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Usability of Information and Communications Technology in Electrical Installation and Maintenance: Its Impact On Improving Technical Proficiency in Creating and Understanding Electrical Circuits

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ABSTRACT: This study examined the usability of Information and Communications Technology (ICT) tools, teacher cognition regarding ICT integration, and students' technical proficiency in Electrical Installation and Maintenance (EIM) among junior high school students in pasig. Specifically, it investigated how teachers use simulation software, computer-aided design (CAD) tools, and instructional videos/multimedia resources, the relationship between ICT usability and teacher cognition, and the influence of teacher demographics on these variables. A descriptive-correlational research design was employed, with data collected from 33 teacher-respondents through total enumeration, representing the entire available population of EIM educators in the selected schools. Statistical analyses, including means, standard deviations, t-tests, ANOVA, and pearson correlation, were used to interpret the results. Findings revealed that teachers extensively used instructional videos and multimedia resources, while simulation software and CAD tools were underutilized. Teacher cognition regarding ICT integration was generally high in multimedia resources but low for specialized CAD tools in terms of awareness, knowledge, and operational skills. Students demonstrated proficiency in wiring diagram accuracy and installation skills and were highly proficient in safety practices. Significant differences in ICT usability and teacher cognition were influenced by age, sex, grade level taught, and years of teaching experience, whereas students' technical proficiency was not significantly affected by these demographic factors. Correlational analysis showed that simulation software, CAD tools, and multimedia resources positively influenced teacher cognition, while only instructional videos and multimedia resources significantly impacted students' safety practices. Based on these findings, a blended ICT-based instructional framework was proposed, integrating simulation software, CAD tools, and multimedia resources with hands-on practice, assessment, and feedback to enhance both teacher competence and student technical proficiency. This study highlights the importance of ICT integration in technical education, emphasizing that teacher competence with ICT tools enhances instructional delivery, while practical application remains essential for developing students' technical skills in EIM.

KEYWORDS: computer-aided design, instructional videos and multimedia resources, simulation software, technical proficiency, teacher cognition

I. INTRODUCTION

In today's digital era, the integration of Information and Communications Technology (ICT) into education is recognized globally as a pivotal strategy for advancing teaching and learning. This integration is particularly critical in technical-vocational domains such as Electrical Installation and Maintenance (EIM), where both cognitive and psychomotor skills are essential for student competence. International organizations, including UNESCO and the International Monetary Fund (IMF), underscore ICT's role in cultivating higher-order thinking, technical accuracy, and problem-solving abilities, particularly in skill-intensive disciplines. Globally, the use of ICT tools such as simulations, computer-aided design (CAD) software, and instructional videos has transformed traditional pedagogical methods by offering interactive, visual, and practice-based learning opportunities that mirror real-world applications. These tools are especially relevant in fostering proficiency in essential EIM tasks, including accurate interpretation of wiring diagrams and safe execution of electrical installations, thereby preparing learners for industry-aligned employment opportunities.

This global trend toward digital competency is reflected in the philippine educational landscape through policy reforms designed to modernize technical and vocational training. Republic Act No. 10533, the Enhanced Basic Education Act of 2013,

institutionalizes a learner-centered and globally competitive system equipped with technical proficiencies responsive to the 21st-century workforce. Complementing this, the Department of Education (DepEd) issued Order No. 16, s. 2023, or the Revised Guidelines on the Implementation of the DepEd Computerization program (DCp), mandating ICT infrastructure, software provision, and professional development to strengthen technology integration across schools. These policies form a robust framework for embedding ICT into technical-vocational education programs, thereby reinforcing the national commitment to global competitiveness.

Within the K–12 curriculum, the Technology and Livelihood Education (TLE) strand highlights ICT integration as a pedagogically sound and research-informed approach to technical skill development. Empirical studies further validate the effectiveness of ICT in this domain. For instance, Nurtanto et al. (2020) and Afolayan and Okorie (2023) demonstrate that simulations enhance students' accuracy and safety awareness in technical tasks. Similarly, Cezar (2023) and Jayme et al. (2020) highlight that interactive learning environments significantly increase student engagement and comprehension of electrical concepts. Juera (2022) and Mistades and Orolfo (2023) likewise emphasize that ICT-mediated instruction supports both conceptual understanding and practical performance in EIM competencies.

However, challenges persist despite these promising developments. Issues such as teacher ICT readiness, unequal resource distribution, and infrastructure limitations continue to impede the full realization of ICT-enhanced instruction. At the Grade 9 and 10 level, many learners still struggle with accurately constructing wiring diagrams and executing safe electrical installations skills, which are foundational in EIM. Furthermore, while ICT has been extensively studied in relation to other disciplines such as physics and automotive technology, research focusing specifically on its application in junior high school EIM remains scarce. Tools such as phET simulations, mobile-based Electrical Wiring Simulators (EWS), and digital twin laboratories have shown potential in enhancing concept mastery, yet studies like Moses et al. (2021) caution that barriers related to teacher training, resource inequity, and implementation fidelity remain pronounced, particularly in public school contexts such as pasig City.

Against this backdrop, the present study seeks to address existing research gaps by examining the usability of ICT in teaching EIM at the Grade 9 and 10 level. Specifically, it aims to evaluate the extent to which ICT tools and strategies enhance both cognitive and psychomotor skills in creating and understanding electrical circuits, while also identifying the contextual challenges teachers encounter in ICT integration. Anchored on national education mandates and supported by empirical evidence, this study aspires to generate insights that will inform curriculum development, teacher capacity-building programs, and policy refinements in technical-vocational education. Ultimately, its findings are expected to contribute to the development of technically proficient and safety-conscious learners in pasig City junior high schools.

Research Question

This study, titled Usability of Information and Communications Technology In Electrical And Installation Maintenance: Its impact on improving technical proficiency in creating and understanding electrical circuits, sought to address the following research questions:

1. What is the demographic profile of the teacher-respondents in terms of:
   1.1 Age;
   1.2 Sex;
   1.3 Grade level taught; and
   1.4 Years of teaching experience?
2. What is the extent of usability of ICT tools in teaching Electrical Installation and Maintenance as perceived by teacher-respondents, in terms of:
   2.1 Simulation software;
   2.2 Computer-aided design (CAD) tools; and
   2.3 Instructional videos and multimedia resources?
3. What is the level of cognition of teacher-respondents regarding ICT integration in Electrical Installation and Maintenance, in terms of:
   3.1 Awareness of ICT tools;
   3.2 Knowledge of ICT applications; and
   3.3 Skills in operating ICT resources?
4. What is the level of students' technical proficiency in Electrical Installation and Maintenance as assessed by teachers, in terms of:

4.1 Wiring diagram accuracy;
4.2 Installation skills; and
4.3 Safety practices?

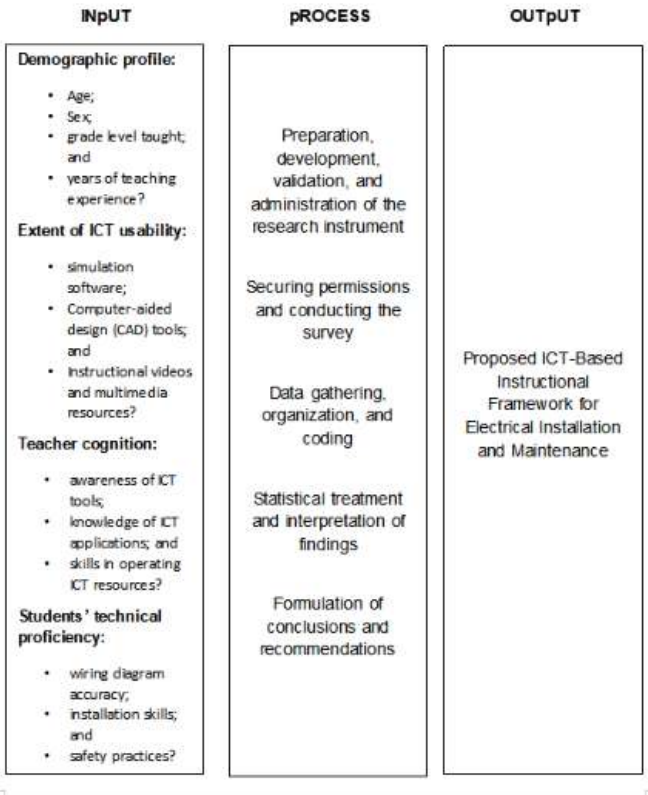
5. Is there a significant difference in the extent of usability of ICT tools in teaching EIM when grouped according to the profile of the respondents?
6. Is there a significant difference in the level of cognition of teacher-respondents regarding ICT integration in EIM when grouped according to the profile of the respondents?
7. Is there a significant difference in the level of students' technical proficiency in EIM, as assessed by teachers, when grouped according to the profile of the respondents?
8. Is there a significant relationship between the extent of usability of ICT tools, the level of cognition of teacher-respondents regarding ICT integration, and the level of students' technical proficiency in EIM?
9. Based on the findings, what ICT-based instructional framework can be proposed to enhance technical proficiency in Electrical Installation and Maintenance among junior high school students in pasig City?

II. SCOPE AND LIMITATION OF THE STUDY

This study, titled Usability of Information and Communications Technology in Electrical Installation and Maintenance: Its Impact on Improving Technical proficiency in Creating and Understanding Electrical Circuits, was delimited to junior high schools in pasig City that offered the Electrical Installation and Maintenance (EIM) program. It specifically assessed the demographic profile of teacher-respondents in terms of age, sex, grade level taught, and years of teaching experience. The study examined the extent of usability of ICT tools in teaching EIM as perceived by teacher-respondents, focusing on three key dimensions: simulation software, computer-aided design (CAD) tools, and instructional videos and multimedia resources. In addition, it investigated the level of cognition of teacher-respondents regarding ICT integration in EIM, which was measured in terms of awareness of ICT tools, knowledge of ICT applications, and skills in operating ICT resources. Moreover, the study assessed the level of students' technical proficiency in EIM, as evaluated by teachers, concentrating on wiring diagram accuracy, installation skills, and safety practices.

A total of 33 Grade 9 and 10 EIM teachers served as respondents, selected through total enumeration to ensure that all available educators actively teaching EIM in the selected schools were included in the study. The research utilized a descriptive-correlational design and was conducted during the school year 2025–2026.

Framework



This study is anchored on the Constructivist Learning Theory of piaget and Vygotsky and the Experiential Learning Theory of Kolb, which emphasize that meaningful learning occurs when learners actively construct knowledge through engagement, collaboration, reflection, and authentic experiences. These theories provide the pedagogical foundation for integrating Information and Communications Technology (ICT) into Electrical Installation and Maintenance (EIM) instruction, as ICT tools allow learners to visualize concepts, perform simulations, solve authentic problems, and apply theoretical knowledge in practical situations. Through these technology-enhanced learning experiences, students are expected to develop both cognitive understanding and technical competencies essential for Electrical Installation and Maintenance.

Guided by these theoretical foundations, the study adopted the Input–process–Output (IpO) Model as its conceptual framework. The IpO model illustrates the logical flow of the study by identifying the variables to be examined, the procedures undertaken to achieve the objectives, and the expected outcome based on the findings.

The Input of the study consists of the demographic profile of the teacher-respondents in terms of age, sex, grade level taught, and years of teaching experience. It also includes the extent of usability of ICT tools in teaching Electrical Installation and Maintenance as perceived by teachers, specifically simulation software, computer-aided design (CAD) tools, and instructional videos and multimedia resources. Furthermore, the input covers the level of cognition of teacher-respondents regarding ICT integration, particularly their awareness of ICT tools, knowledge of ICT applications, and skills in operating ICT resources. Lastly, the input includes the level of students' technical proficiency in Electrical Installation and Maintenance, as assessed by teachers, in terms of wiring diagram accuracy, installation skills, and safety practices.

