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Development and Effectiveness of Electrical Trainer in Basic Electrical Connection

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Abstract: An Electrical Trainer was developed and tested to serve as an instructional aid for Basic Electrical Connection. It includes authentic electrical equipment, safety elements (such as circuit breakers), analog multitester, and transportation frame to allow students to practice wiring, switching, measuring and fault detection. The purpose of the study was to identify technical features; to evaluate pre/post test student performance; to assess if there is a significant difference between pre/post test performances; and to establish acceptability for composition, operating attributes, and safety. Developmental method of research was utilized. The device were designed, manufactured, tested and evaluated through both engineers and students. Evaluation of the Trainer included members evaluating technical features, quality of design, operating performance and safety. Data were collected through; engineer manufacturing evaluations, student performance evaluations prior to use of Trainer vs. after use; acceptability; through statistical analysis of means and paired sample t-tests. Evaluation results indicated that an Electrical Trainer manufactured with wood frame/base, plywood wiring board, switching devices, electrical outlets (supply), incandescent bulbs, alarm device (sound and visual), residual current circuit breaker, prototype analog multitester, junction boxes, tool/personal protective equipment compartment, casters, and fault detection capability. Student performance improved from Satisfactory (Pre Test) to Excellent (Post Test) by use of the Trainer to develop practical skills in wiring, switching, measuring, troubleshooting. Statistical analysis supports that the improvement in performance from Pre Test vs. Post Test was statistically significant. Because of this, it has been determined that the increase in performance is directly correlated to use of the Trainer. The Electrical Trainer has been rated Very Acceptable in terms of design, operating performance, and safety. Conclusions from this study support the theory that an Electrical Trainer for Basic Electrical Connection is functional, safe, acceptable, and a means to provide improvement in practical competency for students studying for a career in Electrical.

Keywords: Electrical Trainer; Basic Electrical Connection; Electrical Installation; Electrical Maintenance; Technical-Vocational Education; Hands-on Learning; Instructional Device; Skill Development; Competency-Based Learning.

I. INTRODUCTION

Electrical trainer kits are valuable instructional tools in technical-vocational education that support hands-on learning, improve technical skills, and enhance students' understanding of electrical concepts and practical applications. Recent studies have focused on the development and feasibility of electrical trainer kits as instructional tools in enhancing technical-vocational education. For instance, Sukir et al. (2023) developed a smart building electrical trainer and found it highly feasible and effective as a learning medium for electrical installation practices. However, their study mainly emphasized product feasibility and acceptability, with limited investigation into how such trainers directly influence students' performance in basic electrical connections and hands-on competency development. Similarly, Ugot and Pasion (2023) developed an AC/DC Electrical Installation and Maintenance trainer and highlighted improvements in usability and learner engagement. Nonetheless, their research primarily concentrated on design, functionality, and usability aspects, leaving a gap in evaluating the measurable performance outcomes of learners in executing basic electrical connection tasks. Therefore, there remains a clear research gap in determining how the development of an electrical trainer specifically affects students' performance in basic electrical connections, particularly in terms of skill mastery, accuracy, safety practices, and practical application. This gap justifies the need for further study focusing on both device development and student performance outcomes.

This electrical trainer is designed as a general-purpose instructional device for basic electrical training suitable for beginners, students, technicians, maintenance staff, vocational learners, and individuals working with residential, commercial, and light industrial electrical systems. It provides foundational knowledge and practical competencies in electrical theory, circuit connections, wiring installation, measurement, troubleshooting, and safety procedures without requiring advanced mathematical skills or prior technical experience. The trainer is strictly aligned with Philippine national laws, competency standards, and training regulations, including the Technical Education and Skills Development Authority (TESDA) Training Regulations, the Philippine Electrical Code (PEC), Republic Act No. 7920, and Republic Act No. 7796. Moreover, it is contextualized to local community needs, particularly at the barangay, municipal, and city

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levels, focusing on residential wiring, small-scale establishments, permit compliance, and practical electrical work commonly encountered in local settings. It also supports the competencies required under TESDA Electrical Installation and Maintenance (EIM) NC II standards and the Department of Education (DepEd) K–12 Technology and Livelihood Education (TLE) curriculum.

The development of the electrical trainer addresses the problem of limited laboratory spaces, insufficient classroom facilities, and inadequate access to hands-on electrical training materials in many educational institutions. Through the provision of a portable and functional instructional device, the study directly supports Sustainable Development Goal (SDG) 4: Quality Education, particularly Target 4.4, which aims to increase the number of youth and adults possessing relevant technical and vocational skills for employment and entrepreneurship. Likewise, the study contributes to SDG 8: Decent Work and Economic Growth by preparing students with industry-relevant electrical competencies that can improve employability in the construction, maintenance, and electrical service sectors. Furthermore, the study aligns with the College of Education Research Thrusts and Priorities (2024–2028), particularly on Techno Transfer, which emphasizes translating research outputs into market-ready educational tools and commercializing instructional innovations developed by faculty and students. It is likewise consistent with the principles of the CRAFT Framework of the Master of Arts in Education – Technology and Livelihood Education, specifically in promoting Curriculum Innovation and Advanced Pedagogy, Research and Reflective Professional Practice, Applied Technology and Knowledge Transfer, Flexible Cultural and Global Perspectives, and Transformative Collaboration and Lifelong Learning.

