed toward higher scores. The kurtosis value of 7.371 for "Engagement" indicates a sharp peak in the distribution, showing consistent agreement among students. Scores range from a minimum of 1.00 to a maximum of 5.00, demonstrating variability in perceptions, particularly for interest in physics and real-life application. Students overwhelmingly agree that guided practical activities improve their understanding of physics concepts (M = 4.28) and academic performance (M = 4.54). High engagement (M = 4.44) reflects the effectiveness of guided activities in making learning interactive and enjoyable. While students reported increased interest in physics (M = 3.72), this area could still be targeted for further improvement. Students feel capable of transferring the skills and knowledge gained from practical activities to real-life contexts (M = 4.18), reinforcing the practical relevance of physics education.

The findings indicate that guided practical activities contributed positively to students' conceptual understanding, academic performance, and classroom engagement. These outcomes support the study's objective of integrating structured hands-on experiences to strengthen motivation and improve learning outcomes in physics.

Although students reported a relatively high level of interest in physics, with a mean score of 3.72, this value was lower compared to other measured variables such as perceived importance and confidence. This suggests that while the intervention was effective, there remains an opportunity to further enhance students' curiosity and enthusiasm. Designing more inquiry-driven, problem-based, and contextually relevant practical activities may help to stimulate deeper interest and sustained engagement in physics learning.

The ability to apply knowledge to real-life scenarios (M = 4.18) highlights the broader educational value of guided practical activities, emphasizing their role in fostering practical problem-solving skills. Incorporate more innovative and relatable experiments to further boost student interest and engagement in physics. Include activities that explicitly connect physics concepts to real-world problems to strengthen the applicability of knowledge. Stakeholders should prioritize equipping laboratories with tools and resources to ensure students continue to benefit from hands-on learning experiences.

Table 7 shows the results of students' responses to five questions (Q16 to Q20) on the changes in their conceptual understanding; section D.

Table 7

Analysis of Students' Responses on Section D of the Questionnaire

	FREQUENCY				
Likert Scale Point	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**
1	20	8	24	3	28
2	23	24	17	23	16
3	6	15	8	20	4
4	1	3	1	3	1
5				1	1
Total	**50**	**50**	**50**	**50**	**50**

This analysis evaluates students' perceptions of guided practical activities in terms of their motivation, understanding of electricity, enjoyment, real-life application, and critical thinking development. The descriptive statistics for the analyzed variables are summarized below.

The mean of 1.56 (SD = 0.50) suggests a nearly balanced gender distribution, with one gender slightly predominating. Students reported high motivation, with a mean score of 4.24 (SD = 0.74). The mode of 4.00 indicates that many students rated this aspect positively. A mean score of 3.70 (SD = 0.84) reflects moderate to high improvement in understanding electricity through guided activities. The mean score of 4.32 (SD = 0.74) indicates that students generally enjoy learning electricity concepts through practical methods, with a mode of 5.00 showing strong agreement.

Students reported an ability to relate concepts to real-life scenarios, with a mean score of 3.92 (SD = 1.16). The mode of 5.00 suggests that many students find these activities relevant to their daily lives. The mean score of 4.48 (SD = 0.71) highlights students' agreement that guided practical activities foster critical thinking skills, with a mode of 5.00 showing consistent positive responses. Negative skewness values across variables, ranging from -0.237 to -1.371, indicate that most students rated these items positively, with scores leaning toward the higher end of the scale. The kurtosis value of 1.913 for "Critical Thinking Skills" suggests a sharp peak, indicating consistency in student responses. Scores range from a minimum of 1.00 to a maximum of 5.00, with the highest variability observed in the ability to relate electricity concepts to real-life situations (SD = 1.16). Students reported high levels of motivation (M = 4.24) and enjoyment (M = 4.32) from learning physics through guided practical activities. These findings indicate that hands-on experiences make physics engaging and enjoyable. Students showed a moderate to high improvement in their understanding of electricity (M = 3.70), demonstrating the effectiveness of practical activities in reinforcing theoretical knowledge. The ability to relate electricity concepts to real-life scenarios (M = 3.92) highlights the practical relevance of guided activities, though variability in responses suggests room for improvement in connecting lessons to students' daily experiences. The highest mean score (M = 4.48) indicates that students feel guided activities enhance their critical thinking skills, suggesting that practical experiences effectively promote analytical and problem-solving abilities.

The data affirm that guided practical activities play a significant role in boosting motivation, enjoyment, and critical thinking skills among students. These activities also enhance students' understanding of electricity concepts, aligning with the objectives of the study. While students demonstrated the ability to connect physics concepts to everyday life, the relatively higher standard deviation suggests a need to strengthen this aspect through activities explicitly designed to bridge classroom lessons and practical real-world scenarios. The findings underscore the importance of incorporating guided practical activities into physics curricula to foster deeper understanding, motivation, and skill development among students.

Develop practical tasks that clearly link electricity concepts to real-life problems and practical solutions in order to enhance relevance and understanding. Maintain emphasis on activities that foster critical thinking and problem-solving skills, since these competencies are vital for success in STEM-related academic pursuits and careers. Additionally, incorporate diverse and innovative practical experiences to maintain and further stimulate students' motivation and interest in physics.

Table 8 shows the results of students' responses to five questions (Q21 to Q25) on their application of physics in real world, captioned section E.

Table 8

Analysis of Students' Responses on Section E of the Questionnaire

	FREQUENCY				
Likert Scale Point	Q21	Q22	Q23	Q24	Q25
1	12	12	17	20	27
2	13	14	18	22	17
3	20	19	12	17	2
4	5	4	2		2
5		1	1	1	2
Total	50	50	50	50	50

The mean of 1.56 (SD = 0.50) reflects a nearly balanced gender distribution, with one gender slightly predominating.

Students reported a moderate ability in this area, with a mean score of 3.62 (SD = 0.97). The mode of 3.00 indicates that many students rated this ability as average or above average. The mean score of 3.62 (SD = 1.01) suggests that students feel moderately prepared to discuss electricity in practical scenarios, with variability in their responses.

A mean score of 4.00 (SD = 0.95) indicates strong agreement that guided activities are effective in addressing real-world challenges. Students strongly agreed with this statement, reflected by a mean score of 4.20 (SD = 0.83) and a mode of 4.00.

A mean score of 4.30 (SD = 1.01) highlights students' confidence in understanding safety measures, with a mode of 5.00 reflecting high ratings among respondents.

Skewness values ranged from -0.156 to -1.865, indicating that most ratings leaned toward higher scores, especially for safety precautions and identifying electricity's role in technology. High kurtosis for safety precautions (3.442) and identifying electricity's role in technology (2.921) indicates a clustering of responses around the mean, suggesting consistent agreement among students. Scores ranged from 1.00 to

5.00, with the smallest variability observed in the ability to identify electricity's role (SD = 0.83).

Students reported moderate confidence in explaining how electricity works in real-world applications (M = 3.62). This suggests room for improvement in connecting classroom knowledge with practical contexts. While students feel moderately prepared to discuss electricity concepts practically (M = 3.62), the variability in responses highlights a need for more targeted interventions to build confidence.

The mean score of 4.00 indicates that guided activities effectively enhance students' problem-solving skills related to electricity. High ratings for identifying electricity's role (M = 4.20) and understanding safety precautions (M = 4.30) suggest that students have a solid grasp of these areas, likely due to hands-on activities reinforcing theoretical concepts. The data suggest that guided practical activities are successful in enhancing students' ability to relate electricity concepts to technology, daily life, and safety. These activities also foster problem-solving skills relevant to real-world challenges. Moderate ratings in explaining electricity's real-world applications and preparedness for practical discussions indicate a need for additional focus on bridging the gap between theoretical learning and practical contexts.

The findings underscore the significance of guided activities in developing foundational competencies, including safety awareness and the application of technological concepts, which are crucial for academic achievement and practical problem-solving.

During the first two weeks, the researcher engaged students in several pre-intervention activities aimed at assessing their academic performance and the extent of science process skills already acquired. These competencies are considered essential for effective learning in physics. Exercises 1 and 2 were conducted in the first week, while Exercise 3 was administered in the second week as a pre-intervention assessment to further evaluate students' baseline skills.

The activities carried out by students in Exercises 1 and 2 in the pre-intervention stage were marked (total of 10marks) and the appropriate feedback was given to the students to incorporate in their learning. Further teaching was done and the students acted on feedback to correct their mistakes through collaboration with their class mates. This approach helped students to develop some scientific inquiry skills which aided them to surmount challenges in subsequent lessons.

4.3 Research Question 3

What is the effect of guided practical activities on students' conceptual understanding?

Table 9

Analyses of Students' Scores of the Intervention exercise 1 for Week3

Students Represented by Codes(St)	Students' Scores of week 3	Students Represented by Codes(St)	Students' Scores of week 2
St1	3	St26	3
St2	3	St27	1
St3	7	St28	2
St4	6	St29	6
St5	6	St30	2
St6	7	St31	7
St7	3	St32	2
St8	5	St33	1
St9	6	St34	6
St10	5	St35	1
St11	5	St36	5
St12	2	St37	7
St13	4	St38	6
St14	4	St39	3
St15	8	St40	5
St16	6	St41	8
St17	6	St42	2
St18	3	St43	5
St19	3	St44	1
St20	4	St45	5
St21	4	St46	4

Students Represented by Codes(St)	Students' Scores of week 3	Students Represented by Codes(St)	Students' Scores of week 2
St22	5	St47	3
St23	2	St48	6
St24	4	St49	3
St25	6	St50	3
Average Score		**4.06**	

The students' scores in the first intervention exercise is presented in Table 9.The data from Week 3, shows a notable improvement in students' scores, with an average score of 4.06, compared to the pre-intervention averages of 2.86 (Week 1) and 3.38 (Week 2). This analysis ties directly into the research purpose, objectives, and significance, highlighting the potential impact of guided practical activities. The increase in average scores indicates that hands-on, guided interventions may indeed make learning more effective and engaging. The increase in individual scores, such as St15, (8) and St41 (8), suggests a better grasp of concepts due to the intervention. Though perception of electricity was not directly measured, the improved scores may also reflect a more positive attitude toward the topic as a result of engaging, practical activities.