The process involves the systematic conduct of the research. It begins with the preparation, development, validation, and administration of the research instrument. This is followed by securing the necessary permissions, conducting the survey among the respondents, gathering and organizing the data, applying the appropriate statistical treatments, interpreting the findings, and formulating the conclusions and recommendations. These procedures ensure that the study is conducted objectively and that the data collected are reliable, valid, and appropriate for addressing the research objectives.

The Output of the study is the development of a proposed ICT-Based Instructional Framework for Electrical Installation and Maintenance. This framework is intended to strengthen ICT integration in EIM instruction by providing evidence-based strategies that enhance teachers' instructional practices and improve students' technical proficiency in creating and understanding electrical circuits. Ultimately, the proposed framework aims to support curriculum enhancement, teacher professional development, and improved learning outcomes among junior high school students in pasig City.

Research Design

This study employed a quantitative descriptive-correlational research design, which was deemed appropriate for capturing existing practices and evaluating the impact of Information and Communication Technology (ICT) integration in the teaching of Electrical Installation and Maintenance (EIM). The design was suitable for systematically collecting and analyzing quantifiable data from a defined group, specifically Grade 9 and 10 EIM teachers in selected junior high schools in pasig City. Its descriptive nature allowed an in-depth examination of how ICT tools and strategies were utilized in instruction and how these were related to students' technical proficiency in creating and understanding electrical circuits (Kumar, 2020).

Data were gathered through a structured survey questionnaire administered to 33 EIM teachers who were included in the study through total enumeration. The instrument was designed to measure the extent of ICT usability, particularly in terms of awareness of ICT tools, knowledge of ICT applications, and skills in operating ICT resources. It also assessed teachers' perceptions of students' technical proficiency, focusing on wiring diagram accuracy, circuit installation skills, comprehension of electrical circuits, and adherence to safety practices.

The descriptive quantitative approach involved the numerical representation, tabulation, and analysis of responses, followed by interpretations that revealed observable trends, relationships, and patterns (Cohen et al., 2021). This approach enabled the researcher to determine the prevalence and perceived effectiveness of ICT integration in EIM instruction, providing insights that informed the improvement of ICT-based instructional strategies for technical-vocational education.

This methodology was particularly suitable for the study, as it supported evidence-based analysis of instructional practices without manipulating variables, thereby ensuring objectivity and generalizability (Babbie, 2022). Although it was acknowledged that quantitative methods might not fully capture the complexities of classroom interactions and individual learning experiences, the approach yielded statistically grounded conclusions essential for curriculum enhancement, professional development, and policy-making in the field of technical-vocational education (Creswell & Creswell, 2021).

Research Instrument

The primary data collection tool utilized in this study was a researcher-developed survey questionnaire. This instrument is designed as a structured tool to gather essential quantitative data aligned with the study's objective of assessing the impact of ICT integration in Electrical Installation and Maintenance (EIM) instruction on students' technical proficiency in selected junior high schools in pasig City.

The questionnaire was consisted of Four major sections that comprehensively address the study's variables and research questions.

Part I specifically assessed the demographic profile of teacher-respondents in terms of age, sex, grade level taught, and years of teaching experience. part II examined the extent of usability of ICT tools in teaching EIM as perceived by teacher-respondents, focusing on three key dimensions: simulation software, computer-aided design (CAD) tools, and instructional videos and multimedia resources. In addition, part III investigated the level of cognition of teacher-respondents regarding ICT integration in EIM, which was measured in terms of awareness of ICT tools, knowledge of ICT applications, and skills in operating ICT resources. Moreover, part IV assessed the level of students' technical proficiency in EIM, as evaluated by teachers, concentrating on wiring diagram accuracy, installation skills, and safety practices.

Data Gathering

To ensure the validity and reliability of data collection, the researcher implemented a series of systematic procedures aligned with the study's objective of evaluating the impact of ICT integration in Electrical Installation and Maintenance (EIM) instruction on the technical proficiency of junior high school students in pasig City.

The process began with the face validation of the researcher-developed survey instrument by the research adviser. This initial step confirmed that the questionnaire items were clear, relevant, and aligned with the study's key variables, namely the extent of ICT tool usability and the perceived level of student proficiency in EIM. The validated instrument was then submitted to a panel of experts in Technical-Vocational Education, Electrical Technology, and Educational Research for further review and refinement.

Once the instrument was finalized, the researcher formally sought approval from the Schools Division Superintendent of pasig City to conduct the study in selected public junior high schools offering the EIM specialization for Grades 9 and 10. Correspondence was also made with the respective school principals and TLE/EIM department heads to ensure cooperation and support throughout the data-gathering process.

Following the approval, the survey questionnaires were distributed to the 33 EIM teacher-respondents included through total enumeration. Clear instructions were provided to all participants regarding the purpose of the study, the confidentiality of responses, and the proper completion of the survey. The researcher coordinated closely with school administrators to schedule the administration of the survey in a manner that minimized disruption to teaching schedules. To maintain the integrity of the process, the researcher and trained assistants personally facilitated the distribution and retrieval of questionnaires while addressing clarifications raised by the respondents.

After the data collection, responses were systematically organized, coded, and analyzed using statistical software such as SpSS and Microsoft Excel. Descriptive statistics, including frequency counts, percentages, means, and standard deviations, were employed to present the demographic profile of respondents and summarize the extent of ICT integration and student proficiency levels. Inferential statistics such as t-tests, ANOVA, and pearson's correlation were applied to identify significant differences and relationships between demographic factors, ICT usability, and student performance indicators.

This systematic approach ensured that the findings of the study were valid, reliable, and grounded in rigorous methodological practices, thereby providing actionable insights into the role of ICT in improving students' technical proficiency in EIM instruction.

Statistical Treatment

The researcher assumed full responsibility for data generation, organization, and analysis. The data collected were systematically categorized based on the research problems formulated for this study.

To address problem 1, which pertained to the demographic profile of the respondents in terms of age, sex, grade level taught, and years of teaching experience, Descriptive Statistics were employed. This included frequency counts, percentages, means, and standard deviations, which provided a clear and comprehensive profile of the 33 EIM teacher-respondents.

To address problem 2 (the extent of ICT tools and strategies used in EIM instruction) and problem 3 (the level of cognition of teachers on ICT integration), Descriptive Statistics were likewise utilized. Specifically, the mean and standard deviation were

computed for each identified ICT integration strategy, such as simulation software, CAD tools, and multimedia instructional resources.

For problem 4, which sought to determine the level of students' technical proficiency in terms of wiring diagram accuracy, installation skills, and safety practices, the mean and standard deviation were also calculated based on the teachers' assessments.

To answer problem 5, which examined whether there was a significant difference in the extent of usability of ICT tools when grouped according to teachers' demographic profiles, Independent Samples t-tests (for dichotomous variables like sex) and One-Way Analysis of Variance (ANOVA) (for variables with more than two categories, such as years of teaching experience) were applied. The null hypothesis (H_0) assumed no significant difference existed, while the alternative hypothesis (H_1) suggested that a significant difference was present.

To address problem 6, which investigated whether there was a significant difference in the level of cognition of teacher-respondents regarding ICT integration when grouped according to demographic profile, Independent Samples t-tests and One-Way ANOVA were also used to determine whether variations in demographic factors influenced their ICT-related cognition.

For problem 7, which assessed whether there was a significant difference in students' technical proficiency when grouped according to their teachers' demographic profiles, the same inferential statistical tools (Independent Samples t-tests and One-Way ANOVA) were employed.

To address problem 8, which aimed to determine the significant relationship between ICT usability, teacher cognition of ICT integration, and students' technical proficiency, pearson's Correlation Coefficient was utilized. This analysis measured the strength and direction of the relationship among these variables.

Finally, to address problem 9, an ICT-based instructional framework was proposed based on the findings of the study. This framework served as a strategic guide to enhance the use of ICT in EIM instruction, bridging gaps identified in technology integration and its influence on student proficiency. The framework was designed to support improved curriculum delivery, teaching effectiveness, and student technical competence in junior high school EIM programs within pasig City.

III. RESULTS

This chapter presents, analyzes, and interprets the findings of the study regarding the usability of Information and Communications Technology (ICT) tools, the level of cognition of teacher-respondents regarding ICT integration, and the level of students' technical proficiency in Electrical Installation and Maintenance (EIM) among selected public junior high schools in pasig City. The presentation of data follows the sequence of the Statement of the problem to ensure proper alignment between the research objectives, findings, and interpretations. The results are presented through tables, followed by discussions supported by relevant literature and previous studies.

1. What is the demographic profile of the teacher-respondents in terms of:
1.1 Age;

Age	Frequency	percentage
21 – 25 years old	0	0.0
26 – 30 years old	5	15.2
31 – 35 years old	8	24.2
36 years old and above	20	60.6
Total	**33**	**100**

The age distribution reveals that the majority of teacher-respondents are 36 years old and above, accounting for 60.6% of the total sample. This is followed by those aged 31–35 years old (24.2%) and 26–30 years old (15.2%), with no respondents in the 21–25 age group. This pattern indicates that the teaching workforce in the study is predominantly composed of older and more experienced individuals. It suggests that most respondents have likely spent several years in the profession, allowing them to develop deeper pedagogical knowledge, classroom management skills, and professional maturity.

The predominance of older teachers implies a workforce rich in experience, which can positively influence instructional quality and student outcomes. However, the absence of younger teachers (21–25 years old) may indicate limited entry of new educators into the profession or possible retention issues among early-career teachers. This could lead to challenges in sustaining innovation, integrating new teaching methodologies, and adapting to rapidly evolving educational technologies. Therefore, educational institutions may need to strengthen recruitment strategies and provide support systems for younger teachers to ensure a balanced age distribution and long-term workforce sustainability.

Recent research highlights the benefits of age diversity in the teaching profession. A mixed-age teaching workforce promotes both stability and innovation, with experienced teachers providing guidance and institutional knowledge, while younger teachers contribute fresh perspectives, technological adaptability, and innovative instructional approaches (Darling-Hammond, Hyler, &

Gardner, 2023). This underscores the importance of a balanced teacher age profile for maintaining high-quality education and fostering a dynamic, adaptable learning environment.

1.2 Sex;

Sex	Frequency	percentage
Male	25	75.8
Female	8	24.2
Total	**33**	**100**

In terms of sex, the data reveal that the majority of the teacher-respondents are male, accounting for 25 respondents or 75.8%, while 8 respondents or 24.2% are female. This indicates a clear predominance of male teachers among the respondents. The findings suggest that the teaching population represented in the study is largely male-dominated, with female teachers comprising a smaller proportion of the sample. This pattern may reflect existing gender distributions in certain teaching fields or institutions, where male educators are more represented. The predominance of male teachers may have implications for diversity and inclusivity within the educational environment.

According to Ingersoll, Merrill, and Stuckey (2022), balanced gender representation among teachers enhances student engagement, improves collaborative learning, and introduces a wider variety of teaching approaches.

Moreover, Darling-Hammond et al. (2023) argue that diverse teaching teams foster more inclusive educational practices, support equity in student outcomes, and encourage role modeling for underrepresented groups. These findings suggest that promoting gender balance among teaching staff is not only a matter of equity but also a strategy to enrich educational quality.

1.3 Grade level taught;

Grade Level Taught	Frequency	percentage
Grade 9	18	54.5
Grade 10	15	45.5
Total	**33**	**100**

As to grade level taught, more than half of the teacher-respondents are teaching Grade 9, with 18 respondents or 54.5%, while 15 respondents or 45.5% are teaching Grade 10. The difference between the two groups is relatively small, indicating that both grade levels are well represented in the study. However, Grade 9 teachers comprise a slightly larger share of the respondents, suggesting that the sample leans more toward teachers handling the lower grade level in junior high school.

This distribution indicates that the perspectives gathered in the study reflect experiences from both Grade 9 and Grade 10 teachers, providing a balanced view of teaching practices within junior high school. The slightly higher number of Grade 9 teachers may influence the overall findings, as their teaching context, student readiness, and curriculum demands may differ from those of Grade 10.