Moreover, the study ensures that students are equipped with practical knowledge, technical skills, and competencies aligned with current industry trends and workforce demands in the field of electrical technology. The use of the electrical trainer fosters critical thinking, problem-solving abilities, creativity, innovation, and technical decision-making as students perform actual circuit connections, identify faults, and apply troubleshooting procedures. In addition to strengthening academic learning, the development and utilization of the trainer enhance students' confidence, work readiness, and entrepreneurial mindset in the electrical technology sector. The trainer also promotes experiential and competency-based learning by allowing learners to actively engage in realistic electrical tasks in a safe and controlled environment. Overall, the study contributes to the development of skilled, competent, and industry-ready individuals who are prepared for employment, certification, lifelong learning, and productive participation in the electrical and technical-vocational industry.

Objective of the Study

Generally, this study aimed to develop an Electrical Trainer in basic electical connection and evaluate its effectiveness on the Performance of electrical students in Basic Electrical Connection. Specifically, the study sought to:

1. describe the technical features of the electrical trainer in basic electrical connections;
2. determine the pre-test and post-test performance of the students before and after using the trainer;
3. determine if there is a significant difference between the pre-test and post-test during the performance of the students; and,
4. determine the acceptability level of the electrical trainer in terms of composition, operating performance, and safety as evaluated by experts and students.

II. METHODOLOGY

Prior Art

A related prior art is the US11417239B1, invented by Kim Carter and Kevin L. Cousineau and published in 2022. This invention describes an electrical circuit training simulator designed for hands-on learning of electrical systems. The device enables students to assemble and test circuits such as motor control systems while allowing instructors to introduce faults for troubleshooting exercises. It includes multiple electrical components (e.g., relays, switches, power supplies) mounted on a panel, simulating real-world industrial electrical environments.

The simulator emphasizes safe and controlled training, allowing learners to practice electrical connections and diagnostics without exposure to real hazardous systems. It also integrates features such as hidden fault injection and multi-user training capability, making it similar to a multi-function mock-up device used in technical education.
Another closely related patent is US10950142B2, which presents a training apparatus with multiple selectable circuits using a rotary mechanism. This device allows students to study different circuit configurations (series, parallel, etc.) in a single system, supporting multi-functional learning similar to a portable mock-up trainer.

Methods of Research

This study used the developmental method of research because it involved the design, fabrication, testing, and evaluation of an Electrical Trainer in Basic Electrical Connection. This method was appropriate since the study aimed to produce a functional instructional device and determine its acceptability and effectiveness in improving students' practical performance. Richey and Klein (2007) stated that developmental research involves the systematic design, development, and evaluation of instructional products and tools.

The method was applied by first identifying the need for a practical training device, then designing and fabricating the Electrical Trainer using appropriate electrical components such as switches, bulbs, sockets, junction boxes, an alarm device, RCCB, analog multitester, wooden frame, and caster wheels. After fabrication, the trainer was tested for functionality, safety, and usability. It was then evaluated by respondents in terms of composition, operating performance, and safety. This method also followed the basic process of instructional product development. Spatioti et al. (2022) explained that educational products commonly undergo analysis, design, development, implementation, and evaluation. In this study, the trainer was developed, tested, and evaluated to determine whether it could support hands-on learning in basic electrical connection. Therefore, the developmental method was used because it matched the purpose of the study, which was to develop an instructional device, assess its acceptability, and determine its effect on students' performance.

Design Criteria

The Electrical Trainer was designed based on the need for a safe, functional, durable, portable, and affordable instructional device for Basic Electrical Connection. Its design focused on helping students perform actual wiring activities, observe circuit behavior, identify faults, and practice proper safety procedures during hands-on learning.

In terms of safety, the trainer was provided with protective features such as a Residual Current Circuit Breaker, alarm device, proper wiring layout, tool and PPE compartment, and caster wheels with lock. These features were included to reduce possible risks such as electric shock, short circuit, and unsafe movement of the device during use.

The trainer was also designed to be functional and instructional. It included electrical components such as switches, bulbs, sockets, junction boxes, and an analog multitester so that students could practice basic electrical connections, switching operations, load testing, and measurement activities. These parts allowed learners to apply classroom concepts through actual performance tasks.

Instrumentation

The instrumentation used in this study was designed to evaluate the Electrical Trainer and determine its effectiveness in improving students' skills in basic electrical connection. The study employed a combination of tools to assess both the trainer itself and the practical performance of students.

A structured questionnaire was prepared for technical experts, faculty members, and students to measure the trainer's acceptability. Using a five-point Likert scale, evaluators rated the trainer in terms of composition, operating performance, and safety. Composition included structural stability, accessibility, and organization of components; operating performance measured the functionality of switches, sockets, bulbs, the alarm device, RCCB, and analog multitester; while safety evaluated protective features, proper wire arrangement, storage of PPE, and mobility. This allowed the researchers to gather both expert and user perspectives on the trainer's usability and instructional value.

