# TECHNICAL LEARNING OUTCOMES, SOCIAL VALUE CONTRIBUTIONS, AND DEVELOPMENT OF A SELF-PACED INDUSTRIAL MOTOR CONTROLLER SYSTEM TRAINER USING THE ADDIE MODEL

ROEY C. SUMAOY[1*], Margarita M. Ladanan[1], Anna May A. Proel[1]

[1]North Eastern Mindanao State University, Philippines

[1]Department of General Teacher Training (ROEY C. SUMAOY, Margarita M. Ladanan) | Department of Industrial Technology (Anna May A. Proel)

[1]ORCID: https://orcid.org/0009-0004-8779-8840 | Email: rcsumaoy@nemsu.edu.ph

[1]ORCID: https://orcid.org/0009-0002-7793-3557 | Email: mmladanan@nemsu.edu.ph

[1]ORCID: https://orcid.org/0009-0002-5261-1658 | Email: amaproel@nemsu.edu.ph

*Corresponding Author: ROEY C. SUMAOY | Email: rcsumaoy@nemsu.edu.ph

**ABSTRACT**

This study aimed to address instructional challenges in the Industrial Motor Controller subject at North Eastern Mindanao State University-Cantilan Campus, where outdated and limited instructional equipment hindered students' technical competency and opportunities for hands-on learning. Specifically, the study sought to develop and evaluate a self-paced industrial motor controller system trainer and examine its educational effectiveness and social value within technical and vocational education. The study employed a developmental research design guided by the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. Thirty (30) students enrolled in technical and vocational education programs were purposively selected to participate in the implementation and evaluation phases. Data were collected through pre-test and post-test assessments, a student feedback survey, an observation checklist, and semi-structured interviews with selected students and instructors. Quantitative data were analyzed using descriptive statistics and paired-samples t-test, while qualitative responses were analyzed through thematic analysis. Results revealed high levels of satisfaction with the trainer in terms of usability, functionality, flexibility, perceived impact, and design, all of which received "Strongly Agree" ratings. The significant improvement in post-test scores confirmed the trainer's effectiveness in enhancing students' knowledge and practical competencies in industrial motor control systems. Qualitative findings further revealed that the trainer generated social value by improving educational accessibility, supporting equitable and self-paced learning, strengthening workforce readiness, and promoting instructional sustainability through efficient utilization of training resources. The findings highlight the potential of innovative, self-paced training systems to enhance technical education in resource-constrained settings. Beyond improving learning outcomes, the developed trainer contributes to broader social value by expanding learning opportunities, supporting diverse learner needs, fostering industry-relevant competencies, and promoting sustainable instructional practices in technical and vocational education.

**Keywords**: ADDIE model, development, industrial motor controller system trainer, self-paced, effectiveness, technical education

## INTRODUCTION

Industrial motor controllers are crucial components in modern automation and industrial processes, as they regulate the speed, torque, and direction of electric motors. These systems are integral in various applications, including manufacturing, robotics, and energy management, where precise motor control is essential for efficiency and safety (Giri, 2013). As industries increasingly adopt automation, there is a growing demand for technically skilled personnel proficient in operating, troubleshooting, and maintaining motor controller systems (Popoola et al., 2024).

The significance of training in industrial motor control lies in its potential to improve workforce competency, enhance operational productivity, and ensure equipment longevity (De Felice et al., 2013). Wettaka (2020) demonstrated that targeted, hands-on training can significantly boost learners' understanding and skills in technical areas like motor control. Ebbini (2023) found that hands-on, self-paced learning modules improved knowledge retention and application among technical students in motor control. Similarly, studies in technical and vocational education indicate that adaptable learning tools, which cater to different learning speeds and styles, are particularly effective in building technical proficiency and confidence among learners (Wu, 2024; Udeze, 2024; Holik et al., 2023).

Despite its importance, the field of industrial motor control education faces several challenges (Maddikunta et al., 2022). Traditional training methods often involve instructor-led sessions and rigid schedules, which may not accommodate all learners' needs and can limit their ability to engage deeply with the material (Fair, 2021; Clark & Mayer, 2023). Additionally, many institutions lack adequate resources, facilities, or trainers to deliver comprehensive, hands-on motor control training (Volansky, 2019). According to Schneider et al. (2023), these challenges are particularly prominent in settings where the curriculum is heavily theory-based, leaving little room for practical application, which is essential for skill acquisition in technical fields.

To address these issues, instructional design models such as ADDIE (Analysis, Design, Development, Implementation, and Evaluation) have been widely adopted in education and training (Spatioti et al., 2022; Handrianto et al., 2021; Alsaleh, 2020). Abuhassna et al. (2024) highlights that the ADDIE model allows for the systematic design of learning experiences, making it ideal for creating adaptable and effective training tools. Several studies have shown that applying structured instructional design models like ADDIE can enhance learner engagement and success, particularly in technical subjects. They demonstrated that ADDIE-based modules in technical courses led to higher engagement and practical skill development than traditional lecture methods (Abuhassna et al.,2024; Yan et al., 2024; Budoya et al., 2019).

In the Philippines, the government has implemented various initiatives to enhance technical and vocational education, including programs led by the Technical Education and Skills Development Authority (TESDA) (Edralin & Pastrana, 2023). TESDA has developed a range of certification programs and supports curriculum development efforts to ensure alignment with industry standards, particularly in fields such as industrial automation and motor control systems (Reyes, 2018). The Department of Education (DepEd) has also taken steps to modernize technical education by introducing technology-based learning tools and frameworks, such as the DepEd Computerization Program, to increase access to digital resources and improve instructional quality (DepEd, 2021).