A relatively balanced representation of grade levels is important in ensuring that the results are comprehensive and applicable across different stages of junior high school. It allows for better comparison and understanding of instructional practices, challenges, and student engagement between the two grade levels, contributing to more informed educational decisions and strategies. Recent studies support this, emphasizing that diversity in teacher characteristics—including grade level assignment—helps education systems better respond to varying student needs and improve overall teaching effectiveness (Organization for Economic Co-operation and Development, 2024).

Recent research supports the significance of diversity in teacher characteristics and grade-level assignments. For example, Darling-Hammond et al. (2023) emphasize that variations in grade-level context influence instructional approaches and student learning needs, and that balanced representation among teaching assignments helps school systems tailor pedagogy to developmental and curricular differences. A diverse distribution across grade levels facilitates collaboration among teachers, improves alignment of instruction with student readiness, and promotes coherent learning progressions across grades.

1.4 Years of teaching experience

Years of Teaching Experience	Frequency	percentage
1 – 5 years	5	15.2
6 – 10 years	9	27.3
11 – 15 years	1	3.0
16 years and above	18	54.5
Total	**33**	**100**

In terms of years of teaching experience, the largest proportion of respondents have 16 years and above in teaching, with 18 respondents or 54.5%. This is followed by those with 6–10 years of experience at 9 respondents or 27.3%, while 5 respondents or 15.2% have 1–5 years of teaching experience. Only 1 respondent or 3.0% falls under the 11–15 years category. These findings

indicate that the majority of the teacher-respondents are highly experienced, implying that most have spent a considerable length of time in the teaching profession.

A workforce dominated by highly experienced teachers may contribute to stability and effectiveness in instructional delivery. However, it may also highlight the need to encourage the entry and retention of younger teachers to ensure continuity and innovation in the profession. Recent research supports this, noting that a balance between experienced and early-career teachers enhances both instructional quality and adaptability in education systems, as emphasized by the Organization for Economic Co-operation and Development (2023).

2. What is the extent of usability of ICT tools in teaching Electrical Installation and Maintenance as perceived by teacher-respondents, in terms of:

2.1 Simulation software;

Indicators	Mean	VI
I regularly use electrical circuit simulation software (e.g., TinkerCAD, EveryCircuit, proteus) to demonstrate concepts and principles in Electrical Installation and Maintenance lessons.	1.97	LE
I regularly assign students tasks or projects that require them to design and test electrical circuits using simulation software.	2.09	LE
Virtual laboratory environments or interactive simulations are integral to my teaching of electrical installation and maintenance topics, allowing students to explore circuit behavior without physical components.	2.09	LE
I utilize simulation software to provide immediate feedback to students on their circuit designs and troubleshooting skills.	2.00	LE
My instructional materials for Electrical Installation and Maintenance consistently incorporate activities that leverage ICT-based simulation tools to enhance students' understanding of electrical circuits.	2.12	LE
General Assessment	**2.05**	**LE**

Legend:
3.25 – 4.00 Very Great Extent (VGE) *2.50 – 3.24 Great Extent (GE)*
1.75 – 2.49 Low Extent (LE) *1.00 – 1.74 Very Low Extent (VLE)*

The general assessment for simulation software yielded a mean of 2.05, interpreted as Low Extent. The highest mean was 2.12, obtained by the statement, “My instructional materials for Electrical Installation and Maintenance consistently incorporate activities that leverage ICT-based simulation tools to enhance students' understanding of electrical circuits,” which is still interpreted as Low Extent. Meanwhile, the lowest mean was 1.97, obtained by the statement, “I regularly use electrical circuit simulation software (e.g., TinkerCAD, EveryCircuit, proteus) to demonstrate concepts and principles in Electrical Installation and Maintenance lessons,” also interpreted as Low Extent.

This finding supports the study of Audonnet et al. (2022), which emphasized that simulation environments provide realistic and interactive platforms that improve understanding through visual representation and practical modeling. Similarly, pacheco-Velazquez et al. (2024) highlighted that interactive simulation systems and real-time feedback mechanisms enhance technical learning experiences by connecting theoretical concepts with practical applications.

In the context of EIM instruction in pasig City, the use of simulation software provides opportunities for learners to strengthen their conceptual understanding before engaging in actual electrical installation activities. However, continuous teacher training and availability of appropriate digital resources remain necessary to maximize the instructional potential of simulation-based learning.

2.2 Computer-aided design (CAD) tools; and

Indicators	Mean	VI
I use CAD software (e.g., AutoCAD, SketchUp, Fritzing) to demonstrate the creation of electrical circuit diagrams in my lessons.	1.94	LE
I regularly assign students tasks that require them to design and modify electrical circuits using CAD tools.	1.88	LE
My teaching incorporates simulations of electrical circuits generated through CAD software to help students understand circuit behavior.	1.88	LE
I provide structured activities where students interpret and analyze electrical circuit designs created using CAD tools.	1.88	LE
The use of CAD tools significantly enhances my students' technical proficiency in understanding complex electrical circuit concepts.	1.94	LE
General Assessment	**1.90**	**LE**

Legend:
3.25 – 4.00 Very Great Extent (VGE) *2.50 – 3.24 Great Extent (GE)*
1.75 – 2.49 Low Extent (LE) *1.00 – 1.74 Very Low Extent (VLE)*

The general assessment for Computer-Aided Design (CAD) tools obtained a mean of 1.90, interpreted as Low Extent based on the study’s scale legend. The result indicates that CAD tools are minimally utilized by teacher-respondents in teaching Electrical Installation and Maintenance. Although CAD applications provide opportunities for creating accurate electrical layouts, designing wiring diagrams, and improving visualization of circuit structures, their current integration remains limited.

The low utilization of CAD tools may be attributed to possible factors such as limited access to software applications, insufficient teacher training, lack of familiarity with CAD-based instruction, or inadequate institutional support. The finding suggests the need for capacity-building programs that focus on developing teachers' competencies in utilizing CAD applications for technical instruction.

This result is consistent with studies emphasizing that advanced ICT applications require sufficient technological knowledge and confidence among teachers. Cabero-Almenara et al. (2023) noted that specialized digital tools in technical education require continuous professional learning because effective integration depends on teachers' technological competence and pedagogical readiness. Therefore, strengthening CAD integration in EIM instruction may contribute to improving students' ability to interpret technical drawings, visualize electrical systems, and develop workplace-related competencies.

2.3 Instructional videos and multimedia resources?

Indicators	Mean	VI
I regularly incorporate instructional videos to demonstrate electrical circuit concepts and procedures in my Electrical Installation and Maintenance classes.	3.33	VGE
I regularly use multimedia resources (e.g., simulations, interactive diagrams, presentations with embedded media) to enhance students' understanding of electrical circuits.	3.09	GE
Instructional videos and multimedia resources are an integral part of my daily lesson plans for teaching electrical installation and maintenance topics.	3.27	VGE
I utilize instructional videos to provide step-by-step guidance for students in creating and troubleshooting electrical circuits.	3.18	GE
I actively encourage students to explore and use multimedia resources independently to deepen their knowledge of electrical circuits and related concepts.	3.21	GE
General Assessment	**3.22**	**GE**

Legend:
3.25 – 4.00 Very Great Extent (VGE) *2.50 – 3.24 Great Extent (GE)*
1.75 – 2.49 Low Extent (LE) *1.00 – 1.74 Very Low Extent (VLE)*

The general assessment for instructional videos and multimedia resources obtained a mean of 3.22, interpreted as Great Extent. The findings indicate that teacher-respondents frequently utilize instructional videos and multimedia resources to support EIM instruction. These resources are commonly used to demonstrate electrical procedures, explain complex concepts, and provide step-by-step guidance in performing technical activities.

The findings support previous studies emphasizing the effectiveness of multimedia-based instruction in improving learner engagement and conceptual understanding. Interactive and visual resources allow students to observe procedures, review demonstrations, and develop clearer mental representations of electrical concepts.

Overall, the results indicate that while instructional videos and multimedia resources are already integrated into EIM teaching practices, greater attention should be given to strengthening the use of more specialized ICT tools such as CAD applications and simulation software to provide more comprehensive technology-enhanced learning experiences.

3. What is the level of cognition of teacher-respondents regarding ICT integration in Electrical Installation and Maintenance, in terms of:

3.1 Awareness of ICT tools:

Indicators	Mean	VI
I am aware of the availability of simulation software (e.g., circuit simulators) that can be used in teaching Electrical Installation and Maintenance.	2.67	HL
I am familiar with the use of computer-aided design (CAD) tools in developing and interpreting electrical layouts.	2.45	LL
I am aware of various multimedia resources (e.g., instructional videos, interactive modules) that support EIM instruction.	2.82	HL
I am knowledgeable of ICT tools that enhance students' understanding of wiring diagrams and circuit design.	2.70	HL
I am familiar with digital platforms and applications that can be integrated into EIM instruction to improve technical proficiency.	2.70	HL
General Assessment	**2.67**	**HL**

Legend:
3.25 – 4.00 Very High Level (VHL) *2.50 – 3.24 High Level (HL)*
1.75 – 2.49 Low Level (LL) *1.00 – 1.74 Very Low Level (VLL)*

The findings revealed that teacher-respondents demonstrated a High Level of awareness of ICT tools based on the overall weighted mean of 2.67.

This indicates that teachers possess a generally strong familiarity with available ICT resources that may support Electrical Installation and Maintenance instruction. Their awareness is particularly evident in their recognition of multimedia resources such as instructional videos and interactive modules, which are widely used to enhance classroom instruction and improve students' understanding of technical concepts. However, their awareness of more specialized tools such as Computer-Aided Design (CAD) applications is comparatively lower, suggesting limited exposure or experience in using advanced technical software for electrical layout development and interpretation.

This finding is supported by Cabero-Almenara et al. (2023), who emphasized that teachers' technological awareness influences their readiness to adopt digital tools in educational settings. The study highlighted that recognizing the educational value of ICT is an essential factor in promoting meaningful technology integration.

In the context of EIM instruction in pasig City, teachers' awareness of ICT tools provides opportunities for improving instructional strategies and enhancing students' exposure to technology-supported learning experiences.

3.2 Knowledge of ICT applications, and

Indicators	Mean	VI
I know how to use simulation software to demonstrate electrical circuit operations in EIM.	2.55	HL
I am knowledgeable about using computer-aided design (CAD) tools to create accurate wiring diagrams.	2.30	LL
I understand how to apply ICT applications in troubleshooting electrical faults and problems.	2.76	HL
I can integrate multimedia instructional resources (e.g., videos, interactive modules) into my EIM teaching.	3.12	HL
I am familiar with using ICT tools to enhance students' technical proficiency in electrical installation and maintenance.	2.91	HL
General Assessment	**2.73**	**HL**

Legend:
3.25 – 4.00 Very High Level (VHL) 2.50 – 3.24 High Level (HL)
1.75 – 2.49 Low Level (LL) 1.00 – 1.74 Very Low Level (VLL)

The findings revealed that teacher-respondents obtained an overall weighted mean of 2.73, interpreted as High Level in terms of knowledge of ICT applications.

The result indicates that teachers possess knowledge regarding how ICT resources can be applied to support EIM instruction. This includes understanding the possible applications of digital tools in explaining electrical concepts, presenting technical procedures, creating instructional materials, and supporting students' learning activities. The data further show that teachers are most proficient in integrating multimedia instructional resources such as videos and interactive modules, which enhance student engagement and facilitate clearer understanding of complex electrical concepts. However, the lower level of knowledge observed in the use of computer-aided design (CAD) tools suggests that more specialized technical applications are less familiar to the respondents.

Furthermore, studies on ICT integration in technical education emphasized that teachers' technological knowledge contributes to more engaging, interactive, and learner-centered instruction. This suggests that strengthening teachers' ICT knowledge through professional development programs, especially in specialized applications such as CAD software, may improve the quality of EIM instruction and better align teaching practices with industry standards.

