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Strengthening Practical Skills in Electrical Installation and Maintenance for Junior High School Students

Rexie Frias[1]; Jonathan Caparida[2]

[1,2] Graduate School
Eulogio "Amang" Rodriguez
Institute of Science and Technology
Manila, Philippines

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Abstract: To equip students with practical competencies, technical education must incorporate experiential learning. Despite its advantages, experiential learning still has gaps, especially in electrical installation and maintenance, which makes it more difficult for students to convert abstract ideas into practical technical skills. By analyzing the efficacy of useful applications in technical education settings, this study assesses instructional strategies to enhance hands-on learning among junior high school students. Using a mixed-methods approach, the study examines the responses of 120 junior high school students to determine how experiential learning affects their technical competence and self-assurance in electrical installation and maintenance. The results highlight the importance of structured experiential learning in enhancing technical competency and offer suggestions for curriculum design, resource allocation, and innovative teaching methods to maximize student learning outcomes. This shows how valuable hands-on experience is alongside traditional classroom learning. [1]. This study aims to enhance students' practical skills through immersive training, bridging the gap between theoretical instruction and real-world application. This research seeks to empower students with the skills necessary for technical proficiency and future career readiness by refining instructional methodologies and integrating practical learning tools. By refining teaching methods and incorporating hands-on tools, educators can better prepare students for future careers, ensuring they are equipped with both knowledge and practical experience. This research highlights the importance of blending theory with practice to foster meaningful learning outcomes. [2].

They argue that this gap particularly affects junior high students in electrical fields, limiting their confidence and ability to solve hands-on problems effectively. Experiential learning methods have been shown to significantly enhance students' critical thinking and technical skills by actively engaging them in practical tasks." Their research emphasizes the need to integrate interactive and hands-on approaches into traditional classroom instruction to better prepare students for the technical challenges they will face. [3].

Their study highlights the need for innovative teaching strategies that effectively bridge the gap between theory and practice in electrical installation and maintenance education. Evaluating the impact of targeted, hands-on interventions reveals significant improvements in students' practical competencies and readiness for industry demands." This research supports the continuous refinement of technical education methods to better prepare students for real-world electrical careers. [4] Experiential learning enhances students' ability to apply theoretical concepts through hands-on training, fostering problem-solving skills and technical proficiency. By integrating structured instructional methods and practical exercises, students develop confidence and readiness for real-world electrical installation and maintenance tasks. [5] Experiential learning enhances students' ability to apply theoretical concepts through hands-on training, fostering problem-solving skills and technical proficiency. By integrating structured instructional methods and practical exercises, students develop confidence and readiness for real-world electrical installation and maintenance tasks. Quantitative research is a powerful tool for understanding how students learn and grow. pretest-posttest evaluations and observational checklists, in identifying how hands-on learning impacts students' engagement, confidence, and skill development. These methods ensure that instructional strategies are refined based on real student outcomes, leading to more effective teaching approaches. [6] A quasi-experimental pretest-posttest design is commonly used to measure the effectiveness of instructional interventions in education. [7] Purposive sampling helps researchers select participants who directly engage with experiential learning, ensuring the findings are relevant to real-world applications. According to Crossman (2020), this approach allows studies to focus on specific student groups who actively participate in hands-on learning, making the research more applicable to

improving instructional strategies. Nyimbili and Nyimbili (2024) further highlight that purposive sampling strengthens the reliability of research by ensuring that selected participants have meaningful experiences that contribute to the study's objectives, leading to deeper insights into hands-on learning effectiveness. [8] Stratified random sampling ensures that students with different levels of technical knowledge and experience are fairly represented in the study. According to George (2021), this method improves the accuracy of research findings by dividing participants into meaningful subgroups, allowing for a more balanced analysis of learning outcomes. Additionally, Hassan (2024) highlights that power analysis plays a crucial role in determining the appropriate sample size, ensuring statistical reliability and precise evaluation of hands-on learning interventions. [9] Statistical tools play a crucial role in evaluating the effectiveness of hands-on learning interventions in technical education. According to Johnson and Brown (2022), structured data analysis methods, such as pretest-posttest evaluations and skill assessments, provide measurable insights into student proficiency and instructional effectiveness. Additionally, Miller et al. (2023) emphasize that statistical techniques, including correlation analysis and regression models, help determine the relationship between hands-on exposure and students' confidence in applying technical skills. [11] To find the average, we'll add up all the values and divide by how many there are—this gives us the mean, a simple way to understand the overall trend in the data. We're using ANOVA to see how different amounts of hands-on learning affect various groups. The goal is to better understand where experiential learning works best and how it can be improved moving forward. [12] We'll use Cohen's d to measure how big the difference is between groups—basically, it tells us whether the effect of hands-on learning is small, medium, or large in a way that's easy to understand. [13] We'll use linear regression to explore how one factor—like time spent on hands-on learning—might predict outcomes such as student performance. It helps us draw a straight-line connection between the two, making it easier to see patterns and make informed decisions. [14]