Recent developments in technical and vocational education have expanded the concept of educational effectiveness beyond the acquisition of technical competencies to include the broader social value generated by instructional innovations. Social value in education refers to the positive contributions of educational interventions toward accessibility, equity, employability, sustainability, and community development. In the context of technical education, learning technologies and self-paced instructional systems are increasingly recognized for their capacity to democratize access to learning opportunities and accommodate diverse learner needs. Self-paced learning environments enable students to progress according to their individual abilities and prior knowledge, thereby reducing barriers associated with rigid instructional structures and promoting more inclusive participation in technical training programs (Surhano et al., 2025). Similarly, sustainable educational technologies create value not only by improving learning outcomes but also by supporting equitable access to resources and fostering long-term educational sustainability (Alharthi & Spichkova, 2017). International organizations have likewise emphasized that technical and vocational education should serve as a mechanism for expanding access to quality learning opportunities and reducing educational inequalities among learners from diverse backgrounds (UNESCO, 2022; United Nations, 2024; Yusvana, 2024). Furthermore, educational systems that prioritize inclusivity and learner-centered approaches contribute to more equitable educational outcomes and promote social participation among traditionally underserved populations (Gillani & Eynon, 2023; UNESCO Bangkok, 2014). These perspectives suggest that instructional innovations such as self-paced learning trainers possess social value because they extend learning opportunities while supporting educational equity and inclusion.

Beyond educational accessibility, social value is also reflected in the ability of technical education programs to contribute to workforce readiness, institutional sustainability, and socio-economic development. Technical and vocational education plays a critical role in preparing learners for productive employment by equipping them with industry-relevant competencies and practical skills required in rapidly evolving labor markets (OECD, 2024). According to Pavlova (2009), technology and vocational education contribute to sustainable development by enhancing employability and empowering individuals to participate meaningfully in economic and social life. Likewise, the World Bank (2024) recognizes skills development as a key driver of employment generation, poverty reduction, and economic growth, highlighting the broader societal benefits derived from effective technical training. Within educational institutions, innovative instructional tools can also generate social value through more efficient utilization of limited resources, reduced dependence on expensive equipment, and expanded opportunities for hands-on learning. Such benefits are particularly important in resource-constrained institutions where access to modern training facilities remains limited. Consequently, the development of a self-paced industrial motor controller system trainer may be viewed not only as an instructional innovation that enhances technical competencies but also as a socially valuable educational intervention that promotes accessibility, supports equitable learning opportunities, strengthens workforce preparedness, and contributes to the sustainable delivery of technical education. Given these potential contributions, examining the social value generated by instructional innovations in technical education has become increasingly important, particularly in institutions facing limitations in instructional resources and training equipment.

Despite these initiatives, a significant gap persists in the accessibility and effectiveness of hands-on, self-paced learning tools specifically for industrial motor control training. While TESDA certifications and DepEd programs provide foundational skills, there is limited emphasis on advanced, flexible learning models that cater to individual learning speeds and practical skill acquisition (Bansiong & Alawas, 2024). Studies indicate that self-paced, interactive tools can significantly enhance learners' technical competencies by allowing them to practice independently and apply theoretical knowledge in a real-world context (Ebbini, 2023; Surhano et al., 2025). However, few studies have examined how ADDIE-based self-paced learning systems contribute not only to technical competency development but also to broader social value outcomes such as educational accessibility, workforce readiness, and sustainable utilization of instructional resources, particularly within Philippine technical education institutions. This research gap highlights the need for a structured approach to designing training tools that not only align with industry standards but also support adaptable, skill-focused learning as highlighted by Adewolu (2024).

In addition, several issues related to the physical resources available for industrial motor control training further complicate the development of an effective educational program. The allocated budget for purchasing instructional equipment is limited, and the equipment required for hands-on learning is often extremely expensive (Elendu, 2024; Matthews et al., 2022). At North Eastern Mindanao State University-Cantilan Campus, for example, there is a shortage of adequate instructional materials for training in industrial motor controllers, particularly in laboratory or shop settings. The institution still relies on traditional methods of motor control installation, which are now obsolete in the industry.

While these traditional methods provide students with an actual orientation to the job, they have significant drawbacks. Performing a series of activities on outdated equipment often damages critical components, particularly the terminals, due to issues like loosening and damage to screw heads (Frangopol & Liu, 2019; Geitner & Bloch, 2019). Furthermore, the time required for setup and installation can be inefficient, particularly given the high number of students relative to the limited availability of components. These gaps in instructional resources and equipment underscore the need for more advanced, self-paced learning tools that can support a larger student cohort while reducing wear and tear on equipment (Molnar, 2023; Kyriazis, 2021). Several studies recommend using the ADDIE model to develop adaptable, industry-aligned training systems that bridge gaps in traditional technical education by supporting flexible, self-paced, and practical learning experiences (Abuhassna et al.,2024; Adewolu, 2024; Yan et al., 2024; Budoya et al., 2019).

**Purpose of the Study**

The purpose of this study is to apply the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model in the design, development, and evaluation of a self-paced industrial motor controller system trainer that provides a more convenient, informative, efficient, flexible, and hands-on learning experience for students. The study addresses critical challenges in technical education, particularly the lack of adequate instructional equipment, limited opportunities for practical learning, and the continued use of outdated training methods at North Eastern Mindanao State University-Cantilan Campus. The developed trainer is intended to enhance students' acquisition of 21st-century technical skills, strengthen their technical competencies, and support active and independent learning while generating social value through improved educational accessibility, learning equity, workforce readiness, and instructional sustainability. The study further seeks to demonstrate the potential of innovative instructional technologies to expand learning opportunities, accommodate diverse learner needs, reduce dependence on costly and easily damaged training equipment, and contribute to the delivery of quality technical and vocational education for students, institutions, and the broader community.

## METHODOLOGY

**Design**

This study utilized a developmental research design, guided by the ADDIE model, to design, develop, and evaluate a self-paced industrial motor controller training system. The research methodology was organized into five phases: Analysis, Design, Development, Implementation, and Evaluation. A one group pre-test and post-test setup was employed to evaluate the effectiveness of the trainer. This design allowed for the comparison of students' knowledge and skills before and after using the trainer, providing insights into the trainer's impact on learning outcomes. In addition, a qualitative component was incorporated to explore the social value generated by the trainer in terms of educational accessibility, learning equity, workforce readiness, and instructional sustainability as perceived by students and instructors.