3.3 Skills in operating ICT resources

Indicators	Mean	VI
I am able to effectively operate simulation software in teaching Electrical Installation and Maintenance (EIM).	2.52	HL
I am skilled in using computer-aided design (CAD) tools to support instructional delivery in EIM.	2.15	LL
I can integrate instructional videos and multimedia resources smoothly into classroom activities.	3.18	HL
I am proficient in troubleshooting minor technical issues encountered while using ICT tools during instruction.	2.67	HL
I can utilize online platforms or applications to enhance teaching and learning in EIM.	2.76	HL
General Assessment	**2.65**	**HL**

Legend:
3.25 – 4.00 Very High Level (VHL) 2.50 – 3.24 High Level (HL)
1.75 – 2.49 Low Level (LL) 1.00 – 1.74 Very Low Level (VLL)

The findings revealed that teacher-respondents demonstrated a High Level of skills in operating ICT resources, with an overall weighted mean of 2.65.

This indicates that teachers possess varying levels of ability in using ICT tools for instructional purposes. Their skills involve operating digital applications, managing multimedia resources, and incorporating technology-based strategies during EIM instruction. In particular, teachers showed strong capability in integrating instructional videos and multimedia resources smoothly into classroom activities, as reflected in the highest mean score of 3.18, interpreted as High Level. This suggests that they are proficient in utilizing commonly accessible ICT tools that enhance student engagement and support clearer presentation of technical concepts.

However, the result also revealed a notable limitation in more specialized ICT applications, as shown in the lowest mean score of 2.15, interpreted as Low Level, particularly in the use of computer-aided design (CAD) tools.

This indicates that while teachers are comfortable with general ICT resources, they may lack sufficient technical proficiency in advanced software that is highly relevant to Electrical Installation and Maintenance instruction. Such limitation may restrict the depth of simulation-based learning and precision-oriented instruction that CAD tools can provide in technical education.

The result emphasizes that technical competence in operating ICT resources is necessary for transforming technology availability into meaningful classroom applications. Teachers who possess adequate operational skills are more capable of designing technology-supported learning activities that enhance students' understanding and technical performance.

In the context of EIM instruction, this means that while multimedia integration supports conceptual learning, advanced tools like CAD are essential for developing higher-order technical skills and industry-aligned competencies.

This finding is consistent with previous studies emphasizing that teacher competence is one of the major factors affecting successful ICT implementation. Although digital resources may be available, their effectiveness depends on teachers' confidence, skills, and ability to integrate them appropriately into instruction.

The Organization for Economic Co-operation and Development (2023) further supports this, noting that enhancing teachers' operational ICT skills significantly improves teaching effectiveness and student learning outcomes in technical and vocational education.

Therefore, continuous professional development focusing on ICT applications in Electrical Installation and Maintenance is recommended to further improve teachers' technological skills and instructional practices, particularly in strengthening their proficiency in specialized tools such as CAD software.

4. What is the level of students' technical proficiency in Electrical Installation and Maintenance as assessed by teachers, in terms of:

4.1 Wiring diagram accuracy;

Indicators	Mean	VI
My students consistently draw wiring diagrams that accurately represent the components and connections of a given electrical circuit.	3.03	p
My students accurately interpret standard electrical symbols and apply them correctly when creating wiring diagrams.	3.18	p
My students demonstrate a strong understanding of current flow and voltage paths, as evidenced by the logical and correct arrangement of wires in their diagrams.	3.03	p
My students can identify and correct errors in pre-existing wiring diagrams with a high degree of accuracy.	2.88	p
My students are proficient in translating a physical electrical circuit into a precise and readable wiring diagram.	2.94	p
General Assessment	**3.01**	**p**

Legend:
3.25 – 4.00 Highly proficient (Hp) *2.50 – 3.24 proficient (p)*
1.75 – 2.49 Developing (D) *1.00 – 1.74 Basic (B)*

The findings revealed that students demonstrated a proficient Level of proficiency in wiring diagram accuracy, with an overall weighted mean of 3.01.

This indicates that students possess a certain level of ability in preparing and interpreting electrical wiring diagrams. Accuracy in wiring diagrams reflects learners' understanding of electrical symbols, circuit connections, and proper representation of electrical systems based on established standards.

The result suggests that students are developing their technical drawing and circuit interpretation skills, which are essential competencies in Electrical Installation and Maintenance. The higher mean obtained in accurately interpreting standard electrical symbols (3.18) implies that students have a solid grasp of foundational electrical concepts, particularly in recognizing and applying correct symbols in diagram construction. However, the lower mean in identifying and correcting errors in pre-existing wiring diagrams (2.88) indicates that students still need further development in higher-order thinking skills such as analysis, evaluation, and troubleshooting.

This finding supports the importance of integrating technology-based learning resources in technical education. Digital tools such as simulation software and CAD applications can provide students with opportunities to visualize electrical layouts, practice circuit development, and identify possible errors before actual implementation. These tools also allow learners to engage in iterative learning processes where mistakes can be immediately corrected, thereby strengthening their diagnostic and problem-solving abilities.

In the context of EIM instruction in pasig City, strengthening students' wiring diagram accuracy through ICT-supported activities may contribute to improved technical preparation and workplace readiness. Emphasizing error analysis activities, simulation-based exercises, and guided diagram correction tasks may further enhance students' competency in both conceptual understanding and practical application of electrical installation principles.

4.2 installation skills; and

Indicators	Mean	VI
Students consistently demonstrate a high level of accuracy in wiring and connecting electrical components according to circuit diagrams.	2.85	p
Students effectively use appropriate tools and equipment for various electrical installation tasks, such as stripping wires, bending conduits, and mounting devices.	3.00	p
Students adhere to safety protocols and standards while performing electrical installation procedures, minimizing risks and ensuring proper handling of materials.	3.12	p
Students can independently troubleshoot common installation issues and make necessary adjustments to ensure the functionality of electrical circuits.	2.76	p
Students can interpret and follow complex electrical schematics and blueprints to successfully complete installation projects.	2.76	p
General Assessment	**2.90**	**p**

Legend:
3.25 – 4.00 Highly proficient (Hp) *2.50 – 3.24 proficient (p)*
1.75 – 2.49 Developing (D) *1.00 – 1.74 Basic (B)*

The findings revealed that students demonstrated a proficient Level of proficiency in installation skills, with an overall weighted mean of 2.90.

This indicates that students possess the ability to perform electrical installation procedures involving the proper handling of tools, installation of components, and application of technical processes. Installation skills represent the practical application of knowledge gained through classroom discussions, demonstrations, and hands-on activities.

The result suggests that students are generally able to apply electrical concepts during practical tasks; however, continued exposure to authentic learning experiences is necessary to further strengthen their confidence, accuracy, and efficiency in performing installation activities. This is evident in the higher mean obtained in adhering to safety protocols (M = 3.12), which shows that students are well-trained in maintaining safe practices during installations. In contrast, the lower means observed in troubleshooting common installation issues and interpreting complex electrical schematics (M = 2.76) indicate areas where students still require additional support to achieve greater independence and precision in task execution.

This supports the findings of studies emphasizing that simulation-based learning provides safe environments where students can practice technical procedures, strengthen problem-solving abilities, and improve decision-making skills before engaging in real-world tasks. The Organization for Economic Co-operation and Development (2023) further highlights that technical proficiency is strengthened when learners are exposed to both conceptual understanding and applied, technology-supported practice.

Therefore, strengthening ICT-supported practical activities may enhance students' ability to perform electrical installation procedures while promoting safer, more accurate, and more effective learning experiences, particularly in developing higher-order technical competencies such as troubleshooting and schematic interpretation.

4.3 Safety practices.

Indicators	Mean	VI
The student consistently demonstrates the proper use of personal protective Equipment (ppE) when performing electrical tasks.	3.45	Hp
The student always follows lockout/tagout procedures to ensure de-energized circuits before beginning work.	3.52	Hp
The student accurately identifies and mitigates potential electrical hazards in the work environment.	3.45	Hp
The student effectively uses and stores electrical tools and equipment safely, minimizing risks.	3.42	Hp
The student demonstrates a thorough understanding of electrical safety regulations and applies them in practical scenarios.	3.45	Hp
General Assessment	**3.46**	**Hp**

Legend:
3.25 – 4.00 Highly proficient (Hp) *2.50 – 3.24 proficient (p)*
1.75 – 2.49 Developing (D) *1.00 – 1.74 Basic (B)*

The findings revealed that students demonstrated a Highly proficient Level of proficiency in safety practices, with an overall weighted mean of 3.46.

This indicates that students demonstrate awareness and application of safety procedures during Electrical Installation and Maintenance activities. Safety practices include proper use of tools and equipment, compliance with electrical safety standards, and adherence to precautionary measures to prevent accidents.

The result highlights the importance of safety education in technical-vocational instruction. Since electrical tasks involve potential hazards, students must develop not only technical competence but also responsible work practices.

ICT resources may further strengthen safety practices by providing instructional videos, digital demonstrations, and simulated scenarios that allow students to observe correct procedures and understand possible workplace risks. These resources provide additional learning opportunities beyond traditional classroom demonstrations.

The finding supports previous studies indicating that multimedia-based instruction improves students' understanding of procedural knowledge by allowing repeated observation of technical demonstrations and safety protocols. In addition, research emphasizes that consistent reinforcement of safety standards through technology-enhanced instruction helps learners internalize correct practices and reduce operational risks in hands-on environments (Organization for Economic Co-operation and Development, 2023).

5. Is there a significant difference in the extent of usability of ICT tools in teaching EIM when grouped according to the profile of the respondents?

5.1 in terms of Age;

Demographic profile	Usability of ICT tools in Teaching EIM	F-value	df	p-value	Remarks	Decision
Age	Simulation software	12.770	32	0.006	Significant	Reject the Ho
	Computer-aided design (CAD) tools	10.800	32	0.262	Not Significant	Accept the Ho
	Instructional videos and multimedia resources	11.240	32	0.136	Not Significant	Accept the Ho

The results indicate that age was significantly associated with the usability of simulation software, as reflected by the reported p-value of 0.006, which is lower than the 0.05 level of significance. Thus, the null hypothesis was rejected for simulation software. This suggests that the respondents' assessments of the usability of simulation software differed significantly across age groups. In contrast, no significant differences were found in the usability of computer-aided design (CAD) tools (p = 0.262) and instructional videos and multimedia resources (p = 0.136), as both p-values exceeded the 0.05 significance level. Therefore, the null hypothesis was not rejected for these two ICT tools. These findings suggest that age-related differences in ICT usability may be specific to particular technologies rather than applying uniformly to all ICT tools used in teaching Electrical Installation and Maintenance (EIM).

From an instructional perspective, the findings imply that EIM teachers and school administrators should consider providing differentiated training in simulation software based on teachers' technological experiences and learning needs. Teachers who experience difficulty using simulation software may benefit from hands-on demonstrations, guided practice, and mentoring from more experienced users. Meanwhile, the absence of statistically significant differences in CAD tools and instructional videos and multimedia resources suggests that the perceived usability of these tools may be relatively consistent across age groups. Nevertheless, schools should continue providing technical support and professional development opportunities to ensure that all teachers can effectively integrate these resources into EIM instruction.

This interpretation is consistent with the findings of Wong et al. (2025), who examined generational differences in digital competence among Filipino public-school teachers and highlighted the relevance of training, technological resources, and peer collaboration in developing teachers' digital skills. Their findings support the importance of considering teachers' varying needs when designing ICT capacity-building programs. Similarly, the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023) emphasized that effective educational technology integration depends on teacher preparation, equitable access to digital resources, and evidence-based implementation.