Table 1

Analyses of Students' Process Skills Acquired in Week 3

Skills	Frequency of Students (out of 50)	Percentages (%)
Apparatus set up	47	94.00
Determination of least count	45	90.00
Follow procedure	20	40.00
Correct measurement	45	90.00
Correct drawing and labeling of axis	17	34.00
Scale choosing	8	16.00
Plotting of graph	17	34.00
Interpretation of results	8	16.00

Specific skills were identified and measured after the first intervention lesson. Table 10 presents analysis of specific skills expected of physics students. The number of students who exhibited the expected specific skills were recorded and expressed as percentages. There was noticeable improvement in apparatus setup; forty seven students (47) constituting 94.00% were able to set up the apparatus. Forty five students constituting 90.00% of the sampled population were able to determine the least count of the ammeter and the voltmeter. Twenty students (20) representing 40.00% could follow procedure and forty five students (45) making 90% took correct readings on the ammeter and voltmeter. Correct drawing and labeling of graph axes constituted 34.00% as well as correct plotting of graph. The Week 3 analysis shows that while students demonstrate increased proficiency in foundational skills such as apparatus setup (94%) and correct measurement (90%), they continue to struggle with advanced skills like scale choosing (16%) and result interpretation (16%). These findings directly support the purpose of the study, which is to evaluate how guided practical activities improve motivation and performance. The gradual improvement in some skills, such as drawing and labelling axes (34%) compared to Week 2, indicates progress but also highlights areas requiring further attention.

4.3.2 Week Four

The lesson adopted the set up in the previous lesson to measure current (I) in the circuit and potential difference (p.d) across the standard resistor. The results tabulated is used to plot a graph of the two physical quantities (voltage against current). The lesson started by reviewing the activities in the previous lesson. Questions were shared to the six groups of which each member supposed to take individual readings. The facilitator took the students through principles to be employed in graph work. The responses provided in Tables 11 showed the learners acquired the skills for measurement.

Table 2

Analysis of Students' Scores of Intervention Exercise 2 for Week 4

Students Represented by Codes	Students' Scores of week 4	Students Represented by Codes	Students' Scores of week 4
St1	6	St26	7
St2	6	St277	10
St3	3	St28	8
St4	3	St29	3
St5	5	St30	3
St6	8	St31	7
St7	4	St32	6
St8	6	St33	3
St9	5	St34	6
St10	5	St35	3
St11	6	St36	7
St12	5	St37	8
St13	2	St38	7
St14	5	St39	4
St15	5	St40	5
St16	8	St41	2
St17	5	St42	5
St18	4	St43	5
St19	4	St44	7
St20	5	St45	6
St21	6	St46	8
St22	2	St47	5
St23	6	St48	2

Students Represented by Codes	Students' Scores of week 4	Students Represented by Codes	Students' Scores of week 4
St24	5	St49	4
St25	6	St50	4
Average Score		**5.12**	

Table 11 represents the scores of the students in the second intervention exercise in the fourth week of the study. The average score of 5.12 out of 10 marks showed an improved performance of the students; an improvement on the average score of 4.06 over the first intervention exercises presented in Table 10.

Table 3

Analysis of Students' Scores of Process Skills Acquired in Week 4

Expected Skills	Frequency of Students (out of 50)	Percentages (%)
Apparatus set up	45	90.00
Determination of least count	47	94.00
Follow procedure	33	66.00
Correct measurement	47	94.00
Correct drawing and labeling of axis	28	56.00
Scale choosing	20	40.00
Plotting of graph	25	50.00
Interpretation of results	32	64.00

Table 12 presents the analysis of specific skills exhibited in the second intervention exercises. Apparatus setup and correct measurement reached 90.00% and 94.00% respectively. Forty five (45) learners were able to set up the apparatus. Forty seven students (47) which was of the sampled population were able to determine the least count of the ammeter and the voltmeter. Thirty three students (33) representing 66.00% could follow procedure and forty seven students (47) making 94.00% took correct measurement on the ammeter and voltmeter. Twenty eight students (28) did drawing and labeling of graph axis constituted 56.00%. Twenty students (20) were able to choose appropriate scale for the graph plotting, constituting 40.00%. Twenty Five students (25) plotted the points on the graph correctly while thirty two students (32) gave the correct interpretation of results. These constitutes 50.00% and 64.00% respectively. The Week 4 analysis reveals continued improvement in many foundational and advanced science process skills among students, reflecting the effectiveness of guided practical activities. Key skills like apparatus setup (90%) and correct measurement (94%) maintain high proficiency, while skills such as plotting graphs (50%) and interpretation of results (64%) show significant progress compared to previous weeks. This directly supports the study's purpose of evaluating guided practical activities as a method for enhancing motivation and performance in electricity.

Week Five-Intervention Lesson

The topic for the week-five intervention lesson was 'determination of a resistance of a wire'. The Researcher provided apparatus and a circuit diagram for students to serve as a guide for them to construct the setup for the lesson. .After the students have finished with the setup, the Researcher came in to guide the learners to determine the balance point on the setup. The Researcher further asked the learners to vary the length of the wire in the gab on the metre bridge and record the balance point. The result showed a quantum jump in the skills acquisition among learners.

Table 4

Analysis of Students' Scores of Intervention Exercise 3 for Week 5

Students Represented by Codes	Students' Scores of week 5	Students Represented by Codes	Students' Scores of week 5
St1	6	St26	5
St2	7	St27	7
St3	9	St28	6
St4	6	St29	2
St5	4	St30	5
St6	10	St31	7
St7	6	St32	3
St8	6	St33	4
St9	5	St34	4
St10	7	S35	4
St11	7	St36	6
St12	8	St37	8
St13	7	St38	7
St14	6	St39	3
St15	9	St40	7
St16	5	St41	3
St17	6	St42	10
St18	8	St43	4
St19	6	St44	6
St20	5	St45	2
St21	5	St46	7
St22	7	St47	5
St23	8	St48	8
St24	7	St49	3
St25	7	St50	5
Average Score		**5.96**	

Table 13 presents the students' performance scores during the intervention exercise. The mean score of 5.96 out of 10 indicates a substantial improvement compared to the previous two weeks, which recorded average scores of 5.12 and 4.06 respectively. This upward trend suggests that the intervention activities positively influenced students' academic performance.

Table 5

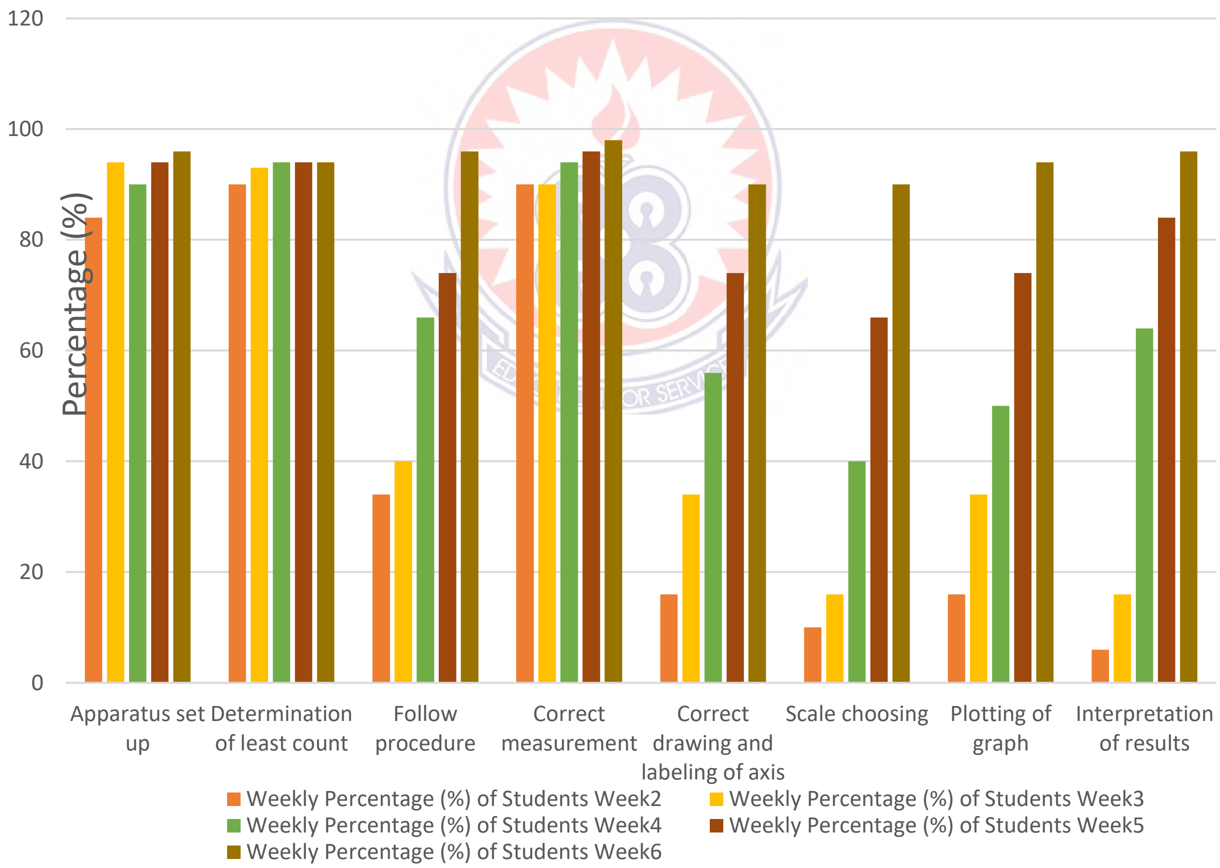
Analysis of Students' Scores of Process Skills Acquired in Week 5