**Participants**

The respondents for this study were students enrolled in technical and vocational education programs at North Eastern Mindanao State University-Cantilan Campus, specifically those pursuing courses that covered industrial motor control systems. The sample size consisted of approximately 30 students, selected through purposive sampling based on their enrollment in relevant courses and availability to participate in both pre-test and post-test assessments. Additionally, a subset of ten (10) participants was purposively selected for the qualitative phase of the study, consisting of eight (8) student participants and two (2) instructors involved in the implementation of the trainer. Student participants were selected based on the following criteria: (1) completion of the training activities using the self-paced industrial motor controller system trainer, (2) participation in both the pre-test and post-test assessments, and (3) willingness to share their experiences during the interview process. Instructor participants were selected based on their direct involvement in supervising and evaluating students during the implementation phase. The interviews were conducted to obtain deeper insights into the educational effectiveness and social value of the trainer, particularly in terms of educational accessibility, learning equity, workforce readiness, and instructional sustainability.

**Instrument**

The study utilized several research instruments, namely the pre-test and post-test assessments, a student feedback survey, a semi-structured interview guide, and an observation checklist. The pre-test was used to establish the students' baseline knowledge and skills in industrial motor control systems, while the post-test measured learning gains after exposure to the self-paced industrial motor controller system trainer. Both assessments consisted of multiple-choice questions, technical identification items, and practical tasks designed to evaluate students' understanding and application of motor control concepts. The student feedback survey employed a Likert-scale format to assess the trainer's usability, functionality, flexibility, perceived impact, design, and alignment with learning objectives. An observation checklist was likewise utilized to document students' interactions with the trainer, monitor engagement during implementation, and identify operational issues encountered during training sessions.

To complement the quantitative findings, a semi-structured interview guide was developed and administered to selected student participants and instructors. The interview guide consisted of open-ended questions designed to elicit participants' experiences, perceptions, and insights regarding the educational effectiveness and social value of the developed trainer. Specifically, the interviews explored themes related to educational accessibility, learning equity, workforce readiness, instructional sustainability, and the overall contribution of the trainer to technical and vocational education. All quantitative instruments underwent pilot testing to establish reliability and consistency, yielding Cronbach's alpha coefficients of 0.87 for the pre-test and post-test assessments, 0.91 for the student feedback survey, and 0.88 for the observation checklist, indicating high reliability. Meanwhile, the semi-structured interview guide underwent expert validation to ensure the relevance, clarity, and alignment of the interview questions with the objectives of the study.

**Data Gathering Procedure**

The data gathering procedure began with a preparation phase, which involved conducting an orientation session for students and instructors to explain the purpose of the study and provide a demonstration of the self-paced trainer. Consent forms were distributed to ensure participants' voluntary involvement and understanding of data privacy. In the pre-test phase, participating students were administered a pre-test to establish a baseline understanding of industrial motor controllers, with scores recorded for later comparison. During the training sessions, students engaged with the self-paced trainer, progressing at their own pace under minimal supervision. An observation checklist was used to monitor student interactions and identify any operational challenges with the trainer. Once the training was completed, a post-test was administered to assess knowledge and skill gains, and scores were compared to the pre-test results to evaluate improvements. Immediately following the post-test, a student feedback survey was distributed to capture insights on the trainer's usability and effectiveness, with both quantitative ratings and qualitative comments analyzed. One-on-one semi-structured interviews were conducted with selected student participants and instructors to gather deeper insights into the trainer's educational effectiveness and social value, particularly in terms of educational accessibility, learning equity, workforce readiness, and instructional sustainability. Finally, all data from the pre-test, post-test, survey, observation checklist, and interviews were compiled and analyzed. Quantitative data were analyzed using descriptive statistics and paired-samples t-test, while qualitative interview responses were analyzed through thematic analysis to identify themes related to the trainer's educational effectiveness and social value.

## RESULTS

The presentation of the results and discussion was aligned with the ADDIE model to ensure a structured and systematic approach to the development, implementation, and evaluation of the self-paced trainer.

### Analysis

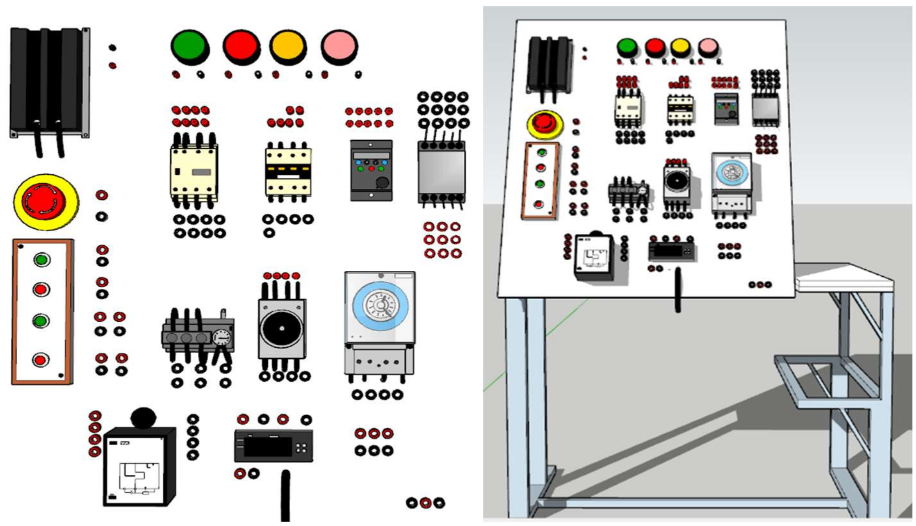
During the analysis phase, the researchers found out that the North Eastern Mindanao State University-Cantilan Campus lacks instructional resources in industrial motor controller subject which is a need in enhancing students' technical competence and cannot meet the demand of the number of students. The researcher also found out that the institution still relies on the outdated and more often damaged equipment.