5.2 in terms of Sex;

Demographic profile	Usability of ICT tools in Teaching EIM	t-value	df	p-value	Remarks	Decision
Sex	Simulation software	-3.437	32	0.002	Significant	Reject the Ho
	Computer-aided design (CAD) tools	-2.229	32	0.033	Significant	Reject the Ho
	Instructional videos and multimedia resources	-0.032	32	0.975	Not Significant	Accept the Ho

The results revealed a significant difference in the usability of simulation software (t = −3.437, p = 0.002) and computer-aided design (CAD) tools (t = −2.229, p = 0.033) when respondents were grouped according to sex. Since both p-values were below the 0.05 level of significance, the null hypothesis was rejected for these two ICT tools. This indicates that the reported usability of simulation software and CAD tools differed significantly between the sex groups. However, no significant difference was found in the usability of instructional videos and multimedia resources (t = −0.032, p = 0.975), as the p-value exceeded the 0.05 significance level. Therefore, the null hypothesis was not rejected for this category. Overall, the findings suggest that sex-related differences in the usability of ICT tools were evident in simulation software and CAD tools but not in instructional videos and multimedia resources. However, the direction and magnitude of these differences cannot be determined from the t-values and p-values alone; the group means and standard deviations are needed.

The findings imply that schools should ensure equitable opportunities for all EIM teachers to learn and use simulation software and CAD tools. Training programs may include practical exercises, guided demonstrations, collaborative activities, and individualized technical assistance to address differences in teachers' experiences and confidence. Since instructional videos and multimedia resources showed no statistically significant difference between the sex groups, these resources may provide a common instructional support option for teachers. Nevertheless, professional development should be based on teachers' actual competencies and learning needs rather than assumptions about their abilities based on sex.

These findings may be viewed in relation to the systematic review by Claro et al. (2024), which identified sociodemographic characteristics, technological experience, and attitudes toward ICT as factors associated with teachers' digital competence. However, differences in perceived usability do not automatically indicate differences in actual technological competence. Accordingly, the present results should be interpreted as evidence of differences in respondents' assessments of specific ICT tools, rather than proof that one sex is more capable of using technology.

5.3 in terms of Grade Level;

Demographic profile	Usability of ICT tools in Teaching EIM	t-value	df	p-value	Remarks	Decision
Grade Level	Simulation software	1.646	32	0.110	Not Significant	Accept the Ho
	Computer-aided design (CAD) tools	0.625	32	0.536	Not Significant	Accept the Ho
	Instructional videos and multimedia resources	1.844	32	0.075	Not Significant	Accept the Ho

The results revealed no significant difference in the usability of simulation software (t = 1.646, p = 0.110), computer-aided design (CAD) tools (t = 0.625, p = 0.536), and instructional videos and multimedia resources (t = 1.844, p = 0.075) when respondents were grouped according to grade level. All computed p-values were greater than the 0.05 level of significance; therefore, the null hypothesis was not rejected for all three ICT tools. These findings indicate that the respondents' assessments of the usability of these ICT resources did not differ significantly according to the grade level they handled. This suggests that grade-level assignment was not significantly associated with variations in the perceived usability of the ICT tools included in the study.

The findings imply that ICT integration initiatives in Electrical Installation and Maintenance (EIM) may be implemented across grade levels without necessarily requiring separate programs based solely on the grade level taught. School administrators and EIM teachers may establish common training sessions, instructional guidelines, and resource-sharing practices for simulation software, CAD tools, and multimedia resources. However, teachers should still adapt the use of these tools to the competencies, complexity of lessons, and learning needs of students at each grade level. providing adequate equipment, technical support, and opportunities for practical application may help sustain the effective use of ICT resources across different EIM classes.

This finding may be considered alongside the Global Education Monitoring Report 2023 of the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023), which emphasized that the effectiveness of educational technology depends on its suitability to instructional objectives, accessibility, and the preparation of teachers. This supports the importance of aligning ICT integration with curriculum requirements and learners' needs rather than relying exclusively on teachers' grade-level assignments. However, the present study's nonsignificant results do not establish that usability is identical across grade levels; they indicate only that the observed differences were insufficient to reach statistical significance at the 0.05 level.

5.4 in terms of Years of Teaching Experience

Demographic profile	Usability of ICT tools in Teaching EIM	F-value	df	p-value	Remarks	Decision
Years of Teaching Experience	Simulation software	12.523	32	0.006	Significant	Reject the Ho
	Computer-aided design (CAD) tools	5.595	32	0.133	Not Significant	Accept the Ho
	Instructional videos and multimedia resources	2.603	32	0.457	Not Significant	Accept the Ho

The results revealed a significant difference in the usability of simulation software when respondents were grouped according to years of teaching experience, with a reported F-value of 12.523 and a p-value of 0.006. Since the p-value was below the 0.05 level of significance, the null hypothesis was rejected for simulation software. This indicates that the perceived usability of simulation software differed significantly among teachers with varying years of teaching experience. In contrast, no significant differences were found in the usability of computer-aided design (CAD) tools (F = 5.595, p = 0.133) and instructional videos and multimedia resources (F = 2.603, p = 0.457), as their reported p-values exceeded the 0.05 significance level. Therefore, the null hypothesis was not rejected for these two ICT tools. Overall, the findings suggest that years of teaching experience may be associated with differences in the perceived usability of simulation software, but the same pattern was not statistically established for CAD tools and instructional videos and multimedia resources.

The findings are further supported by Claro et al. (2024), whose systematic review identified teaching experience, technology use, and attitudes toward ICT among the factors associated with teachers' digital competence. This provides context for understanding why simulation software may be perceived differently by teachers with varying years of experience. However, the significant result in the present study does not establish that more experienced teachers have higher usability ratings; the group means must be examined to determine the direction of the difference.

6. Is there a significant difference in the level of cognition of teacher-respondents regarding ICT integration in EIM when grouped according to the profile of the respondents?

6.1 in terms of Age;

Demographic profile	Level of cognition of teacher-respondents regarding ICT integration in EIM	F-value	df	p-value	Remarks	Decision
Age	Awareness of ICT tools	10.430	32	0.013	Significant	Reject the Ho
	Knowledge of ICT applications	10.890	32	0.024	Significant	Reject the Ho
	Skills in operating ICT resources	12.730	32	0.007	Significant	Reject the Ho

The results revealed significant differences in the level of cognition of teacher-respondents regarding ICT integration in Electrical Installation and Maintenance (EIM) when grouped according to age. Specifically, significant differences were observed in awareness of ICT tools ($F = 10.430$, $p = 0.013$), knowledge of ICT applications ($F = 10.890$, $p = 0.024$), and skills in operating ICT resources ($F = 12.730$, $p = 0.007$). All reported p-values were below the 0.05 level of significance; therefore, the null hypothesis was rejected for all three dimensions. These findings indicate that the respondents' levels of awareness, knowledge, and operational skills concerning ICT integration differed significantly across age groups. This suggests that age may be associated with variations in teachers' familiarity with ICT tools, understanding of their instructional applications, and ability to operate technological resources in EIM teaching. However, the results alone do not identify which age group demonstrated higher levels of cognition.

The findings imply that schools should consider teachers' varying ICT learning needs when planning professional development activities. EIM teachers may benefit from structured training that covers awareness of available ICT tools, practical applications of technology in teaching, and hands-on exercises using digital instructional resources. School administrators may also provide mentoring, collaborative learning opportunities, and guided demonstrations to help teachers strengthen their ICT-related knowledge and skills. These interventions should be based on individual competency assessments rather than assumptions about technological ability based solely on age. Through needs-based training and continuous technical support, schools can promote more inclusive and effective ICT integration in EIM instruction.

This interpretation is supported by Claro et al. (2024), whose systematic review identified sociodemographic characteristics, technology use, teaching practices, and experience as factors associated with teachers' digital competence. Their findings reinforce the importance of assessing teachers' ICT-related knowledge and skills while recognizing that these competencies may vary across individual and professional contexts. Similarly, UNESCO (2023) emphasized teacher preparation and professional development as essential conditions for effective technology integration in education. These sources support providing responsive training opportunities, although they do not establish that age directly causes differences in ICT cognition.

6.2 in terms of Sex;

Demographic profile	Level of cognition of teacher-respondents regarding ICT integration in EIM	t-value	df	p-value	Remarks	Decision
Sex	Awareness of ICT tools	-1.685	32	0.102	Not Significant	Accept the Ho
	Knowledge of ICT applications	-2.142	32	0.040	Significant	Reject the Ho
	Skills in operating ICT resources	-1.976	32	0.057	Not Significant	Accept the Ho

The results revealed no significant difference in the level of cognition of teacher-respondents in terms of awareness of ICT tools ($t = -1.685$, $p = 0.102$) when grouped according to sex. Since the p-value exceeded the 0.05 level of significance, the null hypothesis was not rejected. This indicates that the respondents' awareness of ICT tools did not differ significantly between the sex groups. However, a significant difference was observed in knowledge of ICT applications ($t = -2.142$, $p = 0.040$), as the p-value was below 0.05. Thus, the null hypothesis was rejected for this dimension, indicating that knowledge of ICT applications differed significantly between the sex groups. Meanwhile, no significant difference was found in skills in operating ICT resources ($t = -1.976$, $p = 0.057$), since the p-value was slightly higher than the 0.05 significance level. Therefore, the null hypothesis was not rejected for operational skills. Overall, the findings suggest that sex was significantly associated with differences in teachers' knowledge of ICT applications, but no statistically significant differences were established in their awareness of ICT tools or their skills in operating ICT resources.

These findings may be understood in light of Claro et al. (2024), whose systematic review identified sociodemographic characteristics, technology use, teaching practices, and experience as factors associated with teachers' digital competence. Their review highlights the importance of assessing digital competence across different dimensions rather than treating it as a single

ability. In the present study, the significant difference in knowledge of ICT applications suggests that this dimension may require further assessment and targeted support, while the nonsignificant results for awareness and operational skills indicate that the observed differences in those dimensions were not statistically significant

6.3 in terms of Grade Level

Demographic profile	Level of cognition of teacher-respondents regarding ICT integration in EIM	t-value	df	p-value	Remarks	Decision
Grade Level	Awareness of ICT tools	2.388	32	0.023	Significant	Reject the Ho
	Knowledge of ICT applications	2.066	32	0.047	Significant	Reject the Ho
	Skills in operating ICT resources	2.423	32	0.021	Significant	Reject the Ho

The results revealed significant differences in the level of cognition of teacher-respondents regarding ICT integration in Electrical Installation and Maintenance (EIM) when grouped according to grade level. Specifically, significant differences were observed in awareness of ICT tools ($t = 2.388$, $p = 0.023$), knowledge of ICT applications ($t = 2.066$, $p = 0.047$), and skills in operating ICT resources ($t = 2.423$, $p = 0.021$). All reported p-values were below the 0.05 level of significance; therefore, the null hypothesis was rejected for all three dimensions. These findings indicate that teachers' awareness, knowledge, and operational skills concerning ICT integration differed significantly according to the grade level they handled. This suggests that the instructional responsibilities or technological demands associated with different grade levels may be related to variations in teachers' ICT-related cognition. However, the results alone do not establish which grade level had higher scores.

The findings imply that ICT-related professional development for EIM teachers should consider the instructional requirements of the grade levels they handle. School administrators may provide training that strengthens teachers' awareness of relevant ICT tools, understanding of their applications in technical instruction, and ability to operate digital resources effectively. Collaborative planning, peer mentoring, and demonstrations of grade-appropriate ICT applications may also help teachers exchange effective practices. These activities should be supplemented by assessments of individual competencies to ensure that training responds to actual needs rather than grade-level assignments alone.

The findings are consistent with the broader perspective presented by Claro et al. (2024), whose systematic review highlighted the multidimensional nature of teachers' digital competence and the relevance of contextual and professional factors in understanding ICT-related capabilities. Similarly, UNESCO (2023) emphasized the importance of teacher preparation and appropriate integration of technology into educational practice. These sources support the value of continuous, context-sensitive professional development, although they do not directly establish that grade level causes differences in teachers' ICT cognition.