Expected Skills	Frequency of Students (out of 50)	Percentages (%)
Apparatus set up	47	94.00
Determination of least count	47	94.00
Follow procedure	37	74.00
Correct measurement	48	96.00
Correct drawing and labeling of axis	37	74.00
Scale choosing	33	66.00
Plotting of graph	37	74.00
Interpretation of results	42	84.00

The data in Table 14 presents analysis of students who exhibited specific skills during intervention lesson. A further increase was observed across expected skills. Forty seven students (47) constituting 94.00% were able to set up the apparatus. Again, forty seven students (47) which was 94.00% of the sampled population were able to determine the least count of the ammeter and the voltmeter. Thirty seven students (37) representing 74.00% could follow procedure and forty eight students (48) representing 96.00% took correct measurement on the ammeter and voltmeter. Thirty seven students (37) did correct drawing and labeling of graph axes constituted 74.00% as well as correct plotting of graph. Thirty three students (33) which was 66.00% of the sample were able to choose correct scale for the graph while forty two students (42) interpreted the graph correctly representing 84.00%. The analysis of Week 5 shows marked improvement in key science process skills, with high proficiency in skills such as apparatus setup (94%) and correct measurement (96%). Advanced skills like graph plotting (74%) and result interpretation (84%) also exhibit considerable progress. This aligns with the study's purpose by demonstrating the effectiveness of guided practical activities in fostering engagement and improving student performance in electricity The Week 5 data reveals high proficiency apparatus setup, determination of least count, and correct measurement achieved 94%-96% success rates. Improved intermediate skills such as following procedures, graph plotting, and axis labelling improved to 74%, indicating growing competency. The intervention also saw advancing advanced skills; scale choosing (66%) and result interpretation (84%) show continued progress.

Figure 3

Percentage of specific skill exhibited by students



4.4 Research Question 4

What is the difference in students' test scores and grades in electricity before and after participating in guided practical activities?

Table 6

Analysis of Students' Score of Post-Intervention Test for Week 6

Students Represented by Codes	Students' Scores of week 6	Students Represented by Codes	Students' Scores of week 6
St1	8	St26	4
St2	6	St27	7
St3	10	St28	5
St4	8	St29	7
St5	7	St30	3
St6	9	St31	10
St7	8	St32	6
St8	10	St33	9
St9	3	St34	8
St10	7	St35	4
St11	9	St36	8
St12	6	St37	10
St13	9	St38	10
St14	8	St39	6
St15	4	St40	8
St16	10	St41	6
St17	8	St42	6
St18	5	St43	10
St19	8	St44	6
St20	9	St45	7
St21	8	St46	5
St22	5	St47	9
St23	8	St48	7
St24	8	St49	4
St25	7	St50	8
Average Score		**6.90**	

Table 15 presents the students' performance scores in the post-intervention exercise conducted in the sixth week of the study. The mean score of 6.90 out of 10 demonstrates a clear improvement compared to the average scores recorded in earlier weeks, namely 5.96 in the fifth week, 5.12 in the fourth week, and 4.06 in the third week. This consistent upward progression indicates that the guided practical activities contributed to enhanced academic performance over the intervention period.

Table 7

Analysis of Students' Score of Process Skills Acquired in Week 6

Skills	Frequency of Students (out of 50)	Percentages (%)
Apparatus set up	48	96.00
Determination of least count	47	94.00
Follow procedure	48	96.00
Correct measurement	49	98.00
Correct drawing and labeling of axis	45	90.00
Scale choosing	45	90.00
Plotting of graph	47	94.00
Interpretation of results	48	96.00

Data presented in Table 16 is an analysis of specific skills exhibited in the post-intervention test exercise. Forty eight students (48) constituting 96.00% were able to set up the apparatus. Forty seven students (47) which was 94% of the sampled population were able to determine the least count of the ammeter and the voltmeter. Forty eight students (48) representing 96% could follow procedure and forty nine students (49) making 98%. The number of students who did correct drawing and labeling of graph axes were forty five (45) constituted 90% as well as choosing correct scale on the graph. Forty seven (47) were able to plot the graph correctly and forty eight (48) students also interpreted the graph correctly. These numbers represented 94% and 96% of the sampled population respectively

Table 8

Summary of Students' Average Performance Scores

Weeks	Average scores of fifty students
Week1	2.86
Week2	3.38
Week3	4.06
Week4	5.12
Week5	5.96
Week6	6.90

The average of averages of pre-intervention, intervention and post-intervention stages of the study are as follow:

1. Pre-intervention stage (week1 & week2) = (2.86+3.38)/2 =3.12

2. Intervention stage (week3, week4 &week5) = (4.06+5.12+5.96)/3 = 5.05

3. Post-intervention stage (week6) = 6.90

Table 18

Summary of Students Acquisition of Skills

Expected Skills	Weekly Percentage (%) of Students				
	Week2	Week3	Week4	Week5	Week6
Apparatus set up	84	94	90	94	96
Determination of least count	80	90	94	94	94
Follow procedure	34	40	66	74	96
Correct measurement	90	90	94	96	98
Correct drawing and labeling of axis	16	34	56	74	90
Scale choosing	10	16	40	66	90
Plotting of graph	16	34	50	74	94
Interpretation of results	6	16	64	84	96
Percentage (%)Range	6-90		16-96		90-98

Pre-intervention stage – Week2

Intervention stage – Week3 – Week5

Post-intervention stage – Week6

The percentage range differences of pre-intervention stage, intervention stage and post-intervention stage were 84%, 80% 8% respectively. The consistent decrease in the number of students who did not exhibited at least one of the eight expected skills shows the effect of the guided practical work on the students over the period. Figure 8 shows over 90% of students exhibited scientific process skills after intervention. The figure also shows percentage gap between post-intervention and pre-intervention stages.

4.5 Discussion of Results

The findings of this study provide compelling evidence that guided practical activities significantly enhanced students' science process skills, attitudes, conceptual understanding, and academic performance in electricity. When examined in relation to the literature reviewed, the results strongly support theoretical and empirical claims that learner-centred, activity-based instructional approaches are more effective than traditional teacher-centred methods in physics education. The pre-intervention results revealed that students initially demonstrated low to moderate academic performance and weak mastery of essential science process skills such as setting up apparatus, making accurate measurements, plotting graphs, and interpreting results. This finding is consistent with earlier studies which reported that senior high school students often struggle with electricity due to its abstract nature and the dominance of lecture-based instructional practices (Adusei & Boateng, 2021; Ahiakwo & Siaw, 2022). The moderate mean score recorded at the pre-intervention stage confirms WAEC examiners' reports and aligns with Hodson's (1990) assertion that when practical work is either absent or poorly structured, students fail to develop meaningful understanding and inquiry skills.

The implementation of guided practical activities resulted in a significant improvement in students' academic performance, as demonstrated by the notable increase in mean scores from the pre-intervention to the post-intervention phase. This outcome is consistent with the findings of Antwi et al. (2021) and Scanlon et al. (2002), who reported that structured practical activities positively affect students' achievement in electricity concepts. The improvement further supports the argument advanced by Robin Millar (2004), who contended that practical work enables learners to connect theoretical principles with observable phenomena, thereby strengthening conceptual understanding and academic performance.

Additionally, the enhancement of science process skills, including experimental setup, accurate measurement, data presentation, graph plotting, and interpretation, aligns with the assertions of Joseph Krajcik et al. (2001) and Ian Abrahams and Robin Millar (2008), who emphasized that inquiry-based practical work is fundamental to the development of higher-order scientific competencies. The steady increase in the proportion of students demonstrating these skills throughout the intervention period indicates that science process skills develop progressively through sustained and structured engagement rather than instant acquisition. This finding reinforces the perspectives of Justin Dillon (2016) and Kenneth Tobin (1990), who highlighted the importance of continuous hands-on experiences for meaningful skill development in science education.