To assess students' practical skills, a performance rubric was applied during pre-test and post-test activities. The rubric measured workmanship, accuracy of electrical connections, safety compliance, fault detection, and time management. This provided a clear and standardized way to quantify improvements in students' hands-on skills after using the trainer. Additionally, the prototype analog multitester was used as part of the instrumentation. It allowed students to practice measuring voltage, current, resistance, and continuity while also serving as a tool to verify correct electrical connections during testing. Finally, observational notes were recorded by instructors to capture qualitative data on students' practical difficulties, procedural errors, and adherence to safety protocols. These observations complemented the quantitative results from the questionnaire and rubric, providing a more complete evaluation of the trainer's effectiveness.

Through the combination of questionnaire, performance rubric, analog multitester, and observational notes, the instrumentation provided a comprehensive assessment of the Electrical Trainer. It allowed the researchers to evaluate not

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only the trainer's acceptability and functionality but also its impact on students' technical competence, safety awareness, and hands-on learning outcomes.

Scoring of Variables

The scoring of variables in this study was structured according to each research objective to ensure that the data collected addressed the purpose of the study effectively.

To evaluate the technical features and acceptability, a structured questionnaire using a five-point Likert scale was employed. The evaluators, consisting of technical experts, instructors, and students, assessed the composition of the trainer, including the stability of the wooden frame, layout of electrical components, accessibility, and visibility. Operating performance was scored by observing the correct functioning of switches, sockets, bulbs, the alarm device, RCCB, and analog multitester. Safety was also evaluated by checking protective features, proper wiring layout, mobility, and PPE storage. Higher scores indicated higher acceptability and alignment with design specifications.

Rating	Scale of Mean	Description
5	4.21–5.00	Very Acceptable
4	3.41–4.20	Acceptable
3	2.61–3.40	Moderately Acceptable
2	1.81–2.60	Less Acceptable
1	1.00–1.80	Least Acceptable

The safety and operational performance were assessed through observation during practical activities and questionnaire ratings. Safety variables included the effectiveness of the RCCB, alarm device, safe wiring arrangement, and accessibility for handling. Operational performance was evaluated by checking the proper functioning of switches, bulbs, sockets, and the analog multitester, as well as students' ability to safely manipulate the components. Each variable was scored on a five-point scale, with "5 = Excellent" indicating optimal safety and functionality.

Performance Rating	Description
41 - 50	Excellent
31 - 40	Very Satisfactory
21 - 30	Satisfactory
11 - 20	Good
1 - 10	Poor

The effect on students' practical skills was measured using a performance rubric applied during pre-test and post-test activities. The rubric evaluated workmanship (neatness and precision of wiring), accuracy (correct connections and proper use of switches, bulbs, and multitester), safety compliance (adherence to safety protocols and proper use of PPE), fault detection (ability to identify and correct wiring errors), and time management (completion of tasks within the given time). Each variable was scored on a five-point scale, where higher scores indicated greater proficiency. Pre-test scores served as a baseline, while post-test scores measured improvement.

Parameters for Analysis

The parameters for analysis in this study were established to systematically evaluate the Electrical Trainer and the students' performance in basic electrical connection. The analysis focused on both product acceptability and learning outcomes, ensuring that the data collected addressed the objectives of the study. For product evaluation, the parameters included composition, operating performance, and safety. Composition referred to the structural stability, arrangement, and accessibility of components. Operating performance measured the functionality of switches, sockets, bulbs, alarm device, RCCB, and analog multitester. Safety assessed the effectiveness of protective devices, proper wiring layout, PPE storage, and mobility. These parameters were scored using a five-point Likert scale and analyzed by computing the mean scores to determine the overall acceptability of the trainer. For student performance, the parameters included workmanship, accuracy, safety compliance, fault detection, and time management. Workmanship measured the neatness and precision of wiring connections. Accuracy evaluated the correctness of electrical connections, switch operations, and use of the analog multitester. Safety compliance determined whether students followed proper safety protocols and used PPE correctly. Fault detection assessed students' ability to identify and correct wiring errors, while time management measured the efficiency of completing tasks within the given time. Pre-test and post-test scores were compared using a paired samples t-test to evaluate improvements in students' practical skills.

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III.PRESENTATION, ANALYSES, AND INTERPRETATION OF DATA

This chapter deals with the presentation, analysis, and interpretation of data gathered and tabulated results based on actual evaluation.

Technical Features of the Electrical Trainer in Basic Electrical Connections

The technical features of the Electrical Trainer in Basic Electrical Connections were designed to support safe, functional, and hands-on learning for students in electrical installation and maintenance. The trainer was developed with major components such as a wooden frame and base, plywood wiring board, single-pole single-throw and single-pole double-throw switches, electrical sockets, incandescent bulbs, alarm device, residual current circuit breaker, prototype analog multitester, tool and personal protective equipment compartment, and caster wheels. These features provided students with a controlled instructional device where they could practice wiring, switching, measurement, and fault detection activities.

The wooden frame and plywood wiring board served as the structural foundation of the trainer. These parts provided stability and proper mounting space for the electrical components. The use of a fixed wiring board helped students observe the arrangement of circuits and perform actual wiring activities in a more organized manner. This was consistent with the competency-based approach in Electrical Installation and Maintenance, where learners were expected to develop practical skills through actual performance tasks (Technical Education and Skills Development Authority [TESDA], 2016). The structural design also supported the idea that instructional devices should simulate actual workplace conditions to improve students' readiness for technical work (Pereyras, 2020).