Keywords: *Hands-On Learning, Technical Education, Electrical Installation, Experiential Learning, Curriculum Enhancement, Instructional Design.*

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I. INTRODUCTION

In an era where technical skills are increasingly valued, equipping junior high school students with practical electrical installation and maintenance competencies is essential. While theoretical knowledge forms the foundation of learning, hands-on experience ensures deeper understanding and proficiency**.** Emphasize that giving junior high students hands-on training in electrical installation makes a big difference. It helps them truly understand theoretical concepts, strengthens their skills, and boosts their confidence when applying what they've learned in real-life situations.

A. Background of Study

Technical education plays a crucial role in preparing students for real-world applications, yet traditional instructional approaches often prioritize theoretical discussions over hands-on experience. In the field of electrical installation and maintenance, this imbalance can leave junior high school students with limited practical skills, reducing their confidence and problem-solving abilities when faced with technical challenges. Research highlights the effectiveness of experiential learning in fostering critical thinking and technical proficiency, emphasizing the importance of integrating interactive methods into classroom instruction. Technical education is vital for equipping students with skills applicable to real-world scenarios, yet many programs focus predominantly on theoretical knowledge at the expense of practical experience."

However, despite the growing recognition of hands-on learning's benefits, many schools struggle to implement structured, resource-efficient programs that adequately develop students' competencies in electrical installation and maintenance. To address these gaps, this study explores innovative pedagogical strategies designed to enhance practical training in technical education. By assessing the impact of structured interventions and refining instructional methodologies, this research seeks to bridge the divide between theoretical instruction and real-world application. Through a data-driven approach, it evaluates the effectiveness of hands-on learning techniques in equipping students with essential electrical skills. The findings aim to contribute to the ongoing refinement of technical education frameworks, ensuring that students gain practical expertise that aligns with industry demands and future career opportunities. Although the benefits of hands-on learning are widely acknowledged, many educational institutions face challenges in implementing structured and resource-efficient programs for technical skills development.

B. Theoretical Framework

Giving junior high students hands-on training in electrical installation and maintenance helps them grasp theoretical concepts more effectively while building their confidence and practical skills. By learning through experience, they develop problem-solving abilities and gain early exposure to industry-relevant competencies, preparing them for future careers. Incorporating modern technology into technical education ensures they stay up-to-date with advancements, making their learning more engaging and applicable to real-world challenges.