Students' responses to the questionnaire further revealed significant positive changes in their attitudes toward physics and electricity in particular. High mean scores related to motivation, enjoyment, engagement, and perceived relevance of physics indicate that guided practical activities fostered positive affective outcomes. These results are consistent with the views of Papanastasiou and Zembylas (2002), Glasman et al. (2006), and White (1996), who reported that practical work enhances students' interest, confidence, and enjoyment of science. The finding that students developed a stronger appreciation of the importance of physics also supports Koballa's (2012) assertion that positive attitudes toward a subject are closely linked to sustained engagement and improved learning outcomes. The increased motivation observed among students can be explained through both intrinsic and extrinsic motivation theories discussed in the literature. From an intrinsic motivation perspective, the guided practical activities provided opportunities for task mastery, challenge, and active involvement, which McClelland's achievement motivation theory suggests are key drivers of improved performance. This finding aligns with Deci and Ryan's (1985) self-determination theory, which emphasizes autonomy, competence, and relatedness as fundamental to motivation. From an extrinsic standpoint, the structured guidance provided by the teacher, collaborative group work, and continuous feedback likely contributed to a supportive learning environment, as suggested by Wentzel (2012) and Felner et al. (2007).

The observed improvement in students' conceptual understanding of electricity concepts, including current, resistance, voltage, and circuit behavior, provides strong support for constructivist learning theory. According to Jean Piaget and Lev Vygotsky, learning occurs when individuals actively construct knowledge through interaction with their environment and social engagement. The guided practical activities created structured opportunities for students to test hypotheses, confront misconceptions, and refine their understanding through scaffolding within their Zone of Proximal Development. These findings are consistent with research by Chen and

Lertamornsak (2023), as well as Lazonder and Harmsen (2020), who reported that guided inquiry approaches foster deeper conceptual understanding than traditional instructional methods.

The results also align with Experiential Learning Theory, particularly the work of David A. Kolb, which emphasizes learning through a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Through hands-on experiments, students directly experienced electrical phenomena, reflected on their observations, and applied conceptual knowledge to new contexts. This iterative process explains the enhanced ability of students to apply physics principles to real-life situations, supporting the findings of Kolb et al. (2014) and Rodriguez-Duenas et al. (2022).

From the perspective of Cognitive Load Theory developed by John Sweller, the structured nature of the guided practical activities likely reduced extraneous cognitive load by segmenting complex electricity concepts into manageable components and providing clear procedural guidance. This instructional design allowed students to allocate cognitive resources more effectively to core conceptual understanding rather than procedural confusion. The improved performance and reduced variability in post-intervention scores align with Sweller's (2020) assertion that well-designed instructional strategies enhance learning efficiency.

The findings further underscore the importance of teacher competency in implementing effective guided practical activities. The structured facilitation, clarity of instruction, and pedagogical guidance observed during the intervention support the position of Blomeke et al. (2015), who argued that teachers' pedagogical competence mediates the relationship between content knowledge and student learning outcomes.

These results also reinforce concerns raised by Mohamed et al. (2017) and Magidanga (2017) that insufficient teacher preparation in practical instruction can limit students' learning gains, even in contexts where laboratory resources are available.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

This chapter summarizes the findings, generated conclusion and recommendations based on the analyses of the result of the study. The chapter also includes the implications of the findings for teaching and learning of physics.

5.2 Summary of Findings

This study examined the impact of guided practical activities on the acquisition of science process skills and academic performance in selected electricity topics among Form Two science students at Winneba Senior High School. Conducted as an action research, the study utilized pre- and post-intervention assessments, observation checklists, and questionnaires to evaluate changes in students' performance, skills, attitudes, and conceptual understanding. Results from the pre-intervention phase indicated low to moderate academic performance, with many students struggling to perform essential science process skills such as correct apparatus setup, accurate measurement, graph plotting, data interpretation, and drawing valid conclusions. These difficulties reflected a reliance on rote learning and limited engagement with structured practical work, which contributed to a shallow understanding of electricity concepts.

After the implementation of guided practical activities, students' academic performance improved noticeably. Post-intervention test results revealed a significant increase in mean scores, demonstrating that students performed better after participating in hands-on, teacher-guided laboratory exercises. These findings indicate that guided practical activities effectively facilitated the connection between theoretical concepts and observable phenomena, thereby improving both conceptual understanding and overall academic achievement.

The study also found significant gains in students' science process skills. Over the course of the intervention, an increasing proportion of students were able to competently set up experimental apparatus, take accurate readings, select appropriate scales for graph plotting, analyze data, and interpret results correctly. These improvements demonstrate that guided practical activities foster the gradual development of inquiry skills when learners are actively involved and adequately scaffolded.

In addition, the findings revealed positive changes in students' attitudes toward physics and electricity. Students reported increased motivation, confidence, enjoyment, and engagement during physics lessons. Many students also indicated that guided practical activities helped them understand electricity better and made learning more interesting and relevant. The majority of students agreed that they could apply concepts learned through practical activities to real-life situations, highlighting the functional value of physics education when taught through experiential methods. Therefore, the findings indicate that guided practical activities had a positive and meaningful impact on students' academic performance, science process skills acquisition, conceptual understanding, and attitudes toward learning electricity.

5.3 Conclusion

Based on the study's findings, it can be concluded that guided practical activities provide an effective instructional approach for enhancing the teaching and learning of electricity in senior high school physics. The results indicate that active engagement in structured, teacher-guided laboratory exercises significantly improves students' comprehension of abstract physics concepts.

The observed improvement in academic performance confirms that guided practical activities help bridge the gap between theory and practice, enabling students to construct knowledge meaningfully rather than relying on memorization. The enhanced acquisition of science process skills further indicates that practical-based instruction equips students with essential inquiry skills required for scientific reasoning, experimentation, and problem-solving.

The positive shift in students' attitudes toward physics suggests that guided practical activities not only improve cognitive outcomes but also foster affective outcomes such as motivation, confidence, and interest in learning. These affective gains are critical for sustaining students' engagement with physics and reducing the perception of the subject as difficult or abstract. The findings also emphasise the importance of teacher guidance in practical work. Well-structured practical activities, clear instructions, timely feedback, and appropriate scaffolding were central to the success of the intervention. This highlights the need for competent physics teachers who are skilled in designing and implementing effective laboratory-based instruction.

Guided practical activities provide a viable and impactful strategy for enhancing students' academic performance and science process skills in electricity. The study contributes context-specific empirical evidence to science education in Ghana and affirms the relevance of learner-centred, activity-based teaching approaches in improving physics learning outcomes at the senior high school level.

5.4 Recommendation

Based on the findings of the study, the following recommendations are made in line with the study's objectives:

1. Physics teachers at the senior high school level should consistently integrate guided practical activities into the teaching of electricity and other abstract physics topics.
2. Deliberate emphasis should be placed on the development of students' science process skills during physics instruction.
3. School administrators and education stakeholders, including the Ghana Education Service, should ensure that physics laboratories are adequately equipped and maintained to support effective guided practical activities.
4. Professional development programmes should be organised for physics teachers to strengthen their competence in planning, implementing, and assessing guided practical activities.

5.5 Suggestion for Further Study

1. Future research could investigate whether certain aspects of electricity (e.g., understanding circuits, safety precautions) are more challenging for students and whether targeted guided practical activities addressing these challenges lead to improved performance.
2. Studies could be conducted to investigate how incorporation of affective domain into guided practical lessons will stimulate skills development and positive attitudes toward science learning in secondary schools.

5.6 Contribution to Knowledge

This research reinforces the efficacy of guided practical activities as a transformative pedagogical tool in physics education. It provides actionable insights into improving students' learning outcomes, engagement, and attitudes toward electricity and physics, paving the way for innovative and inclusive teaching methods that align with 21st-century educational goals. By addressing gaps in the literature, it offers empirical support for integrating active, hands-on learning strategies to enhance STEM education globally.

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APPENDICES

APPENDIX A

INTRODUCTORY LETTER

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Our Ref: *ISED/PG/VOL.1/51*

24th October, 2024

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION:

I write to introduce to you the bearer of this letter Ebenezer Mawulorm Kuatsikor with index number **8241610012,** a student of Science Education in the University of Education, Winneba who is reading a Master of Philosophy programme in Science Education.

As part of the requirements of the programme he is undertaking a research topic; The Effect of Guided Practical Work on Students' Conceptual Understanding in Selected topics in Electricity. He needs to gather information to analyse the said research topic.

I would be grateful if he would be given the needed assistance to carry out this exercise.

Thank you.

Yours faithfully,

DR. CHARLES K. KOOMSON

Ag. Head of Department

APPENDIX B

STUDENTS' LEARNING EVALUATING FORMS

Criteria

1. Response related to the question asked
2. Response satisfies the demands of the question
3. Response exhibits correct acquisition of skills

Preamble: Responses that contain all parts of the science process inquiry skills are classified as "Correct". The evaluation exercise were ranked on 10marks.

Table 9: A sample of Students' performance in tests assessment form

Students Represented by Codes	Students' Scores of week 1 (total of 10 marks)
St1	
St2	
St3	
St4	
St5	
Average Score	

Table 10: A sample of Students' Checklist

Expected Skills	Tally
Apparatus set up	
Follow procedure	
Correct reading/measurement	
Correct drawing and labeling of axis	
Scale choosing	
Plotting of graph	
Interpretation of results	

Table 3: A sample of Students' Summary Checklist

Expected Skills	Frequency of Students	Percentages (%)
Apparatus set up		
Determination of least count		
Follow procedure		
Correct reading/measurement		
Correct drawing and labeling of axis		
Scale choosing		
Plotting of graph		
Interpretation of results		

APPENDIX C

SAMPLE LESSON PLANS

PRE-INTERVENTION LESSON PLAN

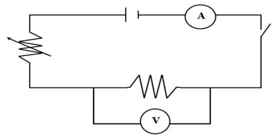
Number on Roll: 50 Class: SHS2
Subject: Physics Duration: 120
Reference: Asiedu (2006), Physics Practical for Senior High School
Teaching Learning Material: wire, paper, test tube, pencil, rule
RPK: Student use measuring instrument.