The inclusion of SPST and SPDT switches, electrical sockets, and incandescent bulbs allowed students to practice basic electrical connections and understand circuit behavior. These components enabled learners to observe how current flowed, how switches controlled loads, and how electrical connections functioned in real situations. Similar studies emphasized that electrical trainers improved students' practical understanding because they allowed learners to apply theoretical concepts through hands-on activities (Pereyras, 2020; Rosales, 2022). Therefore, the trainer's wiring and switching components were useful in strengthening students' technical skills.

The residual current circuit breaker and alarm device were important safety features of the Electrical Trainer. The RCCB protected users by disconnecting the circuit when leakage current or abnormal conditions occurred, while the alarm device warned students and instructors when wiring faults or connection errors were present. These safety features helped reduce the risk of electric shock, short circuit, and unsafe operation during laboratory activities. Safety protection was an important requirement in electrical training because learners must be exposed to practical activities without compromising their safety (National Fire Protection Association [NFPA], 2024). This supported the need for instructional equipment that combined skill development with safe working practices.

The prototype analog multitester was also an important technical feature because it allowed students to measure voltage, current, resistance, and continuity. Through this feature, students were able to connect classroom concepts with actual electrical measurements. The use of measuring tools in practical training helped learners develop accuracy, troubleshooting ability, and confidence in handling electrical systems. TESDA (2016) emphasized that electrical installation learners must demonstrate competence in using tools and equipment properly, which made the analog multitester relevant to the instructional purpose of the trainer.

The trainer also supported fault detection and troubleshooting activities. Through its alarm system, RCCB, and measuring device, students were able to identify wiring errors and understand the effects of faulty connections. This feature was valuable because simulation-based learning allowed students to practice technical problem-solving in a safe and controlled environment. Chernikova et al. (2020) found that simulation-based learning improved complex skills, especially when learners were given opportunities for guided practice and feedback. In the same way, the Electrical Trainer helped students develop troubleshooting skills without exposing them to unnecessary electrical hazards.

The tool and PPE compartment improved the organization and safety of the trainer. It allowed the proper storage of tools and protective equipment, which encouraged students to observe good laboratory practices. The caster wheels also made the trainer portable and easier to move from one instructional area to another. These features increased the usability of the trainer, especially in classrooms, laboratories, and community-based training activities. Instructional devices with practical design, mobility, and safety features were found to be useful in improving technical-vocational instruction because they supported flexible and experiential learning (Sukir et al., 2023).

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Overall, the technical features of the Electrical Trainer were appropriate for teaching basic electrical connections. The trainer combined structural support, electrical wiring components, measuring instruments, safety devices, fault detection features, storage space, and mobility. These features made the trainer functional, safe, and useful as an instructional tool. Its design followed the principles of instructional product development, where learning devices were systematically planned, developed, tested, and evaluated to meet specific educational needs (Spatioti et al., 2022).

Pre-test and Post-test Performance in Basic Electrical Connection

Table 5 presents the pre-test and post-test performance of Electrical Technology students in Basic Electrical Connection. The table shows the students' scores, corresponding remarks, and the overall improvement after using the Electrical Trainer.

The pre-test and post-test results of Electrical Technology students in Basic Electrical Connection were analyzed to determine the effectiveness of the Electrical Trainer in enhancing students' practical skills. The pre-test data showed that students' baseline performance ranged from Good to Satisfactory, with scores between 18 and 30. The mean pre-test score was 23, which fell under the Satisfactory category.

This indicated that students had a basic understanding of electrical connections but required further hands-on experience and guided practice to develop accuracy, confidence, and troubleshooting skills. These results reflected the common challenge in technical-vocational education, where theoretical knowledge does not always translate to practical proficiency without appropriate instructional tools (Chernikova et al., 2020).

After the intervention, where students used the Electrical Trainer, post-test scores increased substantially, ranging from 42 to 49, with a mean score of 45, categorized as Excellent. This significant improvement highlighted the effectiveness of the trainer in enhancing practical skills, including proper wiring, switch operation, use of the analog multitester, and fault detection.

The trainer provided a safe and controlled environment for repeated practice, which allowed students to correct errors, understand circuit behavior, and develop problem-solving strategies. These outcomes aligned with active learning principles, where hands-on practice reinforces cognitive understanding and skill mastery (Theobald et al., 2020). The relevance of this finding lies in its implications for technical-vocational education. By using the Electrical Trainer, students could safely engage in realistic electrical tasks, which bridged the gap between theory and practice.

This approach is particularly important because it allowed learners to internalize electrical concepts, observe real-time consequences of faulty connections, and develop work-ready skills that are applicable in professional settings (Sukir et al., 2023). Additionally, instructors could use the trainer to demonstrate concepts effectively, monitor student performance, and provide immediate feedback, which enhances both teaching efficiency and learning outcomes.

The advantages of using the Electrical Trainer included improved student engagement, reduced risk of electrical hazards, immediate error detection through built-in safety features such as the RCCB and alarm system, and structured assessment of practical skills.