### Design

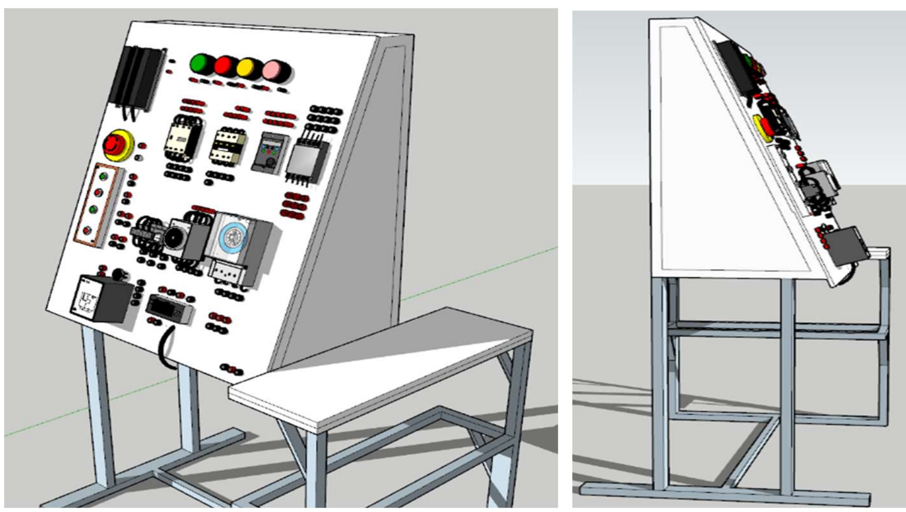
With that, during the design phase, a detailed instructional design blueprint was developed for a self-paced industrial motor controller trainer that aligned with industry standards (see figure 1, a & b). This was designed using the sketch-up software application. The instructional goals, learning objectives, and assessment methods were outlined to ensure they matched the identified skills and competencies. In addition, the design phase specified the essential materials, tools, and technologies required to construct the training system, ensuring maximum flexibility and accessibility for students.

**Figure 1**

*Design of the Industrial Motor Controller System Trainer (a. front views, b. side views)*



a.



b.

**Development**

In the development phase, the necessary instructional materials and components for the industrial motor controller trainer were created and assembled based on the design blueprint (see figure 2). Initial trials of the trainer were conducted to test its functionality and necessary adjustments were made by the developer expert.

**Figure 2**

*Development of the Industrial Motor Controller System Trainer*


**Implementation and Evaluation Phase**

The implementation phase involved introducing the industrial motor controller trainer to a sample group of students at North Eastern Mindanao State University-Cantilan Campus. Training sessions were conducted to ensure students understood how to engage with the system effectively and independently. Throughout this phase, instructors observed the students' interactions with the trainer, providing support as needed.

Meanwhile, the evaluation phase was conducted in two parts: formative evaluation (implementation phases) and summative evaluation (after implementation). Results from formative evaluation on the salient features includes feedbacks from surveys regarding the trainer's usability, functionality, flexibility, perceived impact, and design (see table 1).

Table 1 shows the salient features evaluation results, where students rated each feature using a Likert scale. Results indicated high satisfaction levels, with all categories receiving a "Strongly Agree" (SA) rating. The usability average score of 4.47 reflects that the trainer was easy to navigate, with clear instructions enabling independent task completion. The functionality average of 4.57 highlights the smooth operation, accurate simulation, and responsive feedback provided by the trainer. Similarly, flexibility scored an average of 4.57, indicating that the trainer supported various learning paces and styles, allowing students to progress at their own speed. The perceived impact category, with an average of 4.40, suggests the trainer significantly contributed to improving students' understanding and practical application of motor control concepts. Finally, the design category achieved the highest score, averaging 4.57, emphasizing the well-organized, visually engaging, and interactive layout conducive to hands-on learning.

In addition, the feedbacks from instructors with regards to the trainer reveals several key concepts. One of the instructor said that "Yes, it allows the students to work at their own pace", when asked if the trainer effectively support students' learning progress and engagement. Then, the second instructor also recommends to add more safety features to promote safe training during operation. He added that labels must be imbedded to all the electrical components to avoid confusion and damage.

**Table 1**
*Salient Features Evaluation Results*

| No. | Variables/Item Statements | Weighted Mean | Verbal Description |
|---|---|---|---|
| Usability | | | |
| 1 | The trainer was easy to navigate and use without much guidance. | 4.33 | SA |
| 2 | The instructions provided within the trainer were clear and easy to follow. | 4.17 | SA |
| 3 | I was able to independently complete tasks in the trainer. | 4.50 | SA |
| 4 | The trainer's interface was user-friendly and intuitive. | 4.67 | SA |
| 5 | I felt confident using the trainer after an initial orientation. | 4.67 | SA |
| | Average | 4.47 | |
| Functionality | | | |
| 1 | The trainer operated smoothly without experiencing technical issues. | 4.67 | SA |
| 2 | All features of the trainer functioned as expected during my use. | 4.50 | SA |
| 3 | The trainer accurately simulated industrial motor control systems. | 4.50 | SA |
| 4 | The trainer provided instant feedback when performing tasks. | 4.67 | SA |
| 5 | The trainer allowed me to easily correct errors and retry tasks. | 4.50 | SA |
| | Average | 4.57 | SA |
| Flexibility | | | |
| 1 | The trainer allowed me to progress through tasks at my own pace. | 4.67 | SA |
| 2 | I had the freedom to revisit any section of the training as needed. | 4.67 | SA |
| 3 | The trainer accommodated my learning pace and preferences. | 4.67 | SA |
| 4 | I was able to adjust my learning approach to suit my individual needs. | 4.33 | SA |
| 5 | The trainer supported various learning styles effectively. | 4.50 | SA |
| | Average | 4.57 | SA |
| Perceived Impact | | | |
| | Using the trainer improved my understanding of industrial motor control systems. | 4.50 | SA |
| | I believe the trainer enhanced my ability to perform practical tasks in motor control. | 4.33 | SA |
| | After using the trainer, I feel more confident in applying motor control concepts in real-life scenarios. | 4.33 | SA |
| | The trainer significantly contributed to my learning of motor control systems. | 4.33 | SA |
| | I believe the trainer was an effective tool in helping me meet the course learning objectives. | 4.50 | SA |

| | | |
|---|---|---|
| Average | 4.40 | SA |
| Design | | |
| The layout and design of the trainer made the training process easy to follow. | 4.67 | SA |
| The design of the trainer was appropriate for the subject matter it aimed to teach. | 4.67 | SA |
| The trainer's design promoted an interactive and engaging learning experience. | 4.67 | SA |
| The materials and components used in the trainer were well-organized and conducive to hands-on learning. | 4.33 | SA |
| The visual design helped me focus and engage with the content. | 4.50 | SA |
| Average | 4.57 | SA |