Topic/Sub-topic	Objectives	Teacher/Learner Activity	Core Points	Evaluation
<u>Topic</u> Measurement <u>Sub-topic</u> Use of 1.metre rule 2.ammeter 3.voltmeterc	By the end of the lesson, students will be able to: 1.name the measuring instruments. 2. determine the least count of the measuring instruments. 3. measure with the instrument provided. 4. Record measurement with the right unit	<u>Activity 1</u>. Teacher ask students to draw the symbol of the measuring instruments and label them. <u>Activity 2</u> Teacher guided students to calculate the least count of each of the instruments. <u>Activity 3</u> Students measure the objects provided on the bench in turns. <u>Activity 4</u> Teacher ask students to record the units of the physical quantities measured.	Fig. i metre rule Fig. ii. ammeter Fig. iii. voltmeter Least count(C),interval(I)and divisions within interval(D) C=I/D 1.metre rule- 0.1cm 2. ammeter;1.0mA 3. voltmeter;1.0V	Qn.1 State the least count of the following instrument: i.micrometer screw gauge. ii. vernier caliper iii. metre rule Qn.2. State the instrument that can be used to measure: a.internal diameter of test tube b.length of pencil c.diameter of wire. <u>Answers</u> <u>Qn.1.i. 0.001</u> <u>ii. 0.01</u> <u>iii. 0.1</u> <u>Qn.2.a.vernier caliper</u> <u>b.metre rule</u> <u>c.micrometer screw gauge</u>

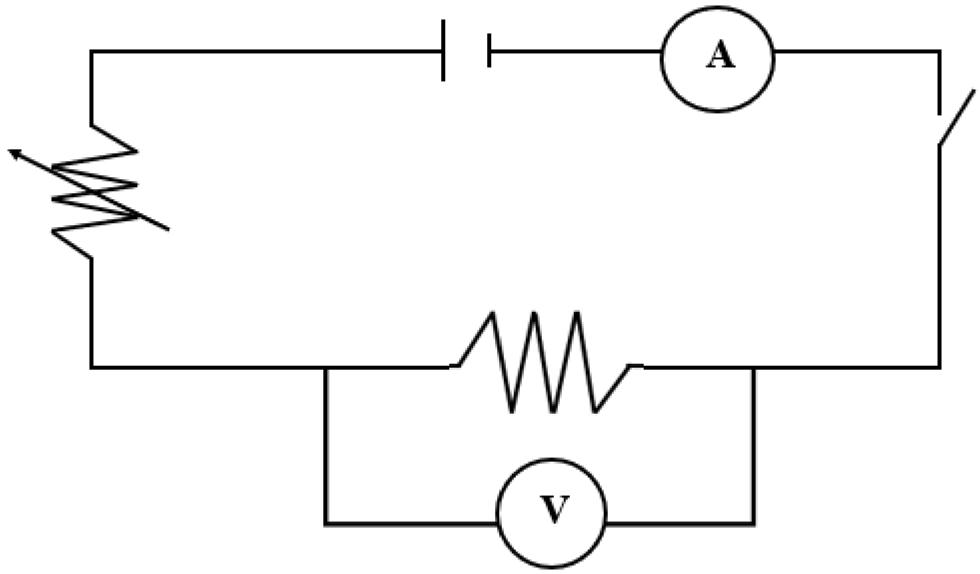
The Researcher organized remedial lesson after marking. The lesson covered terminologies in electricity, measuring skills and identification of apparatus and their symbols. The teaching-learning strategy employed was class discussion and activity where students were allowed to hand pick apparatus for identification. The class further discussed the function of displayed apparatus.

INTERVENTION LESSON PLAN 1

Number on Roll: 50 Class: SHS2
Subject: Physics Duration: 120
Reference: Asiedu (2006), Physics Practical for Senior High School
Relevant Previous Knowledge:
Teaching Learning Material: connecting wire, plug switch, cells, standard resistor ammeter volt meter, and resister box.

Topic/Sub-topic	Objectives	Teacher/Learner Activity	Core Points	Evaluation
<u>Topic</u> Determination of resistance of unknown resister	By the end of the lesson, students will be able to: 1.set up apparatus. 2. read and record ammeter and voltmeter 3.plot graph of V against I 4. state at least two precaution for the experiment	<u>Activity 1</u>. Teacher guided students to set up the apparatus. <u>Activity 2</u> Students read and record the ammeter and volt meter <u>Activity 3</u> Teacher discussed how to state precaution with the students	 Current(I)=I_1+I_2/2/A Voltage(V)=V+V/2/ Eg. Open the key before recording the readings to avoid increasing the resistance of the circuit.	Qn.1 Read and record the ammeter and volt meter in the table provided. Qn.2 Plot a graph of V on the vertical axis and I on the horizontal axis 3. State two precautions

Electric circuit set up for intervention lesson 1



Electric Circuit

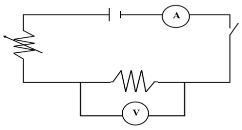
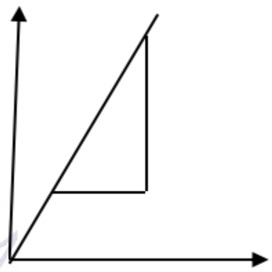
R-Resister box, E-Cell, K-Plug key, W-Standard resister, A-Ammeter, V-Voltmeter

Connect up the circuit as shown above. Set R to 10Ω and measure the potential difference across R and the corresponding current I through the ammeter. Repeat the procedure for values of R= 20Ω, 30Ω, and 50Ω. Calculate the product IR.

Plot a graph of IR as ordinate and V as abscissa. Measure the slope of the graph.

INTERVENTION LESSON PLAN 2

Number on Roll: 50 Class: SHS2
Subject: Physics Duration: 120
Reference: Asiedu (2006), Physics Practical for Senior High School
Relevant Previous Knowledge:
Teaching Learning Material: connecting wire, plug switch, cells, standard resistor ammeter volt meter, and resister box.

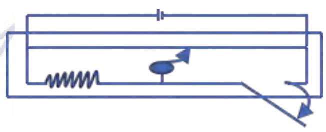
Topic/Sub-topic	Objectives	Teacher/Learner Activity	Core Points	Evaluation
<u>Topic</u> Verification of Ohm's law <u>Sub-topic</u> Determination of resistance of unknown resister	By the end of the lesson, students will be able to: 1. Set up the apparatus. 2. read and record ammeter and voltmeter 3.plot voltage against current 4. calculate the slope of the graph 5. state at least two precaution for the experiment	<u>Activity 1</u> Teacher guided students to set up the apparatus. <u>Activity 2</u> Students read and record the ammeter and volt meter <u>Activity 3</u> Students plot the graph with their values <u>Activity 4</u> Students calculate the slope of the graph <u>Activity 5</u> Teacher discussed how to state precaution with the students	 Current(I)=$I_1+I_2/2$/A Voltage(V)=V+V/2/V  IR/V V/V Slope=$^{dIR}/_{dIV}$ Eg. Open the key before recording the readings to avoid increasing the resistance of the circuit.	Qn.1 Read and record the ammeter and volt meter in the table provided. Qn.2 Plot a graph of V against I Qn.3 Calculate the slope of the graph

Week Five-Intervention Lesson

The topic for the week-five intervention lesson is a 'determination of a resistance of a wire'. The Researcher provided apparatus and a circuit diagram for students to serve as a guide for them to construct the setup for the lesson. .After the students have finished with the setup, the Researcher came in to guide the learners to determine the balance point on the setup. The Researcher further asked the learners to vary the length of the wire in the gab on the bridge and record the balance point. The result showed a quantum jump in the skills acquisition among learners.

INTERVENTION LESSON PLAN 3

Number on Roll: 50 Class: SHS2
Subject: Physics Duration: 120
Reference: Asiedu (2006), Physics Practical for Senior High School
Relevant Previous Knowledge:
Teaching Learning Material: connecting wire, plug switch, cells, standard resistor ammeter volt meter, and resister box.

Topic/Sub-topic	Objectives	Teacher/Learner Activity	Core Points	Evaluation
<u>Topic</u> Determination of resistance of tungsten wire	By the end of the lesson, students will be able to: 1.set up apparatus below. 2. determine the balance point 3.measure the distance *l* on the metre bridge	<u>Activity 1</u>. Teacher guides students to set up the apparatus. <u>Activity 2</u> Teacher guides students to determine the balance point. <u>Activity 3</u> Students read and record the length *l* on the metre bridge	 Theory: PQ/S=l/100-l	Qn.1 Read and record the value *l* at the balance point Qn.2 State condition at balance point <u>Answer</u> Qn. Potential across S&100-l is equal to potential across l & PQ

APPENDIX D

TRIAL EXERCISES

Week 2

4.2.1 Exercise 1: Figure (i), (ii) and (iii) are measuring instrument use in the physics laboratory. Name each of the equipment and state the physical quantity it measures. Determine the least count for each of instrument named.