Table 5. Pre-test and post-test performance in basic electrical connection of electric technology students

A. **Student number**	B. **Pre-Test Result**	C. **Remarks**	D. **Post-Test Result**	E. **Remars**
F. N=15	G. 23	H. Satisfactory	I. 45	J. Excellent

The trainer also promoted confidence and independence among students, as they were able to perform tasks repeatedly and evaluate their own work, a method validated in prior studies emphasizing simulation-based learning and competency development in electrical education (Pereyras, 2020; Rosales, 2022).

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In conclusion, the pre-test and post-test results demonstrated that the Electrical Trainer effectively enhanced the students' practical competence in Basic Electrical Connection. The observed improvement from a Satisfactory to an Excellent level reflected the importance of incorporating hands-on instructional tools in technical-vocational curricula. These findings validate the trainer as a reliable, safe, and instructional resource for improving learning outcomes, supporting both educators and students in achieving the competencies required by TESDA and other technical standards (TESDA, 2016).

Difference Between the Pre-test and Post-test During the Performance of the Students

Table 6 presents the paired-samples t-test results comparing the pre-test and post-test performance of students in Basic Electrical Connection. The analysis aimed to determine whether the use of the Electrical Trainer had a statistically significant effect on students' practical skills.

The t-test results showed a t-value of -22.883, with 14 degrees of freedom (df) and a p-value of .000, which is less than the significance level of 0.05. These results indicate that there was a significant difference between the pre-test and post-test scores, confirming that the Electrical Trainer had a positive effect on the students' performance.

The negative t-value reflected that the post-test scores were substantially higher than the pre-test scores, demonstrating that students' skills in wiring, switch operation, measurement, and fault detection improved after using the trainer. The high level of statistical significance validated that the observed improvement was not due to chance but directly related to the hands-on practice facilitated by the trainer. The significant increase in post-test performance implies that the Electrical Trainer effectively enhanced practical competencies in Basic Electrical Connection. Students were able to apply theoretical knowledge to real-world electrical tasks, improving accuracy, workmanship, and safety compliance. This finding supports previous studies emphasizing the importance of hands-on instructional tools in technical-vocational education (Chernikova et al., 2020; Pereyras, 2020; Rosales, 2022).

The result also suggests that implementing structured, practical learning tools like the Electrical Trainer can improve students' problem-solving skills, fault recognition, and confidence, aligning with TESDA's competency-based training guidelines (TESDA, 2016). Instructors can use these findings to justify the integration of similar trainers in classroom and laboratory settings to maximize learning outcomes and skill acquisition.

Table 6. Difference between the pre-test and post-test during the performance of the students

K. **Parameters**	L. **t-value**	M. **df**	N. **p-value**	O. **Remarks**
P. Pretest Performance in Basic Electrical Connection Posttest Performance in Basic Electrical Connection	Q. -22.883	R. 14	S. 0.000	T. s

Acceptability of Electrical Trainer in Basic Electrical Connection in Terms of Composition

Table 7 showed the acceptability level of the Electrical Trainer in Basic Electrical Connection in terms of composition, as evaluated by 20 technical experts and 20 electrical students.

The findings revealed that Statement No. 5, *"The Electrical Trainer used single-pole double-throw (SPDT) and single-pole single-throw (SPST) switches,"* obtained the highest mean score of 4.98, with a verbal interpretation of "Very Acceptable." This result indicates that the evaluators highly recognized the trainer's inclusion of essential switching components necessary for practical electrical applications.

Meanwhile, Statement No. 4, *"The Electrical Trainer contains a cabinet for tools and equipment,"* obtained a mean score of 4.90, also verbally interpreted as "Very Acceptable." This finding suggests that the availability of organized storage components contributed positively to the trainer's functionality, safety, and overall usability during instructional and practical activities.

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Statement No. 5, “The Electrical Trainer used single-pole double-throw (SPDT) and single-pole single-throw (SPST) switches,” obtained the highest mean score of 4.98, with a verbal interpretation of “Very Acceptable.” This result indicates that the inclusion of essential switching components contributed significantly to the trainer’s acceptability among the evaluators.

Statement No. 4, “The Electrical Trainer contains a cabinet for tools and equipment,” obtained a mean score of 4.90, also verbally interpreted as “Very Acceptable.” This finding suggests that the provision of organized storage facilities enhanced the trainer’s functionality, convenience, and safety during instructional activities.

Meanwhile, Statements Nos. 1 and 2, “The Electrical Trainer consists of a frame made of wood” and “The Electrical Trainer has plywood for electrical wiring connections,” both obtained a mean score of 4.85, with a verbal interpretation of “Very Acceptable.” These findings imply that the trainer’s structural design and construction materials were highly regarded in terms of durability and suitability for instructional purposes.

Lastly, Statement No. 3, “The Electrical Trainer has casters to enhance mobility and reduce the effort required to move objects,” obtained a mean score of 4.83, with a verbal interpretation of “Very Acceptable.” This result indicates that the trainer’s mobility feature was also positively evaluated, emphasizing its practicality and ease of transport within the learning environment.

The findings imply that the composition of the Electrical Trainer significantly contributed to its high acceptability among technical experts and electrical students. The positive evaluation of components such as SPDT and SPST switches, cabinet storage, structural materials, and mobility features indicates that instructional tools designed with safety, functionality, and usability enhance technical learning experiences. According to Azubuike et al. (2021), technical and vocational education becomes more effective when learners are provided with instructional facilities and equipment that simulate real workplace environments. The inclusion of authentic electrical components in the trainer promotes experiential learning and strengthens learners’ practical competencies.