*Note:* 4.3 – 5.0 – Strongly Agree (SA); 3.5 – 4.2 – Agree (A); 2.7 – 3.4 – Neutral (N); 1.9 – 2.6 – Disagree (D); 1.0 – 1.8 – Strongly Disagree (SD)

The results from summative evaluation based on pre-test and post-test, and interviews to assess the overall effectiveness of the trainer in improving students' practical skills and aligning their learning with industry standards is shown in table 2, which is the Pre-test and Post-test scores. The results of the paired samples t-test comparing pretest and posttest evaluations. The pretest mean score was 7.97, with a mean difference of -9.5 observed between the pretest and posttest scores. The standard deviation of the differences was 1.59201. The t-test yielded a t-value of -32.684 with 29 degrees of freedom and a p-value of .0000.

**Table 2**

*Pre-test and Post-test*

| Evaluation | Mean | Mean Difference | SD | t-value | df | p-value |
|---|---|---|---|---|---|---|
| Pretest | 7.97 | -9.5 | 1.59201 | -32.684 | 29 | .0000 |
| Posttest | 17.47 | | | | | |

**Qualitative Question:** *What social value outcomes emerged from the implementation of the self-paced industrial motor controller system trainer as perceived by students and instructors?*

While the quantitative findings demonstrated the effectiveness of the self-paced industrial motor controller system trainer in improving students' learning outcomes, the qualitative findings provided deeper insights into the educational and social value generated by the developed trainer. Analysis of the interview responses from eight student participants and two instructors revealed four major themes: (1) Enhancing Educational Accessibility, (2) Supporting Self-Paced and Equitable Learning, (3) Strengthening Workforce Readiness, and (4) Promoting Instructional Sustainability. These themes highlight the broader contributions of the trainer beyond academic performance and demonstrate its value in improving technical education delivery.

**Theme 1: Enhancing Educational Accessibility**

One of the recurring themes that emerged from the interviews was the trainer's ability to increase students' access to hands-on learning opportunities. Participants noted that the trainer allowed more students to engage in practical activities without relying heavily on limited laboratory equipment.

A student participant shared:

*"Before, we had to wait for our turn because there were only a few available materials in the laboratory. With the trainer, more students can practice and understand the activities without waiting too long."*

Similarly, another student remarked:

*"The trainer made it easier for me to learn because I could focus on the activity itself rather than worrying about whether equipment would be available."*

An instructor also observed:

*"The trainer addressed one of our major challenges, which is the limited availability of instructional equipment. More students were able to participate in practical activities simultaneously."*

These responses suggest that the developed trainer contributes to educational accessibility by providing learners with greater opportunities to engage in practical and experiential learning activities despite resource limitations. The findings indicate that the trainer supports a more inclusive learning environment where students can actively participate in technical training.

**Theme 2: Supporting Self-Paced and Equitable Learning**

Participants consistently highlighted the trainer's ability to accommodate different learning speeds and levels of prior knowledge. Students appreciated the opportunity to repeat procedures and review concepts independently without feeling pressured by time constraints.

One student explained:

*"I liked that I could repeat the activities until I understood the process. If I made mistakes, I could try again without feeling embarrassed."*

Another participant stated:

*"Not all students learn at the same speed. The trainer helped me learn comfortably because I was able to work at my own pace."*

An instructor similarly noted:

*"Students who usually struggle during laboratory activities became more engaged because they could follow the lessons according to their own learning pace."*

The findings indicate that the trainer promotes learning equity by accommodating diverse learner needs and allowing students to progress according to their individual capabilities. Such flexibility creates a more supportive learning environment and reduces barriers that may hinder student participation and achievement.

**Theme 3: Strengthening Workforce Readiness**

Another important theme that emerged was the trainer's contribution to the development of industry-related skills and confidence. Participants perceived the trainer as a valuable tool for preparing them for future employment in technical and industrial settings.

One student shared:

*"The activities felt similar to actual motor control tasks. Because of that, I became more confident in performing the procedures."*

Another student remarked:

*"The trainer helped me understand the connections and components better. I feel more prepared if I encounter these systems during work."*

An instructor explained:
*"The trainer allows students to practice essential motor control skills repeatedly, which is important in preparing them for industry requirements."*
These responses suggest that the trainer contributes to workforce readiness by providing opportunities for repeated practice, skill development, and confidence building. The findings demonstrate that the trainer serves not only as a learning tool but also as a mechanism for enhancing students' preparedness for technical occupations.

**Theme 4: Promoting Instructional Sustainability**
The interviews further revealed the trainer's role in promoting sustainable instructional practices. Both students and instructors recognized its potential to reduce wear and tear on expensive laboratory equipment while maximizing instructional resources.
An instructor commented:
*"One advantage of the trainer is that students can practice without constantly using the actual equipment, which helps reduce damage and maintenance costs."*
Another instructor added:
*"The trainer is practical because it allows repeated training activities while preserving our limited resources."*
A student participant also noted:
*"The trainer gave us enough opportunities to practice without worrying about damaging expensive components."*
The findings indicate that the developed trainer contributes to instructional sustainability by supporting efficient resource utilization and reducing dependence on costly equipment. This is particularly beneficial in resource-constrained institutions where access to modern instructional facilities may be limited.