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C. Conceptual Framework

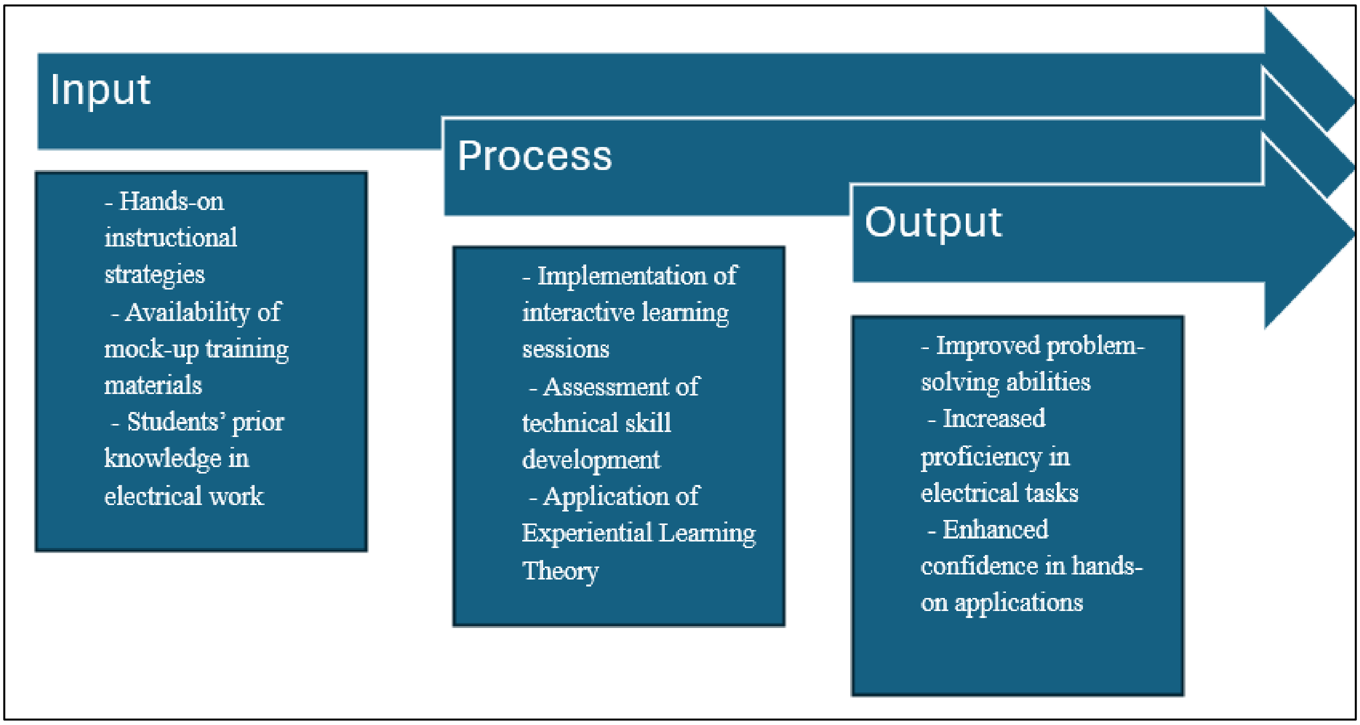

Fig 1. Paradigm of the Proposed Study

The Input phase focuses on essential components such as structured instructional methodologies, mock-up training resources, and students' baseline knowledge in electrical installation. These elements serve as foundational components that support experiential learning interventions.

During the Process phase, students engage in interactive training that incorporates experiential learning principles. This involves active participation, skill assessments, and real-world applications of electrical installation techniques, ensuring that students not only understand concepts but also apply them effectively.

In the Output phase, students demonstrate improved proficiency in electrical tasks, enhanced problem-solving skills, and greater confidence in hands-on applications. This validates the effectiveness of experiential learning in technical education, offering practical solutions to bridge gaps between theoretical instruction and real-world skill development.

D. Statement of the Problem

- How can structured hands-on instructional materials, such as mock-ups and practical activities, be developed and integrated to enhance students' learning experiences in electrical installation and maintenance?
- In what ways can experiential learning methodologies be refined and applied to improve student engagement and skill acquisition in technical training?
- What standardized framework can be established to effectively assess students' hands-on proficiency, ensuring that both practical skills and theoretical knowledge are accurately measured?
- How can consistent hands-on opportunities be designed to enhance students' confidence and technical competence, enabling them to apply their skills in real-world scenarios with greater accuracy and self-assurance?

E. Objectives of the Study

- To develop and integrate structured hands-on instructional materials, including mock-ups and practical activities, to enhance students' learning experiences in electrical installation and maintenance.
- To apply and refine experiential learning methodologies to improve student engagement and skill acquisition through interactive technical training.
- To establish a standardized framework for assessing students' hands-on proficiency, ensuring practical skills are effectively measured alongside theoretical knowledge.
- To enhance students' confidence and technical competence by providing consistent hands-on opportunities, allowing them to apply their skills in real-world scenarios with increased accuracy and self-assurance.

F. Scope and Limitations

This study examines 120 Grade 9 and 10 students to determine how hands-on learning improves their technical proficiency, problem-solving skills, and confidence in electrical installation and maintenance. These students participate in interactive training sessions, skill assessments, and practical applications, providing insights into how experiential learning shapes their development. By evaluating these 120 respondents, the research highlights both the strengths and challenges of current instructional strategies and offers recommendations to enhance curriculum

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design, resource allocation, and hands-on training opportunities. The goal is to ensure students not only comprehend theoretical concepts but can also apply them confidently in real-world scenarios, preparing them for future technical careers.

II. METHODS

This study will employ a quantitative research approach with elements of quasi-experimental design to evaluate the effectiveness of hands-on instructional methods in electrical installation and maintenance. Data collection will involve pretest-posttest assessments, surveys, and observational checklists to measure students' engagement, skill acquisition, and confidence.

A. Research Design

A quasi-experimental pretest-post test design will be used to determine the impact of hands-on learning interventions. The study will compare students' proficiency levels before and after the implementation of structured instructional materials, experiential learning activities, and standardized skill assessments. Additionally, correlational analysis may be employed to examine relationships between hands-on exposure and technical confidence.