The findings also support the work of Ramdani et al. (2022), who emphasized that hands-on instructional tools improve students’ engagement, technical understanding, and skill acquisition in technical and vocational education programs. The presence of organized storage systems, durable construction materials, and operational safety mechanisms contributes to a conducive learning environment that enhances instructional efficiency. Similarly, Putri and Widodo (2021) found that instructional devices designed with usability and practical functionality positively influence learner performance and technical skill development.

Furthermore, the findings align with research by Sari et al. (2023), which highlighted that educational training devices incorporating mobility, safety features, and industry-based components improve learning outcomes and student competency development in technical education. The high acceptability ratings obtained in the present study indicate that the trainer composition supports effective instructional delivery and practical learning experiences.

However, if previous studies reviewed in Chapter 2 reported differing results, variations may be associated with contextual factors, learning environments, or differences in instructional implementation. Overall, the findings emphasize that carefully designed instructional trainers contribute significantly to strengthening electrical education and technical competency development.

The findings imply that the composition of the Electrical Trainer plays a crucial role in enhancing its acceptability, usability, and effectiveness as an instructional tool in Basic Electrical Connection. The inclusion of essential electrical components, safety mechanisms, organized storage facilities, durable construction materials, and mobility features contributes to a more efficient and practical learning environment.

These design characteristics support experiential and hands-on learning, allowing students to strengthen their technical competencies, improve operational skills, and develop safety awareness. The results further suggest that well-designed instructional trainers can facilitate better instructional delivery and promote meaningful learning experiences in electrical education.

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Table 7. Acceptability of the electrical trainer in basic electrical connection in terms of composition.

U. **Statement**	V. **Mean**	W. **Verbal Interpretation**
X. 1. The Electrical Trainer consists of a frame made of wood.	Y. 4.85	Z. Very Acceptable
AA. 2. The Electrical Trainer has plywood for electrical wiring connections.	BB. 4.85	CC. Very Acceptable.
DD. 3. The Electrical Trainer has a caster to enhance mobility and reduce the effort required to move the objects.	EE. 4.83	FF. Very Acceptable.
GG. 4. The Electrical Trainer contains a cabinet for the tools and equipment.	HH. 4.90	II. Very Acceptable.
JJ. 5. The Electrical Trainer used single-pole double-throw (SPDT) and single-pole single-throw (SPST) switches	KK. 4.98	LL. Very Acceptable.
MM. **Grand Mean**	NN. **4.76**	OO. **Very Acceptable.**

Acceptability of the Electrical Trainer in Basic Electrical Connection in Terms of Operating Performance

Table 8 presents the acceptability level of the Electrical Trainer in terms of operating performance as evaluated by technical experts and faculty members. The table includes the mean scores and verbal interpretation for each statement, reflecting the evaluators' perception of how well the trainer performed during practical use. The first statement, *"The trainer can operate continuously for a certain time,"* received a mean score of 4.9, interpreted as Very Acceptable. This indicated that the trainer was capable of consistent operation without interruption, ensuring reliability during extended classroom or laboratory use. Continuous operation is critical in hands-on technical training, as it allows students to complete exercises without delays or technical interruptions, supporting the principles of competency-based learning (Technical Education and Skills Development Authority, 2016).

The second statement, *"This trainer deals with different electrical faults, including short circuits,"* received a mean of 4.93, also interpreted as Very Acceptable. This finding demonstrated that the trainer was effective in simulating fault conditions, allowing students to practice troubleshooting and error detection safely. Fault simulation aligned with findings from Chernikova et al. (2020) and Sukir et al. (2023), which emphasized the value of simulation-based learning in developing complex technical skills and problem-solving capabilities in electrical education.

The third statement, *"The analog tester is used to read voltage, AC, DC, ohms, and total resistance,"* also scored 4.93 (Very Acceptable). This indicated that the analog multitester provided a realistic measurement experience for students, reinforcing practical learning in electrical measurement, a key competency in TESDA's Electrical Installation and Maintenance training regulations (TESDA, 2016).

The fourth statement, *"An analog tester illustration can be used to demonstrate proper use to assess the operating performance of the electrical system and components,"* received a mean of 4.78 (Very Acceptable). This highlighted the instructional usefulness of the analog tester as both a measurement tool and a demonstration device, allowing instructors to guide students on proper techniques and interpretation of readings. It supported active learning, where students could observe and replicate electrical measurements under supervision (Theobald et al., 2020).

The fifth statement, *"The whiteboards are used to illustrate concepts, demonstrate operating processes in writing, and explain further aspects of the electrical system,"* received a mean of 4.90 (Very Acceptable). This indicated that visual aids complemented the hands-on operation of the trainer, reinforcing conceptual understanding and linking theoretical knowledge to practical tasks, as suggested by Pereyras (2020) and Rosales (2022) in their studies on instructional trainers. The grand mean of 4.91, interpreted as Very Acceptable, reflected the overall excellence of the trainer's operating performance. This result implied that the Electrical Trainer effectively met the functional requirements for teaching basic electrical connection, providing reliable, safe, and instructional operation. The high mean scores validated the design and fabrication process described in the study and aligned with previous literature emphasizing the importance of operational

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functionality, safety, and instructional value in training equipment (Ashby, 2016; Chernikova et al., 2020; Spatioti et al., 2022).