Instruments

Figure 1: Meter Rule

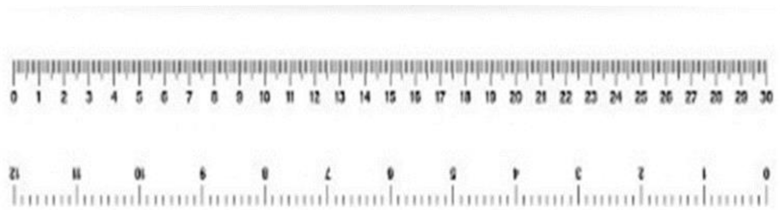


Figure 2: Ammeter

Figure 3:Voltmeter

Marking Scheme
1. i.meter rule; length; 0.1cm
ii. ammeter; current; 1.0mA
iii. voltmeter; potential difference (p.d); 1.0V

4.1.3 Exercise 3

1. Construct a simple direct current (d.c.) electric circuit with the apparatus provided on the bench.

2. Name the apparatus; E, X, R, K, A and V

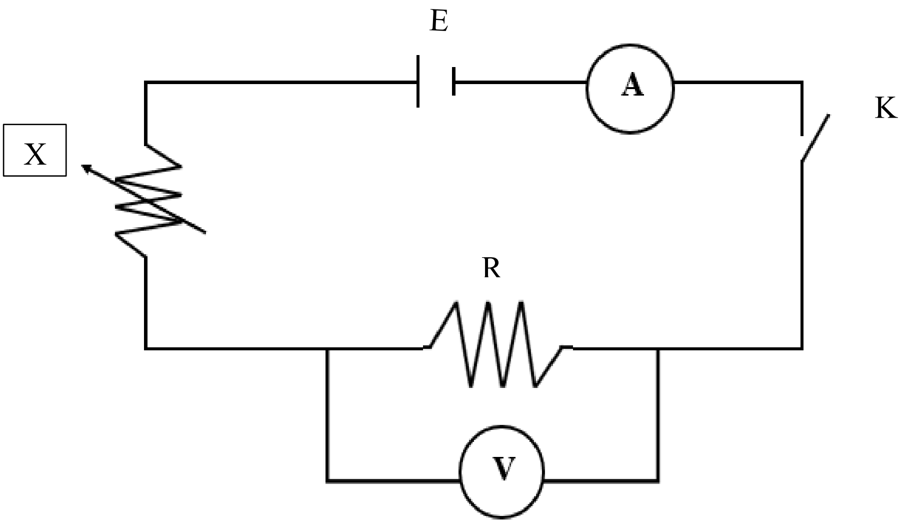
3. Close the circuit and record your observation

4. Vary X, four times and record the corresponding A and V values

5. Plot V against I and determine the slope.

Marking Scheme

1.



2. i. **E-** cell

ii. ivariable resistor

iii. R – Standard resistor

iv. K – Key

v. Ammeter

vi. voltmeter

3. The ammeter and voltmeter reading change

Table of results-Week 3

R/Ω	I_1/A	I_2/A	$I=(I_1+I_2)/2$	V_1	V_2	$V=(V_1+V_2)/2$	V/I
10	0.51	0.53	0.52	0.69	0.69	0.69	0.133
20	0.43	0.41	0.42	0.54	0.56	0.55	0.299
30	0.27	0.29	0.28	0.39	0.39	0.39	0.43
40	0.16	0.18	0.17	0.22	0.24	0.23	0.135

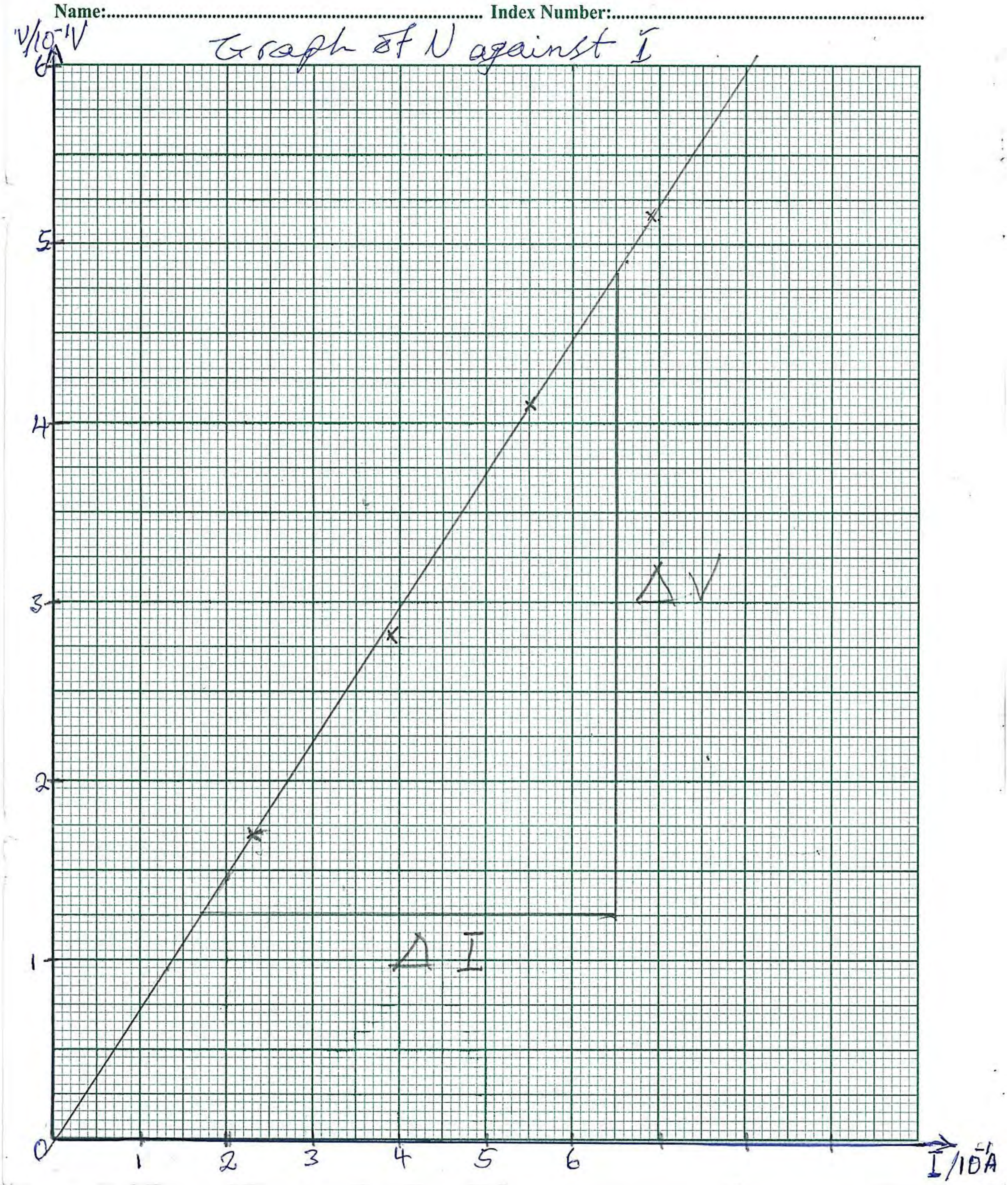
Plotted Values

$V/10^{-1}$ V	5.2	4.2	2.8	1.7
$I/10^{-1}$A	6.9	5.5	3.9	2.3

5.

(To be fastened together with other answers to paper)

Name:.. Index Number:..



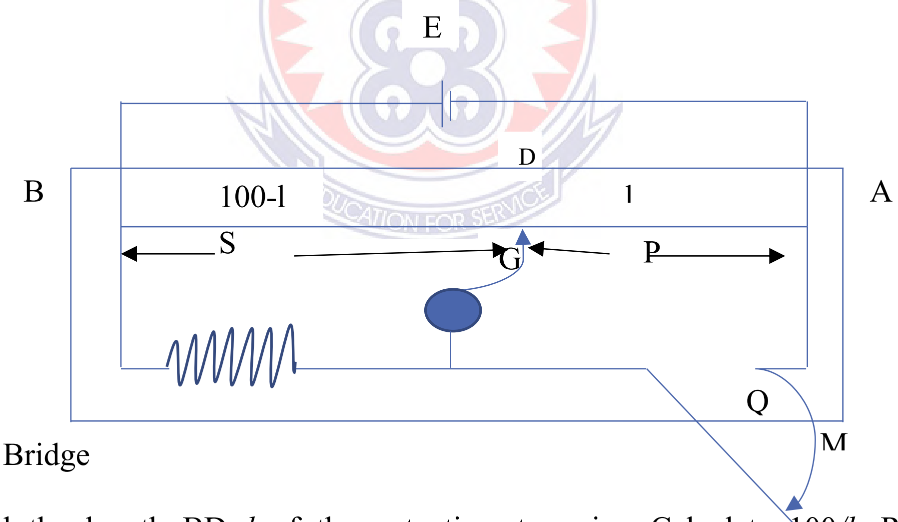
Exercise 4

Connect up the circuit as shown above. BA is a potentiometer wire which is 1.0m long and PM is a bare resistance wire which is about 1.0m long. S is 2Ω resistor. Q is a crocodile clip for making connection with the bare wire PM. Connect Q to PM such that the length y=80.0cm.With the jockey D, locate a point on the potentiometer wire BA such that there is no deflection of the galvanometer G when the key K is closed. Record the length BD=*l* of the potentiometer wire. Calculate 100/*l* .Repeat the procedure for y=70cm, 50cm, and 40cm. Tabulate your readings

Plot a graph with 100/*l* as ordinate and y abscissa, both axes from the origin.

Determine the slope of the graph and the intercept on the axes.