6.4 in terms of Years of Teaching Experience;

Demographic profile	Level of cognition of teacher-respondents regarding ICT integration in EIM	F-value	df	p-value	Remarks	Decision
Years of Teaching Experience	Awareness of ICT tools	10.731	32	0.013	Significant	Reject the Ho
	Knowledge of ICT applications	9.012	32	0.029	Significant	Reject the Ho
	Skills in operating ICT resources	8.132	32	0.043	Significant	Reject the Ho

The results revealed significant differences in the level of cognition of teacher-respondents regarding ICT integration in Electrical Installation and Maintenance (EIM) when grouped according to years of teaching experience. Specifically, significant differences were observed in awareness of ICT tools ($F = 10.731$, $p = 0.013$), knowledge of ICT applications ($F = 9.012$, $p = 0.029$), and skills in operating ICT resources ($F = 8.132$, $p = 0.043$). All reported p-values were below the 0.05 level of significance; therefore, the null hypothesis was rejected for all three dimensions. These findings indicate that teachers' awareness, knowledge, and operational skills concerning ICT integration differed significantly across groups with varying years of teaching experience. This suggests that teaching experience may be associated with differences in teachers' familiarity with ICT tools, understanding of their instructional applications, and ability to operate technological resources. However, the results do not identify which experience group demonstrated the highest level of cognition.

The findings imply that professional development programs for EIM teachers should address differences in ICT-related competencies among teachers with varying lengths of service. School administrators may organize practical training sessions, peer mentoring, collaborative lesson planning, and demonstrations focused on awareness of ICT tools, their classroom applications, and the effective operation of digital resources. Teachers may also be encouraged to share successful ICT integration practices with colleagues. Importantly, training opportunities should be based on individual competency assessments rather than assumptions that teachers with more years of experience necessarily possess greater technological knowledge or skills. These strategies may help strengthen teachers' capacity to integrate ICT into EIM instruction effectively.

The findings may be contextualized using the systematic review of Claro et al. (2024), which examined factors associated with teachers' digital competence and highlighted the importance of considering professional and contextual characteristics when assessing technology-related capabilities. UNESCO (2023) likewise emphasized teacher preparation and professional development as important conditions for effective educational technology integration. These sources support the value of sustained, needs-based ICT training, although they do not establish that years of teaching experience directly cause differences in teachers' ICT cognition.

7. Is there a significant difference in the level of students' technical proficiency in EIM, as assessed by teachers, when grouped according to the profile of the respondents?

7.1 in terms of Age:

Demographic profile	Level of students' technical proficiency in EIM	F-value	df	p-value	Remarks	Decision
Age	Wiring diagram accuracy	10.770	32	0.878	Not Significant	Accept the Ho
	Installation skills	10.930	32	0.826	Not Significant	Accept the Ho
	Safety practices	8.870	32	0.830	Not Significant	Accept the Ho

The results revealed no significant differences in the level of students' technical proficiency in Electrical Installation and Maintenance (EIM), as assessed by teachers, when respondents were grouped according to age. Specifically, no significant difference was reported in wiring diagram accuracy ($F = 10.770$, $p = 0.878$), installation skills ($F = 10.930$, $p = 0.826$), and safety practices ($F = 8.870$, $p = 0.830$). Since all reported p-values exceeded the 0.05 level of significance, the null hypothesis was not rejected for all three dimensions. These findings suggest that teachers' assessments of students' technical proficiency did not differ significantly according to the teachers' age. This indicates that age was not statistically associated with differences in teachers' evaluations of students' abilities to interpret wiring diagrams, perform electrical installation tasks, and observe safety procedures. However, the findings do not establish that students' actual proficiency levels were identical across all assessments.

The findings imply that the assessment of students' technical proficiency in EIM should emphasize observable performance, competency standards, and established assessment criteria rather than the age of the teacher conducting the assessment. Schools may strengthen the consistency of evaluation by using standardized performance rubrics, practical demonstrations, wiring diagram exercises, and safety checklists. Teachers may also participate in collaborative assessment activities to ensure that students are evaluated consistently against the required competencies. These practices can help maintain fair and objective assessment of students' technical performance and identify areas requiring additional instruction or practical training.

The findings may be contextualized through UNESCO's (2023) discussion of aligning educational technology and instructional practices with learning objectives and educational needs. In technical-vocational education, assessment is most informative when it focuses on demonstrable competencies and clearly defined performance standards. Nevertheless, the present study's nonsignificant results specifically concern differences associated with teachers' age and should not be interpreted as direct evidence that the assessment process was equally reliable across all teachers.

7.2 in terms of Sex:

Demographic profile	Level of students' technical proficiency in EIM	t-value	df	p-value	Remarks	Decision
Sex	Wiring diagram accuracy	0.499	32	0.622	Not Significant	Accept the Ho
	Installation skills	0.807	32	0.426	Not Significant	Accept the Ho
	Safety practices	1.474	32	0.151	Not Significant	Accept the Ho

The results revealed no significant differences in the level of students' technical proficiency in Electrical Installation and Maintenance (EIM), as assessed by teachers, when respondents were grouped according to sex. Specifically, no significant difference was found in wiring diagram accuracy ($t = 0.499$, $p = 0.622$), installation skills ($t = 0.807$, $p = 0.426$), and safety practices ($t = 1.474$, $p = 0.151$). All reported p-values exceeded the 0.05 level of significance; therefore, the null hypothesis was not rejected for all three dimensions. These findings indicate that the teachers' assessments of students' technical proficiency did not differ significantly according to the teachers' sex. This suggests that male and female teacher-respondents provided statistically comparable assessments of students' ability to interpret wiring diagrams, perform installation tasks, and observe electrical safety procedures. However, these results do not establish that students' actual technical proficiency was identical across all groups.

The findings imply that the assessment of students' technical proficiency in EIM should be guided by standardized performance criteria and demonstrated competencies rather than the sex of the teacher conducting the assessment. Schools may use common rubrics, practical examinations, wiring diagram interpretation tasks, and safety checklists to promote consistency in evaluating student performance. Furthermore, collaborative assessment and periodic review of scoring procedures may help

ensure that students are evaluated fairly and objectively. These measures can support reliable identification of students' strengths and areas requiring improvement in technical-vocational learning.

The findings may be contextualized using UNESCO's (2023) discussion of the importance of aligning educational practices and resources with clearly defined learning objectives. In EIM instruction, this principle supports the use of structured, competency-based assessments that focus on observable student performance. Nevertheless, the present findings specifically indicate that no statistically significant differences were detected in teachers' assessments according to sex; they do not independently establish the reliability or validity of the assessment instruments.

7.3 in terms of Grade Level;

Demographic profile	Level of students' technical proficiency in EIM	t-value	df	p-value	Remarks	Decision
Grade Level	Wiring diagram accuracy	-0.380	32	0.707	Not Significant	Accept the Ho
	Installation skills	-0.501	32	0.620	Not Significant	Accept the Ho
	Safety practices	-0.372	32	0.371	Not Significant	Accept the Ho

The results revealed no significant differences in the level of students' technical proficiency in Electrical Installation and Maintenance (EIM), as assessed by teachers, when grouped according to grade level. Specifically, no significant difference was found in wiring diagram accuracy ($t = -0.380$, $p = 0.707$) and installation skills ($t = -0.501$, $p = 0.620$). Similarly, the reported result for safety practices ($t = -0.372$, $p = 0.371$) was classified as not significant. Since all reported p-values exceeded the 0.05 level of significance, the null hypothesis was not rejected for all three dimensions. These findings suggest that teachers' assessments of students' technical proficiency did not differ significantly according to the grade level considered in the analysis. In particular, the results indicate no statistically significant differences in teachers' evaluations of students' ability to interpret wiring diagrams, perform installation tasks, and follow electrical safety procedures.

The findings imply that EIM teachers may use consistent assessment standards across grade levels while adjusting the complexity of practical tasks to match the competencies required in each grade. Schools may strengthen assessment practices through common rubrics, practical demonstrations, wiring diagram exercises, and safety checklists. Although the findings did not establish significant differences based on grade level, teachers should continue monitoring students' individual progress and providing appropriate instructional support. This approach can help ensure that students develop the technical competencies required for safe and effective electrical installation work.

The findings may be contextualized through UNESCO's (2023) emphasis on aligning educational practices and resources with clearly defined learning objectives. In technical-vocational education, this principle supports the use of structured assessments that focus on demonstrated competencies and the specific learning outcomes expected at each grade level. However, the cited report provides general educational context rather than direct evidence that grade level has no relationship with students' technical proficiency in EIM.

7.4 in terms of Years of Teaching Experience;

Demographic profile	Level of students' technical proficiency in EIM	F-value	df	p-value	Remarks	Decision
Years of Teaching Experience	Wiring diagram accuracy	0.506	32	0.918	Not Significant	Accept the Ho
	Installation skills	1.035	32	0.793	Not Significant	Accept the Ho
	Safety practices	3.272	32	0.342	Not Significant	Accept the Ho

The results show that simulation software has a significant positive relationship with awareness of ICT tools ($r = 0.652$, $p < 0.001$), knowledge of ICT applications ($r = 0.688$, $p < 0.001$), and skills in operating ICT resources ($r = 0.723$, $p < 0.001$). However, it has no significant relationship with wiring diagram accuracy ($p = 0.127$), installation skills ($p = 0.230$), and safety practices ($p = 0.350$). These findings suggest that greater usability of simulation software is strongly associated with higher teacher cognition regarding ICT integration, but it is not significantly related to the assessed technical proficiency of students in EIM. Thus, the null hypothesis was rejected for the cognition variables and accepted for the student proficiency variables.

These findings suggest that greater usability of simulation software is strongly associated with higher teacher cognition regarding ICT integration, indicating that teachers who frequently use simulation software tend to have better awareness, knowledge, and operational skills in ICT. In contrast, the use of simulation software does not significantly influence the assessed technical proficiency of students in EIM, implying that student outcomes in wiring diagram accuracy, installation skills, and safety practices may depend more on other instructional factors or hands-on practice rather than solely on teachers' use of simulation software.

Thus, the null hypothesis was rejected for the cognition variables, showing significant relationships, and accepted for the student proficiency variables, indicating no significant relationship.

Recent research supports this, noting that simulation software enhances teacher competence and instructional strategies, while its direct effect on student technical skills may require additional hands-on practice and guided application (Organization for Economic Co-operation and Development, 2024).

8. Is there a significant relationship between the extent of usability of ICT tools, the level of cognition of teacher-respondents regarding ICT integration, and the level of students' technical proficiency in EIM?

8.1 in terms of Simulation software;

Usability of ICT tools in Teaching EIM	Level of cognition of teacher-respondents regarding ICT integration in EIM and Level of students' technical proficiency in EIM	R-value	N	P-value	Remarks	Decision
Simulation software	Awareness of ICT tools	0.652	33	0.000	Significant	Reject the Ho
	Knowledge of ICT applications	0.688	33	0.000	Significant	Reject the Ho
	Skills in operating ICT resources	0.723	33	0.000	Significant	Reject the Ho
	Wiring diagram accuracy	0.271	33	0.127	Not Significant	Accept the Ho
	Installation skills	0.215	33	0.230	Not Significant	Accept the Ho
	Safety practices	-0.168	33	0.350	Not Significant	Accept the Ho

The results show that simulation software has a significant positive relationship with awareness of ICT tools ($r = 0.652$, $p < 0.001$), knowledge of ICT applications ($r = 0.688$, $p < 0.001$), and skills in operating ICT resources ($r = 0.723$, $p < 0.001$). However, it has no significant relationship with wiring diagram accuracy ($p = 0.127$), installation skills ($p = 0.230$), and safety practices ($p = 0.350$). These findings suggest that greater usability of simulation software is strongly associated with higher teacher cognition regarding ICT integration, but it is not significantly related to the assessed technical proficiency of students in EIM. Thus, the null hypothesis was rejected for the cognition variables and accepted for the student proficiency variables.

These findings suggest that greater usability of simulation software is strongly associated with higher teacher cognition regarding ICT integration, indicating that teachers who frequently use simulation software tend to have better awareness, knowledge, and operational skills in ICT. In contrast, the use of simulation software does not significantly influence the assessed technical proficiency of students in EIM, implying that student outcomes in wiring diagram accuracy, installation skills, and safety practices may depend more on other instructional factors or hands-on practice rather than solely on teachers' use of simulation software.