## DISCUSSION

The findings of this study demonstrate that the self-paced industrial motor controller system trainer was effective in enhancing students' learning outcomes and generating meaningful social value within technical education. The significant improvement observed between the pre-test and post-test scores indicates that the trainer successfully facilitated knowledge acquisition and skill development in industrial motor control systems. This finding supports Kolb's Experiential Learning Theory (2014), which emphasizes that learning is strengthened through active engagement and hands-on experiences. Likewise, Mayer's Cognitive Theory of Multimedia Learning (2005) suggests that well-designed instructional materials improve comprehension and knowledge retention by allowing learners to interact meaningfully with learning content. The positive evaluation ratings for usability, functionality, flexibility, perceived impact, and design further suggest that the trainer provided an effective learning environment that encouraged independent learning and practical skill development.

Beyond its instructional effectiveness, the qualitative findings revealed that the trainer generated social value through its contribution to educational accessibility, learning equity, workforce readiness, and instructional sustainability. Participants reported that the trainer expanded opportunities for hands-on learning despite limitations in laboratory resources and equipment availability. This finding supports the work of Surhano et al., (2025), who argued that self-paced learning environments increase access to educational opportunities by accommodating differences in learners' pace and prior knowledge. Similarly, UNESCO (2022) emphasized that technical and vocational education should promote inclusive and equitable learning opportunities, particularly in resource-constrained educational settings. The ability of the trainer to accommodate diverse learning needs and allow students to revisit activities at their own pace further reflects the principles of learner-centered and equitable education discussed by Gillani and Eynon (2023) and UNESCO Bangkok (2014).

The findings also indicate that the trainer contributes to workforce readiness by allowing students to repeatedly practice industry-relevant skills and develop confidence in performing motor control tasks. Participants perceived the trainer as a valuable preparation tool for future employment and technical work environments. This observation aligns with the perspectives of the OECD (2024) and Pavlova (2009), who emphasized that technical and vocational education creates societal value by developing employable skills and preparing learners for productive participation in the workforce. In addition, instructors highlighted the trainer's role in reducing dependence on expensive and easily damaged instructional equipment. This suggests that the trainer supports instructional sustainability through more efficient utilization of institutional resources while maintaining opportunities for practical learning. Such findings reinforce the view that educational innovations can generate broader social benefits beyond academic achievement, including resource efficiency, accessibility, and long-term educational sustainability (Alharthi & Spichkova, 2017).

Overall, the results suggest that the developed trainer serves not only as an effective instructional tool but also as a socially valuable educational innovation. Its ability to improve learning outcomes while promoting accessibility, equity, workforce preparedness, and sustainable use of instructional resources highlights its potential contribution to the advancement of technical and vocational education. These findings underscore the importance of integrating innovative, learner-centered, and industry-aligned training systems into technical education programs, particularly in institutions facing resource limitations and increasing demands for quality skills development.

## CONCLUSION

This study successfully addressed the instructional gap in the industrial motor controller subject at North Eastern Mindanao State University-Cantilan Campus, developing a self-paced industrial motor controller trainer. The findings demonstrate that the trainer's usability, functionality, flexibility, perceived impact, and design significantly enhance learning and skill development. Meeting industry standards, the trainer provides students with a modern, practical resource to develop competencies in industrial motor control, bridging the limitations posed through outdated and non-functional equipment.

Beyond its instructional effectiveness, the qualitative findings revealed that the developed trainer generated meaningful social value within the context of technical and vocational education. Participants perceived the trainer as a tool that enhanced educational accessibility by providing greater opportunities for hands-on learning despite limited instructional resources. It also promoted learning equity by accommodating diverse learning paces and needs, allowing students to engage with training activities more independently and confidently. Furthermore, the trainer contributed to workforce readiness by strengthening students' practical competencies and confidence in performing industry-related tasks, while supporting instructional sustainability through the efficient utilization and preservation of laboratory resources. These findings demonstrate that the trainer serves not only as an educational innovation but also as a socially valuable intervention that contributes to inclusive, accessible, and sustainable technical education.

The trainer's intuitive interface and adaptability cater to diverse learning styles and needs, promoting inclusivity and accessibility. These attributes emphasize the role of user-friendly, flexible tools in improving student engagement and learning outcomes. The observed posttest improvements validate the trainer's effectiveness, highlighting the importance of active, reflective, and well-structured learning experiences.

The iterative development process, grounded in the ADDIE model, ensured the trainer’s alignment with educational objectives and industry demands. This approach underscores the importance of structured design and user-centered development in creating impactful educational tools.

The study's findings have significant implications for curriculum development and instructional practices. The trainer’s effectiveness suggests its potential for widespread adoption in technical education programs, particularly in resource-constrained settings. Integrating innovative tools like this trainer enables institutions to enhance technical education, foster critical thinking, and better prepare students for real-world applications. Furthermore, such innovations contribute to producing industry-ready graduates while simultaneously creating social value through improved accessibility, equitable learning opportunities, workforce preparation, and sustainable instructional practices. These outcomes support the continued advancement of technical and vocational education in meeting the demands of an evolving, technology-driven world.

## LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

This study has several limitations that should be addressed in future research. First, the sample size was limited to a specific group of students at North Eastern Mindanao State University-Cantilan Campus, which may not fully represent the broader population of technical education students. Additionally, the study focused exclusively on the industrial motor controller subject, limiting the generalizability of the findings to other technical disciplines. Another limitation is the reliance on self-reported evaluations and pretest-posttest results, which may introduce biases or fail to capture all dimensions of the trainer's effectiveness. Although qualitative interviews were conducted to explore the social value of the trainer, the number of interview participants was limited and may not fully represent the experiences and perspectives of all users. Consequently, the qualitative findings should be interpreted within the context of the selected participants and the specific institutional setting in which the study was conducted. The short duration of the implementation phase also restricted the observation of long-term learning outcomes or the trainer's sustainability in diverse instructional settings. Lastly, the study was conducted in a controlled academic environment, and its applicability in real-world industrial training scenarios remains unexplored.