Apparatus: E=Cell, AB= Metre Bridge, G=Galvanometer, D= Jockey, S= Standard Resister, M= Tungsten Wire



Metre Bridge

Record the length BD=*l* of the potentiometer wire. Calculate 100/*l* .Repeat the procedure for y=70cm, 50cm, and 40cm. Tabulate your readings

Table of Results

y/cm	**S in left gap** *l₁/cm*	**S in right gap** l_2/cm	**Mean** *l*/cm	**100/*l***
80	37.2	37.4	37.30	2.68
70	39.5	39.5	39.50	2.53
50	44.8	44.8	44.70	2.24
40	47.9	47.8	47.85	2.10

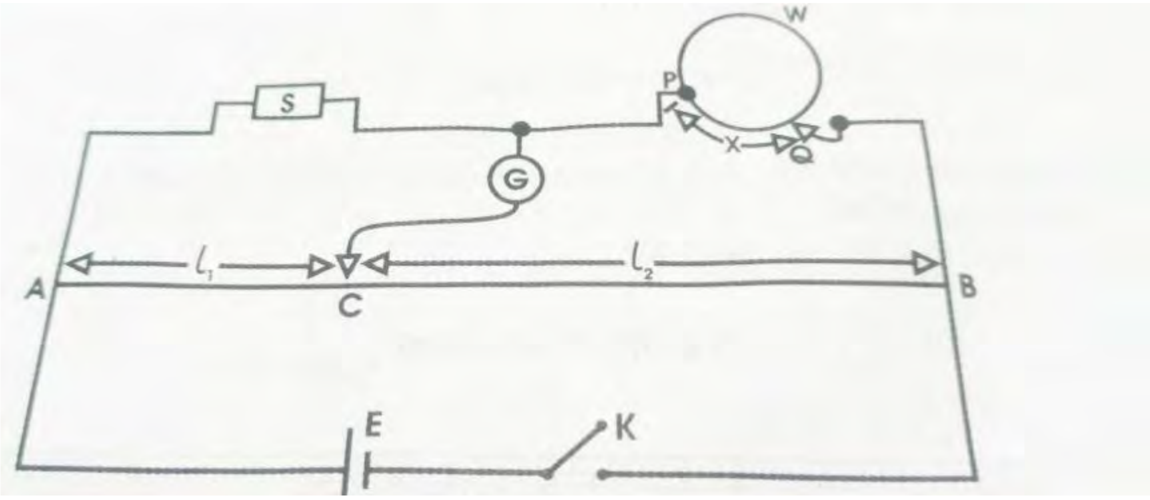
$Y/10^{-2}$ cm	8000	7000	5000	4000
$100/l \times 1/10^{-1}$	268	253	224	210

APPENDIX E

POST TEST

4.4 Post-Intervention Exercise

The evaluation of the effect of intervention strategies implemented on the development of scientific process skills and performance of students was carried out soon after the intervention. The students were able to set up and manipulate the apparatus to obtain readings which were tabulated. From the data tabulated, students drew graph and slope. The data on the learning outcome for the post-intervention test was collected, analyzed and presented in Table 12 and 13.



1. Set up the circuit as shown in the diagram above. Connect the resistant wire loop W in the right gap of the metre bridge and the standard resistance S with value sin the left gap. Use the crocodile clip to make contact on W such that the length PQ = x 15cm. Use the jockey to obtain a balance at Con the metre bridge. Measure and record. l_1 and l_2 .Hence calculate R $= \frac{sl2}{l1}$ and $\frac{R}{x}$ Repeat the experiment with four other resistance =30cm, 45cm, 60cm, and 80cm. Tabulate your results.

Plot a graph of $\frac{R}{x}$ as ordinate and x as abscissa. Determine the slope of the graph and the intercept on the x axis

2.Calculate the least count of the voltmeter.

3.Write down an equation showing the relationship between resistance R, the length l, the resistivity ρ and the cross-sectional area A, of a conductor

Table of results

x/m	S-in $l_{1/m}$	left gap l_2/m	S-in l_1/m	*right* gap l_2/m	Mean l_1/m	l_2/m	$\frac{l2}{l1}$	R/Ω
0.100	0.830	0.170	0.832	0.168	0.831	0.169	0.203	0.203
0.200	0.679	0.321	0.679	0.321	0.679	0.321	0.473	0.473
0.300	0.616	0.384	0.618	0.382	0.6170	0.383	0.621	0.621
0.400	0584	0.416	0.586	0.414	0.585	0.415	0.709	0.709
0.500	0.576	0424	0.578	0.422	0.577	0.423	0.733	0.733

APPENDIX F

STUDENTS' WEEKLY DATA

Table 4.6: Analysis of Students' Scores in the first Pre-Intervention Exercise for week 1

Students Represented by Codes(St)	Students' Scores of week 1	Students Represented by Codes(St)	Students' Scores of week 1
St1	7	St26	3
St2	1	St27	1
St3	2	St28	5
St4	5	St29	6
St5	6	St30	2
St6	2	St31	4
St7	0	St32	2
St8	4	St33	1
St9	0	St34	2
St10	2	St35	1
St11	3	St36	0
St12	3	St37	5
St13	2	St38	8
St14	1	St39	2
St15	5	St40	2
St16	2	St41	1
St17	5	St42	5
St18	1	St43	2
St19	5	St44	3
St20	1	St45	4
St21	4	St46	5
St22	3	St47	3
St23	2	St48	3
St24	3	St49	6
St25	2	St50	4
Average Score		**2.86**	

Table 4.7: Analyses of Students' Scores of the Pre-intervention exercise 2 for Week2

Students Represented by Codes(St)	Students' Scores of week 2	Students Represented by Codes	Students' Scores of week 2
St1	2	St26	8
St2	6	St27	1
St3	3	St28	6
St4	2	St29	1
St5	6	St30	2
St6	5	St31	7
St7	2	St32	2
St8	3	St33	6
St9	2	St34	2
St10	5	St35	1
St11	3	St36	2
St12	3	St37	7
St13	4	St38	4
St14	3	St39	2
St15	3	St40	2
St16	4	St41	3
St17	3	St42	2
St18	3	St43	2
St19	2	St44	3
St20	2	St45	4
St21	1	St46	4
St22	5	St47	2
St23	2	St48	5
St24	1	St49	6
St25	3	St50	7
Average Score		**3.38**	

Table4. 8: Analysis of Students' Science Process Skills Acquired in Week 2

Skills	Frequency of Students	Percentages (%)
Apparatus set up	42	84.00
Determination of least count	40	80.00
Follow procedure	17	34.00
Correct measurement	45	90.00
Correct drawing and labeling of axis	8	16.00
Scale choosing	5	10.00
Plotting of graph	8	16.00
Interpretation of results	3	6.00

Table 9: Analyses of Students' Scores of the Intervention exercise 1 for Week3

Students Represented by Codes(St)	Students' Scores of week 3	Students Represented by Codes(St)	Students' Scores of week 2
St1	3	St26	3
St2	3	St27	1
St3	7	St28	2
St4	6	St29	6
St5	6	St30	2
St6	7	St31	7
St7	3	St32	2
St8	5	St33	1
St9	6	St34	6
St10	5	St35	1
St11	5	St36	5
St12	2	St37	7
St13	4	St38	6
St14	4	St39	3
St15	8	St40	5
St16	6	St41	8
St17	6	St42	2
St18	3	St43	5
St19	3	St44	1
St20	4	St45	5
St21	4	St46	4
St22	5	St47	3
St23	2	St48	6
St24	4	St49	3
St25	6	St50	3
Average Score		**4.06**	

Table4.11: Analyses of Students' Process Skills Acquired in Week 3

Skills	**Frequency of Students (out of 50)**	**Percentages (%)**
Apparatus set up	47	94.00
Determination of least count	45	90.00
Follow procedure	20	40.00
Correct measurement	45	90.00
Correct drawing and labeling of axis	17	34.00
Scale choosing	8	16.00
Plotting of graph	17	34.00
Interpretation of results	8	16.00

Table 4.12: Analysis of Students' Scores of Intervention Exercise 2 for Week 4

Students Represented by Codes	Students' Scores of week 4	Students Represented by Codes	Students' Scores of week 4
St1	6	St26	7
St2	6	St277	10
St3	3	St28	8
St4	3	St29	3
St5	5	St30	3
St6	8	St31	7
St7	4	St32	6
St8	6	St33	3
St9	5	St34	6
St10	5	St35	3
St11	6	St36	7
St12	5	St37	8
St13	2	St38	7
St14	5	St39	4
St15	5	St40	5
St16	8	St41	2
St17	5	St42	5
St18	4	St43	5
St19	4	St44	7
St20	5	St45	6
St21	6	St46	8
St22	2	St47	5
St23	6	St48	2
St24	5	St49	4
St25	6	St50	4
Average Score		**5.12**	

Table4.13: Analysis of Students' Scores of Process Skills Acquired in Week 4

Expected Skills	Frequency of Students (out of 50)	Percentages (%)
Apparatus set up	45	90.00
Determination of least count	47	94.00
Follow procedure	33	66.00
Correct measurement	47	94.00
Correct drawing and labeling of axis	28	56.00
Scale choosing	20	40.00
Plotting of graph	25	50.00
Interpretation of results	32	64.00