Thus, the null hypothesis was rejected for the cognition variables, showing significant relationships, and accepted for the student proficiency variables, indicating no significant relationship.

Recent research supports this, noting that simulation software enhances teacher competence and instructional strategies, while its direct effect on student technical skills may require additional hands-on practice and guided application (Organization for Economic Co-operation and Development, 2024).

8.2 in terms of Computer-aided design (CAD) tools;

Usability of ICT tools in Teaching EIM	Level of cognition of teacher-respondents regarding ICT integration in EIM and Level of students' technical proficiency in EIM	R-value	N	P-value	Remarks	Decision
Computer-aided design (CAD) tools	Awareness of ICT tools	0.614	33	0.000	Significant	Reject the Ho
	Knowledge of ICT applications	0.595	33	0.000	Significant	Reject the Ho
	Skills in operating ICT resources	0.638	33	0.000	Significant	Reject the Ho
	Wiring diagram accuracy	0.279	33	0.116	Not Significant	Accept the Ho
	Installation skills	0.231	33	0.197	Not Significant	Accept the Ho
	Safety practices	-0.275	33	0.121	Not Significant	Accept the Ho

The usability of computer-aided design (CAD) tools was also found to have a significant positive relationship with awareness of ICT tools ($r = 0.614$, $p < 0.001$), knowledge of ICT applications ($r = 0.595$, $p < 0.001$), and skills in operating ICT resources ($r = 0.638$, $p < 0.001$). On the other hand, its relationship with wiring diagram accuracy ($p = 0.116$), installation skills ($p = 0.197$), and safety practices ($p = 0.121$) was not significant. This indicates that the more usable CAD tools are perceived to be, the higher the teachers' cognition regarding ICT integration, but this does not significantly translate into differences in students' technical

proficiency as assessed by the teachers. Therefore, the null hypothesis was rejected for the cognition indicators and accepted for the student proficiency indicators.

These findings indicate that greater perceived usability of CAD tools is associated with higher teacher cognition regarding ICT integration, suggesting that teachers who effectively use CAD tools tend to have stronger awareness, knowledge, and operational skills in ICT. However, this enhanced cognition does not significantly translate into differences in students' technical proficiency in EIM, as assessed by the teachers, implying that student outcomes may depend more on practical experience and hands-on application rather than on teachers' use of CAD tools alone.

Therefore, the null hypothesis was rejected for the cognition indicators, reflecting significant relationships, and accepted for the student proficiency indicators, where no significant relationships were observed.

Recent studies support this, highlighting that while CAD tools improve teacher ICT competence and instructional strategies, their direct impact on student technical performance requires complementary hands-on practice and guided learning activities (Organisation for Economic Co-operation and Development, 2024).

8.3 in terms of Instructional videos and multimedia resources;

Usability of ICT tools in Teaching EIM	Level of cognition of teacher-respondents regarding ICT integration in EIM and Level of students' technical proficiency in EIM	R-value	N	p-value	Remarks	Decision
Instructional videos and multimedia resources	Awareness of ICT tools	0.383	33	0.028	Significant	Reject the Ho
	Knowledge of ICT applications	0.587	33	0.000	Significant	Reject the Ho
	Skills in operating ICT resources	0.576	33	0.000	Significant	Reject the Ho
	Wiring diagram accuracy	0.215	33	0.230	Not Significant	Accept the Ho
	Installation skills	0.087	33	0.630	Not Significant	Accept the Ho
	Safety practices	0.411	33	0.017	Significant	Reject the Ho

Lastly, instructional videos and multimedia resources showed a significant positive relationship with awareness of ICT tools ($r = 0.383$, $p = 0.028$), knowledge of ICT applications ($r = 0.587$, $p < 0.001$), skills in operating ICT resources ($r = 0.576$, $p < 0.001$), and safety practices ($r = 0.411$, $p = 0.017$). However, the relationships with wiring diagram accuracy ($p = 0.230$) and installation skills ($p = 0.630$) were not significant. These findings suggest that the usability of instructional videos and multimedia resources is associated not only with improved teacher cognition regarding ICT integration but also with better safety practices among students. However, it does not significantly relate to wiring diagram accuracy and installation skills. Hence, the null hypothesis was rejected for awareness, knowledge, skills, and safety practices, but accepted for wiring diagram accuracy and installation skills.

These findings suggest that the usability of instructional videos and multimedia resources is associated with enhanced teacher cognition regarding ICT integration and improved student safety practices. Teachers who effectively use these resources tend to have higher awareness, knowledge, and operational skills in ICT, and their students demonstrate better adherence to safety protocols. However, the use of these resources does not significantly impact students' wiring diagram accuracy or installation skills, indicating that these technical competencies may rely more on hands-on practice and direct guidance.

Hence, the null hypothesis was rejected for awareness, knowledge, skills, and safety practices, reflecting significant relationships, and accepted for wiring diagram accuracy and installation skills, where no significant relationships were observed. Recent research supports this, emphasizing that multimedia instructional tools enhance teacher ICT competence and positively influence student safety behaviors, though technical skill development requires complementary practical activities (Organisation for Economic Co-operation and Development, 2024).

9. Based on the findings, what ICT-based instructional framework can be proposed to enhance technical proficiency in Electrical Installation and Maintenance among junior high school students in pasig?

proposed ICT-Based Instructional Framework for Enhancing Students' Technical proficiency in EIM

The proposed framework is based on the study's findings on ICT usability, teachers' ICT cognition, and students' technical proficiency in Electrical Installation and Maintenance (EIM) in selected public junior high schools in pasig City. The results indicate that instructional videos and multimedia resources were used to a greater extent ($M = 3.22$) than simulation software ($M = 2.05$) and computer-aided design (CAD) tools ($M = 1.90$). Teachers demonstrated a high level of ICT awareness ($M = 2.67$), knowledge

(M = 2.73), and operational skills (M = 2.65), but CAD-related competencies were comparatively low. Students were rated proficient in wiring diagram accuracy (M = 3.01) and installation skills (M = 2.90), and highly proficient in safety practices (M = 3.46).

Accordingly, the proposed framework emphasizes strengthening teachers' CAD and simulation competencies, retaining effective multimedia practices, and combining ICT-based learning with guided hands-on activities. The budget amounts below are proposed planning estimates, not actual costs reported by the study, and should be adjusted based on school resources and supplier quotations.

Rationale

The framework prioritizes CAD tools and simulation software because these received lower usability ratings than instructional videos and multimedia resources. The proposed training activities are intended to address the identified gap between teachers' general ICT knowledge and their comparatively lower CAD-related awareness, knowledge, and operational skills.

It also emphasizes ICT-supported practice rather than technology use alone. The study did not establish significant relationships between simulation software or CAD usability and students' wiring diagram accuracy and installation skills. Therefore, the framework pairs digital demonstrations with supervised practical exercises and measurable competency assessments. Instructional videos and multimedia resources are retained as a major strategy because their usability was significantly related to students' safety practices in the reported results. These relationships are correlational and do not, by themselves, prove that the ICT tools caused improvements in proficiency.

Based on the analysis and interpretation of the data, the following findings were obtained:

1. Demographic profile of the Teacher-Respondents

In terms of age, the majority of the 33 teacher-respondents were 36 years old and above, comprising 20 respondents or 60.6%. This was followed by those aged 31–35 years old, with 8 respondents or 24.2%, and those aged 26–30 years old, with 5 respondents or 15.2%. No respondent belonged to the 21–25 age group.

In terms of sex, 25 respondents or 75.8% were male, while 8 or 24.2% were female.

Regarding grade level taught, 18 respondents or 54.5% handled Grade 9, while 15 or 45.5% handled Grade 10.

In terms of years of teaching experience, 18 respondents or 54.5% had 16 years and above of experience, 9 or 27.3% had 6–10 years, 5 or 15.2% had 1–5 years, and 1 or 3.0% had 11–15 years of teaching experience. These findings indicate that the respondents were predominantly male teachers, aged 36 years and above, with considerable teaching experience, and were relatively evenly distributed between Grade 9 and Grade 10 assignments.

2. Extent of Usability of ICT Tools in Teaching Electrical Installation and Maintenance

The findings revealed that instructional videos and multimedia resources obtained the highest general assessment, with a mean of 3.22, interpreted as Great Extent. Simulation software obtained a mean of 2.05, interpreted as Low Extent, while computer-aided design (CAD) tools obtained the lowest mean of 1.90, also interpreted as Low Extent.

Among the simulation software indicators, incorporating ICT-based simulation activities into instructional materials obtained the highest mean of 2.12, while regularly using circuit simulation software to demonstrate EIM concepts obtained the lowest mean of 1.97. For CAD tools, demonstrating electrical circuit diagrams and enhancing students' understanding of circuit concepts both obtained a mean of 1.94, while assigning students circuit-design tasks and providing activities for analyzing CAD-generated designs obtained means of 1.88.

For instructional videos and multimedia resources, regularly incorporating instructional videos to demonstrate electrical circuit concepts and procedures obtained the highest mean of 3.33, interpreted as Very Great Extent. The overall findings indicate that teachers relied more heavily on instructional videos and multimedia resources than on specialized ICT tools such as simulation software and CAD applications.

3. Level of Cognition of Teacher-Respondents Regarding ICT Integration in EIM

The teacher-respondents demonstrated a High Level of cognition in all three dimensions. Awareness of ICT tools obtained a general mean of 2.67, knowledge of ICT applications obtained 2.73, and skills in operating ICT resources obtained 2.65.

For awareness of ICT tools, familiarity with multimedia resources obtained the highest mean of 2.82, while familiarity with CAD tools obtained the lowest mean of 2.45, interpreted as Low Level.

For knowledge of ICT applications, the ability to integrate multimedia instructional resources obtained the highest mean of 3.12, while knowledge of using CAD tools to create accurate wiring diagrams obtained the lowest mean of 2.30, interpreted as Low Level.

For skills in operating ICT resources, the ability to integrate instructional videos and multimedia resources smoothly into classroom activities obtained the highest mean of 3.18. In contrast, skills in using CAD tools for EIM instruction obtained the lowest mean of 2.15, interpreted as Low Level.

These findings indicate that the teachers possessed a generally high level of ICT awareness, knowledge, and operational skills, but their competencies in CAD applications remained an area for improvement.

4. Level of Students' Technical proficiency in Electrical Installation and Maintenance

Based on the teachers' assessments, students demonstrated proficient levels in wiring diagram accuracy and installation skills, with general means of 3.01 and 2.90, respectively. Meanwhile, safety practices obtained a mean of 3.46, interpreted as Highly proficient.

For wiring diagram accuracy, interpreting standard electrical symbols obtained the highest mean of 3.18, while identifying and correcting errors in existing wiring diagrams obtained the lowest mean of 2.88.

For installation skills, adherence to safety protocols during installation activities obtained the highest mean of 3.12. Troubleshooting common installation issues and interpreting complex electrical schematics both obtained the lowest mean of 2.76.

For safety practices, following lockout/tagout procedures to ensure that circuits were de-energized before work obtained the highest mean of 3.52. The proper use and storage of electrical tools and equipment obtained the lowest mean of 3.42, although all indicators were interpreted as Highly proficient.

These findings indicate that students demonstrated strong safety practices, while further improvement was needed in wiring diagram error correction, troubleshooting, and interpreting complex electrical schematics.

5. Significant Differences in the Extent of Usability of ICT Tools When Grouped According to the profile of the Teacher-Respondents

In terms of age, a significant difference was found in the usability of simulation software ($p = 0.006$). However, no significant differences were found in CAD tools $p = 0.262$) and instructional videos and multimedia resources ($p = 0.136$).

In terms of sex, significant differences were found in simulation software $p = 0.002$) and CAD tools ($p = 0.033$), while no significant difference was found in instructional videos and multimedia resources ($p = 0.975$).

In terms of grade level taught, no significant differences were found in simulation software $p = 0.110$), CAD tools ($p = 0.536$), and instructional videos and multimedia resources ($p = 0.075$).