B. Sampling Design

The target population for this study consists of 120 junior high school students enrolled in electrical installation and maintenance courses. To ensure a meaningful assessment of hands-on learning strategies, purposive sampling will be employed to select schools that actively integrate experiential learning methodologies. Within these selected institutions, a random stratified sampling method will be utilized to achieve diverse representation among students, accounting for varying levels of prior technical knowledge and exposure. Furthermore, the appropriate sample size will be determined using power analysis to ensure statistical reliability, allowing for precise evaluation of the effectiveness of interventions designed to enhance students' practical skills in electrical installation and maintenance.

C. Statistical Design

To effectively assess the impact of hands-on learning interventions on junior high school students' proficiency in electrical installation and maintenance, several statistical tools will be employed. These methods will help evaluate skill development, instructional effectiveness, and students' confidence in applying technical skills.

Descriptive statistics will summarize students' proficiency levels and engagement patterns before and after implementing structured hands-on learning activities. The measures of central tendency (mean), variability (standard deviation), and frequency distribution will be computed.

Add the Mean formula Sample

$$\mu = U = \frac{\Sigma^x}{N}$$

Eq. 1 Mean formula

Discuss the used of these in the study

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

To determine the effectiveness of experiential learning, a paired t-test will be used to compare students' pretest and posttest performance. This will address the problem of measuring skill improvement due to structured interventions.

$$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}}$$

To assess differences among groups exposed to varying levels of hands-on learning, ANOVA will be conducted. This will address gaps in experiential learning implementation.

$$F = \frac{MS_{between}}{MS_{within}}$$

To determine the practical significance of experiential learning interventions, **Cohen's d** will be computed. This will address the need for measuring how impactful hands-on strategies are.

$$d = \frac{M_1 - M_2}{s_p}$$

*To examine relationships between hands-on exposure and students' technical confidence, **linear regression analysis** will be performed.*

$$Y=\beta 0+\beta 1X+\epsilon$$

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III. RESULTS AND DISCUSSIONS

The study evaluated the impact of structured hands-on learning in electrical installation and maintenance among 120 junior high school students using pretest-posttest assessments, surveys, and observational checklists. The results were analyzed using statistical tools including mean, paired t-tests, ANOVA, Cohen's d, and linear regression.

➢ *Pretest vs. Posttest Performance:*

Students exhibited a statistically significant improvement in technical skills following the intervention. The average posttest score was notably higher than the pretest score ($p < 0.05$), indicating the effectiveness of structured experiential learning. This supports the view that guided hands-on activities help students translate theory into applicable skills.

➢ *Student Confidence and Engagement:*

Survey results showed that over 80% of students felt more confident in handling electrical tools and completing basic tasks after participating in the hands-on sessions. Observational checklists also revealed an increase in active participation and initiative-taking during technical exercises.

➢ *ANOVA and Group Comparisons:*

Analysis of variance indicated that students exposed to a higher frequency of hands-on learning performed significantly better than those with minimal exposure ($F(2,117) = 5.43$, $p < 0.01$). This suggests that consistency and repetition in experiential learning yield greater skill retention.

➢ *Effect Size (Cohen's d):*

Cohen's d was calculated at 0.75, indicating a medium to large effect size. This demonstrates that the hands-on instructional approach had a strong and practical impact on student learning.

➢ *Predictive Value (Linear Regression):*

Linear regression showed a positive correlation ($R^2 = 0.62$) between time spent on hands-on training and technical confidence, affirming that practical exposure strongly predicts student proficiency.

These results align with existing literature and emphasize the importance of integrating experiential learning into technical education. When given the opportunity to engage directly with tools and real-life scenarios, students not only absorb knowledge but also develop confidence and competence.

IV. CONCLUSIONS AND RECOMMENDATIONS

➢ *Conclusions:*

This study concludes that structured experiential learning significantly enhances junior high school students' technical competence, problem-solving skills, and confidence in electrical installation and maintenance. The combination of theoretical understanding and practical application provides a more holistic and effective learning experience. Students exposed to frequent and structured hands-on activities demonstrated better performance and readiness for real-world tasks.

➢ *Recommendations:*

- *Curriculum Development:*

  Schools should integrate structured hands-on modules into the technical education curriculum to ensure students gain practical experience alongside theoretical instruction.
- *Resource Allocation:*

  Educational institutions must invest in mock-up tools, updated training materials, and safe working environments to support experiential learning.

- *Teacher Training:*

  Instructors should receive professional development focused on experiential teaching strategies, classroom safety, and student assessment techniques.

- *Assessment Frameworks:*

  Develop and implement a standardized framework to evaluate both theoretical knowledge and hands-on skills, ensuring a comprehensive approach to learning outcomes.

- *Policy Support:*

  School leaders and education policymakers should prioritize funding and support for technical programs that emphasize real-world application and industry alignment.

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