The evaluation of the Electrical Trainer demonstrated that it operated consistently and was capable of handling simulated electrical faults safely. This feature allowed students to engage in practical exercises without the risk of electrical hazards, ensuring a reliable and controlled learning environment. The analog multitester effectively supported measurement practice and demonstrations, allowing learners to accurately read voltage, AC, DC, resistance, and continuity, thereby reinforcing their understanding of electrical systems. Instructional aids such as whiteboards complemented the hands-on activities by providing visual explanations of concepts, operating procedures, and circuit diagrams, which enhanced comprehension and overall learning. The grand mean of 4.91, interpreted as very acceptable, confirmed that the trainer's operating performance was highly suitable for hands-on instruction in technical-vocational education.

The findings have several practical implications. Students could rely on the Electrical Trainer for safe, uninterrupted practice, which is critical for building competence and confidence in electrical skills. The inclusion of simulated faults encouraged learners to develop problem-solving and troubleshooting abilities, allowing them to identify errors and correct connections independently. For instructors, the trainer facilitated efficient demonstrations of electrical concepts, enabling them to reinforce theoretical knowledge while providing practical guidance, thus bridging the gap between classroom learning and real-world application. The results of this evaluation were supported and validated by existing literature.

The functionality and reliability of the trainer aligned with Ashby's (2016) principles of materials and design, which emphasize that product performance must correspond to its intended function. The effectiveness of simulation-based learning observed in the study was consistent with findings by Chernikova et al. (2020) and Sukir et al. (2023), who highlighted that hands-on and simulated environments significantly enhance technical skill development. Finally, the integration of practical tools and instructional aids corresponded with the work of Pereyras (2020) and Rosales (2022), confirming that well-designed electrical trainers improve learner competency and facilitate the acquisition of practical skills in technical-vocational education.

Table 8. Acceptability level of the electrical trainer in basic electrical connection in terms of operating performance

PP. **Statement**	QQ. **Mean**	RR. **Verbal Interpretation**
SS. 1.The trainer can operate continuously for a certain time.	TT. 4.90	UU. Very Acceptable
VV. 2.This trainer deals with different electrical faults, including short circuits.	WW. 4.93	XX. Very Acceptable
YY. 3.The analog tester is used to read voltage, AC, DC, ohms, and total resistance.	ZZ. 4.93	AAA. Very Acceptable
BBB. 4.An analog tester illustration can be used to demonstrate proper use to assess the operating performance of the electrical system and components.	CCC. 4.78	DDD. Very Acceptable
EEE. 5.The whiteboards are used to illustrate concepts, demonstrate operating processes in writing, and explain further aspects of the electrical system.	FFF. 4.90	GGG. Very Acceptable
HHH. **Grand Mean**	III. **4.91**	JJJ. **Very Acceptable**

Acceptability Level of the Electrical Trainer in Basic Electrical Connection in Terms of Safety

Table 9 presents the acceptability level of the Electrical Trainer in terms of safety, based on the evaluation of technical experts and faculty members. The mean scores and verbal interpretations reflect the evaluators' assessment of the trainer's ability to operate safely and protect users during hands-on learning.
The first statement, *"The trainer can operate continuously for a certain time,"* received a mean of 4.93, which was interpreted as Very Acceptable. This indicated that the trainer could function reliably during extended classroom or laboratory sessions without interruptions that could compromise safety or learning.

The second statement, *"This trainer deals with different electrical faults, including short circuits,"* obtained a mean score of 4.90 (Very Acceptable). This demonstrated that the trainer effectively simulated potential electrical faults, allowing

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students to experience troubleshooting safely. Simulating faults in a controlled environment promoted critical thinking and reinforced safe working practices, consistent with findings from Chernikova et al. (2020) on simulation-based learning in technical education.

The third statement, *"The analog tester is used to read voltage, AC, DC, ohms, and total resistance,"* received a mean of 4.82, interpreted as Very Acceptable. This confirmed that the analog tester provided accurate measurements, allowing students to verify circuit conditions while practicing safe handling of electrical components, supporting TESDA's competency-based guidelines (TESDA, 2016).

The fourth statement, *"An analog tester illustration can be used to demonstrate proper use to assess the operating performance of the electrical system and components,"* scored 4.93 (Very Acceptable). This highlighted the trainer's instructional value in demonstrating proper measurement procedures and ensuring that students followed safe testing practices.

The fifth statement, *"The whiteboards are used to illustrate concepts, demonstrate operating processes in writing, and explain further aspects of the electrical system,"* had the highest mean of 4.98 (Very Acceptable). This suggested that integrating visual aids enhanced comprehension and reinforced safe procedures during hands-on activities.