In terms of years of teaching experience, a significant difference was found in simulation software ($p = 0.006$). However, no significant differences were found in CAD tools ($p = 0.133$) and instructional videos and multimedia resources ($p = 0.457$).

These findings indicate that differences in the perceived usability of ICT tools were associated with certain teacher characteristics, particularly for simulation software. Nevertheless, the direction of these differences cannot be established without examining the corresponding group means.

6. Significant Differences in the Level of Cognition of Teacher-Respondents Regarding ICT Integration When Grouped According to Their profile

In terms of age, significant differences were found in awareness of ICT tools ($p = 0.013$), knowledge of ICT applications ($p = 0.024$), and skills in operating ICT resources ($p = 0.007$).

In terms of sex, a significant difference was found in knowledge of ICT applications ($p = 0.040$), while no significant differences were found in awareness of ICT tools ($p = 0.102$) and skills in operating ICT resources ($p = 0.057$).

In terms of grade level taught, significant differences were found in awareness of ICT tools ($p = 0.023$), knowledge of ICT applications ($p = 0.047$), and skills in operating ICT resources ($p = 0.021$).

In terms of years of teaching experience, significant differences were found in awareness of ICT tools ($p = 0.013$), knowledge of ICT applications ($p = 0.029$), and skills in operating ICT resources ($p = 0.043$).

These findings indicate that teachers' ICT-related awareness, knowledge, and operational skills differed significantly across several profile categories. The results support the need for professional development that responds to teachers' actual competencies rather than relying solely on demographic characteristics.

7. Significant Differences in the Level of Students' Technical Proficiency When Grouped According to the profile of the Teacher-Respondents

In terms of age, no significant differences were found in wiring diagram accuracy ($p = 0.878$), installation skills ($p = 0.826$), and safety practices ($p = 0.830$).

In terms of sex, no significant differences were found in wiring diagram accuracy p = 0.622), installation skills (p = 0.426), and safety practices (p = 0.151).

In terms of grade level taught, no significant differences were found in wiring diagram accuracy (p = 0.707), installation skills (p = 0.620), and safety practices (p = 0.371).

In terms of years of teaching experience, no significant differences were found in wiring diagram accuracy (p = 0.918), installation skills (p = 0.793), and safety practices (p = 0.342).

These findings indicate that the teachers' assessments of students' technical proficiency did not differ significantly according to the teachers' age, sex, grade level assignment, or years of teaching experience. The results highlight the importance of maintaining consistent assessment standards and evaluating students based on their demonstrated competencies.

8. Significant Relationships Between the Usability of ICT Tools, Teachers' Cognition Regarding ICT Integration, and Students' Technical proficiency in EIM

The findings revealed significant positive relationships between the usability of simulation software and teachers' awareness of ICT tools r = 0.652, (p < 0.001), knowledge of ICT applications r = 0.688, (p < 0.001), and skills in operating ICT resources r = 0.723, (p < 0.001). However, no significant relationships were found between simulation software and wiring diagram accuracy, installation skills, or safety practices.

Similarly, CAD usability had significant positive relationships with teachers' awareness r = 0.614, (p < 0.001), knowledge r = 0.595, (p < 0.001), and operational skills r = 0.638, (p < 0.001). However, no significant relationships were found between CAD usability and the three dimensions of students' technical proficiency.

Instructional videos and multimedia resources had significant positive relationships with teachers' awareness of ICT tools r = 0.383, (p = 0.028), knowledge of ICT applications r = 0.587, (p < 0.001), and skills in operating ICT resources r = 0.576, (p < 0.001). A significant positive relationship was also found between multimedia usability and students' safety practices r = 0.411, (p = 0.017). However, no significant relationships were found between multimedia usability and wiring diagram accuracy or installation skills.

Overall, the findings indicate that the usability of all three ICT categories was significantly associated with teachers' cognition regarding ICT integration. Among the student proficiency indicators, only safety practices demonstrated a significant relationship with instructional videos and multimedia resources. These findings suggest that technology-supported instruction should be combined with guided practical activities to address the technical competencies for which significant relationships were not established.

9. Proposed ICT-Based Instructional Framework

Based on the findings, an ICT-based instructional framework was proposed to enhance technical proficiency in EIM among junior high school students in pasig City. The framework emphasizes seven key result areas: teacher training on CAD tools, simulation-based EIM instruction, multimedia and video-based learning, hands-on technical skills development, electrical safety and risk awareness, ICT resources and technical support, and monitoring, assessment, and framework evaluation.

The proposed framework includes a six-month implementation period and a total estimated budget of ₱90,000. It aims to strengthen teachers' competence in specialized ICT applications, sustain the effective use of multimedia resources, improve students' wiring diagram accuracy and installation skills, maintain strong safety practices, and establish measurable indicators for evaluating implementation.

The framework is a proposed intervention based on the study's findings. Its effectiveness must be evaluated through actual implementation and documented assessment results.

Based on the findings of the study, the following conclusions were drawn:

1. The teacher-respondents were predominantly 36 years old and above, male, and had 16 years or more of teaching experience. Grade 9 and Grade 10 teachers were relatively evenly represented.
2. The extent of ICT usability varied across the tools examined. Instructional videos and multimedia resources were utilized to a great extent, whereas simulation software and CAD tools were utilized to a low extent. This indicates that teachers relied more on accessible multimedia resources than on specialized digital applications for EIM instruction.
3. The teacher-respondents demonstrated a high level of awareness, knowledge, and operational skills regarding ICT integration. However, their relatively low ratings in CAD-related awareness, knowledge, and operational skills indicate a need for targeted professional development in specialized technical applications.
4. Students were assessed as proficient in wiring diagram accuracy and installation skills and highly proficient in safety practices. Nevertheless, the lower ratings in error correction, troubleshooting, and interpreting complex electrical

schematics indicate that further learning opportunities are needed to strengthen students' technical problem-solving and practical competencies.

5. Significant differences in the usability of ICT tools were found in selected demographic comparisons, particularly in the use of simulation software. Differences in usability were not consistent across all ICT categories or teacher characteristics. Therefore, ICT training should be guided by demonstrated needs and competencies rather than demographic assumptions.
6. Teachers' awareness, knowledge, and operational skills regarding ICT integration differed significantly across several profile categories. These findings support the provision of differentiated, competency-based professional development to address variations in teachers' technological knowledge and skills.
7. The teachers' assessments of students' technical proficiency did not differ significantly when grouped according to the teachers' age, sex, grade level taught, and years of teaching experience. This supports the use of consistent, competency-based assessment criteria for evaluating students' technical performance.
8. The usability of simulation software, CAD tools, and instructional videos and multimedia resources was significantly associated with teachers' cognition regarding ICT integration. However, the only significant relationship identified between ICT usability and students' technical proficiency was between instructional videos and multimedia resources and safety practices. These results do not establish causation and suggest that ICT use alone may not be sufficient to address all aspects of technical proficiency.
9. The proposed ICT-based instructional framework provides a structured approach to addressing the identified gaps in ICT integration and student technical proficiency. By combining teacher training, multimedia resources, simulation and CAD activities, supervised practical exercises, safety reinforcement, and systematic assessment, the framework offers a basis for improving EIM instruction. Its actual effectiveness, however, remains to be established through implementation and evaluation.

Based on the findings and conclusions of the study, the following recommendations are presented in accordance with the Significance of the Study.

Students

Students are encouraged to actively participate in ICT-supported EIM learning activities, particularly those involving circuit simulations, digital wiring diagrams, instructional videos, and multimedia demonstrations. They should use these resources to reinforce their understanding of electrical circuits and prepare for practical installation activities.

Furthermore, students should be provided with additional guided exercises involving wiring diagram interpretation, error identification, troubleshooting, and the interpretation of complex electrical schematics. Since safety practices received the highest proficiency rating, students should continue observing proper personal protective equipment use, lockout/tagout procedures, hazard identification, and safe handling of electrical tools and equipment.

EIM teachers should monitor students' progress through practical performance assessments and provide remedial activities to those who need additional support. These measures may help students improve their technical confidence, practical competence, and preparation for future technical-vocational pathways.

Teachers

EIM teachers are encouraged to sustain their use of instructional videos and multimedia resources while gradually integrating simulation software and CAD applications into their teaching practices. Given the low usability ratings and lower CAD-related cognition scores, teachers should participate in hands-on training that develops their ability to create, interpret, and revise electrical wiring diagrams using appropriate digital applications.

Teachers should also combine technology-supported demonstrations with supervised laboratory activities. Simulation and CAD exercises may be used to introduce electrical concepts, identify circuit errors, and prepare students for actual installation tasks. These should be followed by practical activities that assess students' ability to apply what they have learned.

Moreover, teachers should develop and use common assessment rubrics for wiring diagram accuracy, installation skills, and electrical safety. They should monitor students' performance, provide timely feedback, and use assessment results to identify learning gaps. Collaborative lesson planning and peer mentoring may also help teachers share effective ICT integration practices.

School Heads

School heads are encouraged to use the findings as a basis for planning targeted professional development programs for EIM teachers. priority should be given to improving competencies in CAD applications and simulation software while sustaining effective practices in multimedia-based instruction.

School administrators should conduct a needs assessment to identify teachers' existing ICT competencies and determine the training required. They may organize workshops, invite qualified resource persons, establish peer mentoring arrangements, and allocate sufficient time for teachers to develop and practice their ICT skills.

School heads should also review the availability and functionality of computers, software, internet connectivity, and laboratory resources needed for ICT-supported EIM instruction. Appropriate budget allocations should be considered for teacher training, maintenance of equipment, access to suitable applications, and the implementation of the proposed instructional framework.

Finally, school heads should monitor the implementation of ICT integration initiatives through lesson plan reviews, classroom observations, teacher training records, and student performance reports. These measures can help ensure that resources are used effectively and that instructional improvements are supported by documented evidence.

Schools

Schools are encouraged to consider adopting and evaluating the proposed ICT-Based Instructional Framework for Enhancing Students' Technical proficiency in EIM. The framework may serve as a guide for coordinating teacher development, ICT resource management, multimedia instruction, simulation activities, hands-on technical practice, and safety education.

School administrators and EIM departments should prioritize the availability of appropriate ICT tools and functional laboratory equipment. Where resources are limited, schools may establish shared access to available computers and applications, coordinate schedules for laboratory use, and maximize accessible multimedia learning materials.

Schools should also strengthen the integration of digital instruction and practical application by ensuring that ICT-supported activities are aligned with EIM learning competencies. Standardized performance rubrics, wiring diagram exercises, practical installation assessments, and electrical safety checklists may be used to monitor student progress.

The proposed six-month framework, with its estimated budget of ₱90,000, may be considered for implementation subject to resource availability, school approval, and validation of actual costs. Schools should evaluate the framework using baseline and endline assessments, implementation records, and documented student performance results before deciding whether to sustain, revise, or expand the intervention.

Future Researchers

Future researchers may use the findings of this study as a reference for further investigations on ICT integration in technical-vocational education. Similar studies may be conducted in other schools, school divisions, or technical-vocational specializations to determine whether comparable patterns in ICT usability, teacher cognition, and student technical proficiency are observed.

Researchers are also encouraged to examine the effectiveness of simulation software, CAD applications, and multimedia resources through intervention studies or experimental and quasi-experimental designs. Such studies may compare student performance before and after the implementation of specific ICT-supported instructional strategies.

Further research may also include direct assessments of students' practical competencies rather than relying solely on teachers' evaluations. Additional variables, such as access to ICT resources, frequency of technology use, teacher training, student engagement, and opportunities for hands-on practice, may be examined to provide a more comprehensive understanding of factors associated with technical proficiency.

Finally, future researchers may implement and evaluate the proposed ICT-based instructional framework to determine whether it produces measurable improvements in wiring diagram accuracy, installation skills, and safety practices. They may also examine its implementation costs, sustainability, and applicability to other technical-vocational learning areas. Such investigations can provide additional evidence for refining ICT-supported instruction and strengthening technical-vocational education in junior high schools.

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