Table 4.14: Analysis of Students' Scores of Intervention Exercise 3 for Week 5

Students Represented by Codes	Students' Scores of week 5	Students Represented by Codes	Students' Scores of week 5
St1	6	St26	5
St2	7	St27	7
St3	9	St28	6
St4	6	St29	2
St5	4	St30	5
St6	10	St31	7
St7	6	St32	3
St8	6	St33	4
St9	5	St34	4
St10	7	S35	4
St11	7	St36	6
St12	8	St37	8
St13	7	St38	7
St14	6	St39	3
St15	9	St40	7
St16	5	St41	3
St17	6	St42	10
St18	8	St43	4
St19	6	St44	6
St20	5	St45	2
St21	5	St46	7
St22	7	St47	5
St23	8	St48	8
St24	7	St49	3
St25	7	St50	5
Average Score		**5.96**	

Table 4.15: Analysis of Students' Scores of Process Skills Acquired in Week 5

Expected Skills	**Frequency of Students (out of 50)**	**Percentages (%)**
Apparatus set up	47	94.00
Determination of least count	47	94.00
Follow procedure	37	74.00
Correct measurement	48	96.00
Correct drawing and labeling of axis	37	74.00
Scale choosing	33	66.00
Plotting of graph	37	74.00
Interpretation of results	42	84.00

Table 4.16: Analysis of Students' Score of Post-Intervention Test for Week 6

Students Represented by Codes	Students' Scores of week 6	Students Represented by Codes	Students' Scores of week 6
St1	8	St26	4
St2	6	St27	7
St3	10	St28	5
St4	8	St29	7
St5	7	St30	3
St6	9	St31	10
St7	8	St32	6
St8	10	St33	9
St9	3	St34	8
St10	7	St35	4
St11	9	St36	8
St12	6	St37	10
St13	9	St38	10
St14	8	St39	6
St15	4	St40	8
St16	10	St41	6
St17	8	St42	6
St18	5	St43	10
St19	8	St44	6
St20	9	St45	7
St21	8	St46	5
St22	5	St47	9
St23	8	St48	7
St24	8	St49	4
St25	7	St50	8
Average Score		**6.90**	

Table 4.17: Analysis of Students' Score of Process Skills Acquired in Week 6

Skills	**Frequency of Students (out of 50)**	**Percentages (%)**
Apparatus set up	48	96.00
Determination of least count	47	94.00
Follow procedure	48	96.00
Correct measurement	49	98.00
Correct drawing and labeling of axis	45	90.00
Scale choosing	45	90.00
Plotting of graph	47	94.00
Interpretation of results	48	96.00

Table 4.18: Summary of Students' Average Performance Scores

Weeks	Average scores of fifty students
Week1	2.86
Week2	3.38
Week3	4.06
Week4	5.12
Week5	5.96
Week6	6.90

Table 4.19: Summary of Students Acquisition of Skills

Expected Skills	Weekly Percentage (%) of Students				
	Week2	Week3	Week4	Week5	Week6
Apparatus set up	84	94	90	94	96
Determination of least count	80	90	94	94	94
Follow procedure	34	40	66	74	96
Correct measurement	90	90	94	96	98
Correct drawing and labeling of axis	16	34	56	74	90
Scale choosing	10	16	40	66	90
Plotting of graph	16	34	50	74	94
Interpretation of results	6	16	64	84	96
Percentage (%)Range	6-90		16-96		90-98

APPENDIX G

QUESTIONNAIRE ITEMS

GENERAL INSTRUCTION

This questionnaire seeks to find out the effect of guided practical activities on students' motivation and academic performance of students in Winneba Senior High School. The questionnaire is purely for academic purpose and your identity and confidentiality of information provided in this academic exercise is protected. Please tick (√) the appropriate response.

Thank you.

DEMOGRAPHIC INFORMATION OF RESPONDENTS

1. Female [ ]

2. Male [ ]

SECTION A: ACADEMIC PERFORMANCE OF LEARNERS

1. What is your academic performance in physics?

I. Very satisfied [ ]

II. Satisfied [ ]

III. Neutral [ ]

IV. Dissatisfied [ ]

V. Very dissatisfied [ ]

2. Do you achieve high grades in your science classes?

Always [ ]

Often [ ]

Sometimes [ ]

Rarely [ ]

Never [ ]

3. You feel confident in your ability to perform well in science assessments.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

4. Do you regularly complete my science homework on time?

Always [ ]

Often [ ]

Sometimes [ ]

Rarely [ ]

Never [ ]

5 You understand the importance of science in your education.

Extremely important [ ]

Very important [ ]

Moderately important [ ]

Slightly important [ ]

Not at all important [ ]

SECTION B: ACQUISITION OF SCIENCE PROCESS SKILLS OF STUDENTS

6. You can effectively conduct experiments in science.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

7. You understand the scientific method and its application.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

8. You acquired skills for analysing data from science experiments.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

9. You can formulate hypotheses based on observations.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

10. You feel competent in using scientific tools and equipment.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

SECTION C: IMPACT OF GUIDED PRACTICAL ACTIVITIES.

11. Guided practical activities help you to understand physics concepts better.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

12. You believe that practical activities improve your academic performance in physics. Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree

13 You feel more engaged in learning physics through hands-on activities.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

14 Your interest in physics has increased due to guided practical activities.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

15. I can apply the knowledge gained from practical activities to real-life situations.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

SECTION D: CHANGES IN CONCEPTUAL UNDERSTANDING OF STUDENTS.

16. You feel more motivated to learn physics after participating in practical activities.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

17. Your understanding of electricity concepts has improved through guided activities. Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

18. You enjoy learning about electricity through practical experiences.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

19. You can relate electricity concepts to everyday life after these activities.

Strongly agree [Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

20. You believe that practical activities enhance my critical thinking skills in science.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

SECTION E: REALWORLD APPLICATION OF PHYSICS

21. You can explain how electricity works in real-world applications.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

22. You feel prepared to discuss electricity concepts in practical contexts. Strongly ag

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

23. You believe that guided activities help me solve real-world problems related to electricity.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

24. You can identify the role of electricity in technology and daily life.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

25. You understand the safety precautions necessary when working with electricity.

Strongly agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly disagree [ ]

APPENDIX H

RELIABILITY TEST RESULTS

Instrument	Number of Items	Cronbach's Alpha (α)	Accepted Threshold	Interpretation
Students' Performance Tests	15	0.88	≥ 0.80	High reliability
Science Process Skills Observation Checklist	10	0.85	≥ 0.80	High reliability
Students' Questionnaire	25	0.90	≥ 0.80	Very high reliability
Overall Instrument Reliability		0.90	≥ 0.80	Excellent internal consistency

APPENDIX I

STATISTICAL EXPRESSIONS USED FOR THE COMPUTATION OF MEAN AND STANDARD DEVIATION

Table X: Statistical Expressions Used for the Computation of Mean and Standard Deviation

S/N	Variable / Data Set Analysed	Symbolic Representation	Statistical Expression	Definition of Variables
1	Individual student score (test or questionnaire item)	x_i	–	x_i represents the score or Likert response of the i^{th} student
2	Total score of all students	$\sum x_i$	$\sum x_i = \sum_{i=1} x_i$	Sum of all students' scores or responses
3	Number of students	n	–	Total number of respondents ($n = 50$)
4	Mean score (general)	$\bar{x}$	$\bar{x} = \frac{\sum x_i}{n}$	Average score for a test, skill, or questionnaire item
5	Deviation score	$(x_i - \bar{x})$	–	Difference between an individual score and the mean
6	Squared deviation	$(x_i - \bar{x})^2$	–	Square of each deviation score
7	Sum of squared deviations	$\sum_{i=1}(x_i - \bar{x})^2$	$\sum_{i=1}(x_i - \bar{x})^2$	Total variability of scores
8	Variance (sample)	s^2	$s^2 = \frac{\sum(x_i - \bar{x})^2}{n-1)}$	Average squared deviation from the mean
9	Standard deviation (sample)	s	$s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1)}}$	Spread of students' scores around the mean
10	Mean of Likert-scale responses	$\bar{x}_{LS}$	$\bar{x}_{LS} = \frac{\sum fx}{Zf}$	Mean of Likert responses weighted by frequency
11	Frequency of a response option	f	–	Number of students choosing a particular Likert option
12	Likert response value	x	–	Numerical value assigned to Likert options (1-5)
13	Pre-intervention mean score	$\bar{x}_{pre}$	$\bar{x}_{pre} = \frac{\sum x_{prre}}{n}$	Mean score before guided practical intervention
14	Post-intervention mean score	$\bar{x}_{post}$	$\bar{x}_{post} = \frac{\sum x_{post}}{n}$	Mean score after guided practical intervention
15	Weekly intervention mean score	$\bar{x}_{week}$	$\bar{x}_{week} = \frac{\sum \bar{x}_{wost}}{n}$	Mean score for each intervention week
16	Mean science process skill acquisition	$\bar{x}_{skill}$	$\bar{x}_{skill} = \frac{\sum x_{skill}}{n}$	Average level of skill acquisition
17	Standard deviation of skills	$\bar{s}_{skill}$	$s_{skill} = \sqrt{\frac{\sum(x_{att} - \bar{x}_{suil})^2}{n-1}}$	Variability in science process skills
18	Mean attitude score	$\bar{x}_{att}$	$\bar{x}_{att} = \frac{\sum x_{att}}{n}$	Average attitude score from questionnaire
19	Standard deviation of attitude	$\bar{s}_{ath}$	$\bar{s}_{ath} = \frac{\sum x_{att} - \sum att^2}{}$	Spread of students' attitude scores