The grand mean of 4.80, interpreted as Very Acceptable, indicated that the trainer effectively met the standards for operational safety. It confirmed that the trainer was both functional and secure for practical learning, providing students with a safe environment to develop their skills.
The evaluation of the Electrical Trainer in terms of safety revealed that it operated continuously without posing any risk to students, ensuring a reliable and secure learning environment. The inclusion of simulated electrical faults and the analog tester enhanced safe learning by allowing students to practice identifying and correcting errors while understanding electrical circuits. Additionally, the use of whiteboards and visual aids reinforced comprehension of safe electrical procedures, providing clear guidance for both theoretical and practical aspects of learning. The high grand mean confirmed that the trainer was very acceptable and suitable for hands-on learning in technical-vocational education.

The findings had several practical implications. Students were able to perform hands-on electrical exercises safely, minimizing exposure to hazards. The inclusion of fault simulations encouraged problem-solving and critical thinking while maintaining safe practices. Instructors benefited from the trainer's design by being able to demonstrate electrical concepts safely, effectively bridging theoretical knowledge with practical application.

Table 9. Acceptability level of the electrical trainer in basic electrical connection in terms of safety.

KKK. **Statement**	LLL. **Mean**	MMM. **Verbal Interpretation**
NNN. 1.The trainer can operate continuously for a certain time.	OOO. 4.93	PPP. Very Acceptable
QQQ. 2.This trainer deals with different electrical faults, including short circuits.	RRR. 4.9	SSS. Very Acceptable
TTT. 3.The analog tester is used to read voltage, AC, DC, ohms, and total resistance.	UUU. 4.82	VVV. Very Acceptable
WWW. 4.An analog tester illustration can be used to demonstrate proper use to assess the operating performance of the electrical system and components.	XXX. 4.93	YYY. Very Acceptable
ZZZ. 5.The whiteboards are used to illustrate concepts, demonstrate operating processes in writing, and explain further aspects of the electrical system.	AAAA. 4.98	BBBB. Very Acceptable
CCCC. **Grand Mean**	DDDD. **4.80**	EEEE. **Very Acceptable**

These results were consistent with established literature. The trainer's reliability and safety aligned with Ashby's (2016) principles of materials and design, emphasizing that functional performance depends on appropriate selection and use of materials. The effectiveness of fault simulations and measurement tools supported the findings of Chernikova et al. (2020) and Sukir et al. (2023), who highlighted the role of simulation-based learning in developing technical competencies.

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Furthermore, the integration of practical tools and instructional aids reflected the work of Pereyras (2020) and Rosales (2022), validating that well-designed instructional trainers enhance learner competency while ensuring safety in technical-vocational education.

IV. CONCLUSION

Based on the findings of the study, the following conclusions were drawn:
The Electrical Trainer was successfully developed with functional technical features suitable for teaching Basic Electrical Connection. Its components supported wiring practice, switching operations, electrical measurement, fault detection, mobility, and safety, making it appropriate for hands-on instruction.

The students' performance improved after using the Electrical Trainer. From a Satisfactory pre-test result, the students achieved an Excellent post-test result, showing that the trainer helped enhance their practical skills, accuracy, confidence, and troubleshooting ability.

There was a significant difference between the pre-test and post-test performance of the students. This confirmed that the use of the Electrical Trainer had a positive and measurable effect on students' performance in Basic Electrical Connection.

The Electrical Trainer was found to be Very Acceptable in terms of composition, operating performance, and safety. This indicated that the trainer was well-designed, functional, safe, and suitable as an instructional tool for Electrical Installation and Maintenance learning.

Recommendations

Based on the summary of findings and conclusions, it is recommended that the Electrical Trainer be used as an instructional tool in teaching Basic Electrical Connection. Since the trainer was found to have functional technical features, it may be integrated into laboratory and workshop activities to help students practice wiring, switching operations, electrical measurement, and fault detection. Its use may help students understand electrical concepts better because they can apply lessons through actual hands-on activities.

It is also recommended that instructors provide more guided practice using the Electrical Trainer before conducting performance assessments. Since the students' post-test performance improved from Satisfactory to Excellent, the trainer should be used regularly to strengthen students' accuracy, confidence, workmanship, and troubleshooting skills. Teachers may prepare step-by-step activities, wiring exercises, and fault-finding tasks so that students can practice repeatedly and safely.

The Electrical Trainer should also be maintained and checked regularly to ensure safe and continuous operation. The RCCB, alarm device, switches, sockets, bulbs, wiring connections, analog multitester, and other electrical components should be inspected before and after use. This will help prevent electrical hazards and ensure that the trainer remains reliable for student activities.

It is further recommended that the trainer be improved in future versions. Additional features such as digital measuring instruments, clearer labels, larger wiring boards, modular circuits, and more practice stations may be added to accommodate more students at the same time. These improvements may make the trainer more convenient, accurate, and suitable for different skill levels.

The school administration may also consider producing more units of the Electrical Trainer for wider use in Electrical Installation and Maintenance classes. Since the trainer was rated Very Acceptable in terms of composition, operating performance, and safety, it may serve as a practical learning device for technical-vocational students. Providing more units would allow more learners to participate actively in hands-on activities instead of waiting for their turn.

Lastly, future researchers may conduct further studies on the long-term effectiveness of the Electrical Trainer. They may also compare the performance of students who use the trainer with those who use traditional methods only. Future studies may include larger groups of students, different schools, or other electrical courses to determine whether the trainer can also improve learning outcomes in advanced electrical subjects.

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