Future studies should address these limitations by expanding the sample size to include students from various institutions and technical education programs, allowing for a more comprehensive analysis of the trainer's effectiveness across different contexts. Research could also explore the application of the industrial motor controller trainer in other technical subjects to assess its adaptability and broader impact. To enhance reliability, future studies should consider integrating objective performance metrics, such as task completion accuracy and time efficiency, alongside self-reported feedback. Longitudinal studies are recommended to evaluate the trainer's impact on long-term knowledge retention and skill application. Future studies may also expand the qualitative component by involving a larger and more diverse group of participants, including industry practitioners, administrators, and graduates, to provide a broader understanding of the social value generated by the trainer. Further qualitative investigations may explore how similar instructional innovations influence educational accessibility, learning equity, workforce readiness, and sustainable instructional practices across different technical education contexts. Additionally, exploring the trainer's usability and effectiveness in actual industrial training environments can provide insights into its real-world applicability. Finally, researchers should investigate the integration of emerging technologies, such as augmented or virtual reality, into similar instructional tools to further enhance learning experiences and outcomes.

## ACKNOWLEDGMENT

The authors express their heartfelt gratitude to the Department of General Teacher Training, the Department of Industrial Technology, and the BTVTEd and BSIT Program Chairs at NEMSU-Cantilan Campus. Special appreciation is extended to Dr. Juancho A. Intano, our Campus Director, for his unwavering support throughout the study. We also thank our friends and family, whose encouragement has been instrumental in this endeavor.

**CONFLICT OF INTEREST**

Authors declare that there is no conflict of interests regarding the publication of the paper.

**REFERENCES**

Abuhassna, H., Alnawajha, S., Awae, F., Adnan, M. A. B. M., & Edwards, B. I. (2024). Synthesizing technology integration within the Addie model for instructional design: A comprehensive systematic literature review. *Journal of Autonomous Intelligence*, *7*(5). https:// doi: 10.32629/jai.v7i5.1546

Adewolu Ogwo, A. (2024). Higher Education, skills development and students' preparedness for employability: A case study of the University of Lagos, Nigeria (towards a sustained practice approach with the triple helix model of innovation) (Doctoral dissertation). University College London

Alharthi, A.D., & Spichkova, M. (2017). Individual and Social Requirement Aspects of Sustainable eLearning Systems. *ArXiv, abs/1701.06433*.

Alsaleh, N. (2020). The Effectiveness of an Instructional Design Training Program to Enhance Teachers' Perceived Skills in Solving Educational Problems. *Educational Research and Reviews, 15*(12), 751-763. https:// doi: 10.5897/ERR2020.4082

Bansiong, A. J., & Alawas, D. E. (2024). Alumni's Retrospective Evaluation of Their Undergraduate Secondary Teacher Education Training. *Mountain Journal of Science and Interdisciplinary Research, 84*(1), 46-65. http://portal.bsu.edu.ph:8083/index.php

Budoya, C., Kissaka, M. & Mtebe, J. (2019). Instructional design enabled Agile method using ADDIE model and Feature Driven Development method. *International Journal of Education and Development using ICT, 15*(1). Open Campus, The University of the West Indies, West Indies. https://www.learntechlib.org/p/209737/.

Cha, H. J., & Ahn, M. L. (2019). Design and development of a smart-tool prototype to promote differentiated instruction: a user-centered design approach. *Interactive Learning Environments, 28*(6), 762–778. https://doi.org/10.1080/10494820.2018.1552871

Clark, R. C., & Mayer, R. E. (2023). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. John Wiley & Sons.

De Felice, F., Petrillo, A., & Monfreda, S. (2013). *Improving operations performance with world-class manufacturing technique: A case in the automotive industry*. Operations Management, 13.

Edralin, D., & Pastrana, R. (2023). Technical and vocational education and training in the Philippines: In retrospect and its future directions. *Bedan Research Journal, 8*(1), 138-172. https://doi.org/10.58870/berj.v8i1.50

Ebbini, E. (2023). Enhancing Collaborative and Self-Paced Learning in Traditional and Distance Education Settings. In: Badran, A., Baydoun, E., Hillman, S., Mesmar, J. (eds) Higher Education in the Arab World. *Springer, Cham.* https://doi.org/10.1007/978-3-031-33568-6_12

Elendu, C., Amaechi, D. C., Okatta, A. U., Amaechi, E. C., Elendu, T. C., Ezeh, C. P., & Elendu, I. D. (2024). The impact of simulation-based training in medical education: A review. *Medicine, 103*(27), e38813. https:// doi: 10.1097/MD.0000000000038813

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education, 18*(1), 53. https://doi.org/10.1186/s41239-021-00289-4

Fair, W. (2021). Making a Change: Instructor-Centered to Trainee-Centered Training Environment: Explanatory Case Study (Doctoral dissertation). University of Phoenix.

Geitner, F. K., & Bloch, H. P. (2019). *Machinery component maintenance and repair*. Gulf Professional Publishing.

Giri, F. (Ed.). (2013). *AC electric motors control: advanced design techniques and applications.* John Wiley & Sons.

Gossai, M. V. (2020). *Bridging the gap in online college education: A qualitative phenomenological study*. American College of Education.

Gillani, Nabeel & Eynon, Rebecca. (2023). Understanding and improving social factors in education: a computational social science approach. 10.48550/arXiv.2301.05619.

Handrianto, C., Jusoh, A. J., Goh, P. S. C., & Rashid, N. A. (2021). Using ADDIE model for designing instructional strategies to improve teaching competency of secondary schools' teachers. *Proceeding Webinar Konvensyen Kaunseling Kebangsaan Kali Ke,* 22, 361-371.

Holik, I., Sanda, I. D., & Molnár, G. (2023). The Necessity of Developing Soft Skills in STEM Areas in Higher Education, with Special Focus on Engineering Training. *AJTE, 10*(4), 199-214.

Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development.* FT Press.

Kyriazis, S. J. (2021). A PLC for Digital Age Leadership: Building District Capacity for Meaningful and Effective Technology Integration in K-12 Schools (Doctoral dissertation). Northeastern University.

Loon, M. (2021). *Flexible learning: A literature review 2016–2021*. Advance HE.

Maddikunta, P. K. R., Pham, Q. V., Prabadevi, B., Deepa, N., Dev, K., Gadekallu, T. R., ... & Liyanage, M. (2022). Industry 5.0: A survey on enabling technologies and potential applications. *Journal of Industrial Information Integration,* 26, 100257. https://doi.org/10.1016/j.jii.2021.100257

Marks, J., & Chase, C. C. (2019). Impact of a prototyping intervention on middle school students' iterative practices and reactions to failure. *Journal of Engineering Education, 108*(4), 547-573. https://doi.org/10.1002/jee.20294

Matthews, M., Quan, T., & Rice, F. (2022). Buying into Learning Outcomes: Educational Technology Procurement Policy and Practice in Canada. (Ottawa, ON: Information and Communications Technology Council (ICTC) Available at SSRN: https://ssrn.com/abstract=4501799

Mayer, R. E. (2005). *Cognitive theory of multimedia learning*. Cambridge University Press.

Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J. M., Ramírez-Montoya, M. S., Navarro-Tuch, S. A., ... & Molina, A. (2021). The core components of education 4.0 in higher education: Three case studies in engineering education. *Computers & Electrical Engineering, 93*, 107278. https://doi.org/10.1016/j.compeleceng.2021.107278

Molnar, A. (2023). *Virtual Schools in the US 2023*. National Education Policy Center.

Organisation for Economic Co-operation and Development. (2024). *Vocational education and training (VET)*. OECD. https://www.oecd.org/en/topics/sub-issues/vocational-education-and-training-vet.html

Pavlova, Margarita. (2009). Technology and vocational education for sustainable development: empowering individuals for the future. http://lst-iiep.iiep-unesco.org/cgi-bin/wwwi32.exe/[in=epidoc1.in]/?t2000=028187/(100). 10.1007/978-1-4020-5279-8_4.

Pavlova, M., Huang (Chandler), C.L. (2013). Advancing Employability and Green Skills Development: Values Education in TVET, the Case of the People's Republic of China. In: Maclean, R., Jagannathan, S., Sarvi, J. (eds) Skills Development for Inclusive and Sustainable Growth in Developing Asia-Pacific. Technical and Vocational Education and Training: Issues, Concerns and Prospects, vol 19. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-5937-4_18

Popoola, O. A., Akinsanya, M. O., Nzeako, G., Chukwurah, E. G., & Okeke, C. D. (2024). The impact of automation on maritime workforce management: A conceptual framework. *International Journal of Management & Entrepreneurship Research, 6*(5), 1467-1488. https://doi.org/10.51594/ijmer.v6i5.1095

Reyes, R. (2018). Leading the Country in TVET: Don Bosco Technical Vocational Education and Training Center (Doctoral dissertation). University of Southern California.

Schneider, S., Wessels, A., & Pilz, M. (2023). Theory and practice of teaching and learning in the classroom–Lessons from Indian industrial training institutes. *Vocations and Learning, 16*(1), 99-120. https://doi.org/10.1007/s12186-022-09305-8

Serrano, D. R., Dea-Ayuela, M. A., Gonzalez-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education, 54*(2), 273-286. https://doi.org/10.1111/ejed.12330

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. *Information, 13*(9), 402. https://doi.org/10.3390/info13090402

Suharno S, Ihsan F, Himawanto DA, Pambudi NA, Rizkiana R (2025), "Sustainability development in vocational education: a case study in Indonesia". *Higher Education, Skills and Work-based Learning*, Vol. 15 No. 3 pp. 668–689, doi: https://doi.org/10.1108/HESWBL-01-2024-0018

Udeze, A. N. (2024). E-learning strategies in TVET: Enhancing accessibility, engagement and practical skill development. *International Journal of Innovation Research and Advanced Studies, 4*(2). https://harvardpublications.com/hijiras/article/view/143

UNESCO Bangkok. (2014). *Education and employability: Regional education support strategy 2014–2021*. UNESCO Asia-Pacific Regional Bureau for Education. https://www.britishcouncil.ph/sites/default/files/regional_education_and_employability.pdf

United Nations. (2024). *Goal 4: Quality education*. United Nations Sustainable Development Goals. https://www.un.org/sustainabledevelopment/education/

United Nations Educational, Scientific and Cultural Organization. (2024). *Skills for work and life*. UNESCO. https://www.unesco.org/en/skills-work-life

Volansky, K. (2019). Physical therapist educators' perceptions of the benefits and challenges to teach "hands-on" skills in a blended environment. *Quarterly Review of Distance Education, 20*(3), 11-29. https://books.google.com.ph/books?

Walden, A., Garvin, L., Smerek, M., & Johnson, C. (2020). User-centered design principles in the development of clinical research tools. *Clinical Trials, 17*(6), 703-711. https://doi.org/10.1177/174077452094631

Wettaka, J. (2020). Improving hands-on training for skill acquisition of engineering Students at the Department of Mechanical and Production Engineering, Kyambogo University (Doctoral dissertation). Kyambogo University.

World Bank. (2024). *Education*. World Bank. https://www.worldbank.org/ext/en/topic/education

Wu, S. (2024). Application of multimedia technology to innovative vocational education on learning satisfaction in China. *PLoS One, 19*(2), e0298861. https://doi.org/10.1371/journal.pone.0298861

Xiang, F., Cao, J., Zuo, Y., Duan, X., Xie, L., & Zhou, M. (2024). A Novel Training Path to Promote the Ability of Mechanical Engineering Graduates to Practice and Innovate Using New Information Technologies. *Sustainability, 16*(1), 364. https://doi.org/10.3390/su16010364

Yusvana, R. (2024). Addressing the skills gap in technical and vocational training for sustainable socio-economic growth and development. *International Journal of Research and Innovation in Social Science, 8*(3S), 6311–6325.