

IMPLEMENTATION OF AN ELECTRICAL POWER BASICS E-MODULE TO IMPROVE STUDENT LEARNING OUTCOMES IN VOCATIONAL HIGH SCHOOLS

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DOI: <https://doi.org/10.34125/jkps.v10i4.1070>

Sections Info

Article history:

Submitted: 3 November 2025
Final Revised: 11 November 2025
Accepted: 16 November 2025
Published: 26 November 2025

Keywords:

E-module
Electrical Power Basics
Learning Outcomes
Vocational Education



ABSTRACT

This study aims to describe the extent to which student learning outcomes improved after the implementation of the Basic Electrical Engineering e-module in vocational learning. This study used a pre-experimental design with a one-group pretest-posttest model, involving 32 tenth-grade students of the Electrical Power Installation Engineering expertise program at SMKN 4 Palembang. Data were collected using multiple-choice pretests and posttests that assessed students' conceptual understanding of Basic Electrical Engineering. The e-module was designed with multimedia elements like text, audio, and worksheets to support flexible, independent learning. The results showed a significant improvement in student learning performance, with the average pretest score increasing from 68.9 to 81.1 and an N-Gain value of 0.392, which is included in the moderate category. These findings indicate that the e-module effectively improves student understanding and engagement, while confirming its pedagogical potential in vocational education. The novelty of this study lies in its focus on e-modules for technical-vocational subjects, which can foster conceptual mastery in specific technical materials. This research contributes to the development of literature on technology-based learning and confirms the potential of e-modules as a vocational education innovation.

ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan sejauh mana peningkatan hasil belajar siswa setelah penerapan e-modul Dasar Teknik Ketenagalistrikan dalam pembelajaran vokasional. Penelitian ini menggunakan pre-eksperimental design dengan model one-group pretest-posttest, yang melibatkan 32 siswa kelas X Teknik Instalasi Tenaga Listrik di SMKN 4 Palembang. Data dikumpulkan menggunakan tes pilihan ganda pretest dan posttest yang mengukur pemahaman konseptual siswa terhadap mata pelajaran Dasar Teknik Ketenagalistrikan. E-modul dirancang dengan elemen multimedia seperti teks, audio, dan lembar kerja untuk mendukung pembelajaran yang fleksibel dan mandiri. Hasil penelitian menunjukkan terdapat peningkatan yang signifikan dalam performa belajar siswa, dengan nilai rata-rata pretest meningkat dari 68,9 menjadi 81,1 dan nilai N-Gain sebesar 0,392 yang berada dalam kategori sedang. Temuan ini menunjukkan bahwa e-modul secara efektif meningkatkan pemahaman dan keterlibatan siswa, sekaligus mengonfirmasi potensi pedagogisnya dalam pendidikan vokasional. Kebaruan dari penelitian ini terdapat pada fokusnya tentang e-modul untuk mata pelajaran kejuruan teknis, yang dapat mendorong penguasaan konsep pada materi teknis yang bersifat spesifik. Penelitian ini memberikan kontribusi pada pengembangan literatur tentang pembelajaran berbasis teknologi dan menegaskan potensi e-modul sebagai inovasi pendidikan vokasional.

Kata kunci: E-modul, Dasar Teknik Ketenagalistrikan, Hasil Belajar, Pendidikan Vokasional

INTRODUCTION

Education is a crucial process for developing individuals' potential according to structured curricula and plays an essential role in shaping character, competence, and readiness to face global competition (Agustia & Fauzi, 2020; Fadillah et al., 2021; Sugiyanto et al., 2020). Vocational education, as part of the national education system, aims to produce competitive individuals equipped with cognitive and psychomotor skills to meet the needs of the industrial world and sustainable development (Kalita, 2024; Mahendra & Mariono, 2020; Ramadhani & Yudiono, 2020). The goals of vocational education have been achieved by revitalizing the curriculum, innovating in learning design, and integrating information and communication technology (ICT) (Gola et al., 2022; Lumbantobing et al., 2019; Wu et al., 2023). The rapid development of ICT has changed the paradigm of learning from conventional printed materials to digital and interactive media (Erdi & Padwa, 2021; Godin & Terekhova, 2021; Kumar & Priyanka, 2023), enabling teachers to design innovative learning experiences that support student engagement, creativity, and self-directed learning (Fadhilah & Thahir, 2023; Gunawan et al., 2024; Salsabila et al., 2020).

In the context of vocational schools, learning media serve as vital tools for enhancing students' active participation, interest, and motivation (Budiarto et al., 2021; Kurniawati et al., 2019; Pazlina & Usmeldi, 2020). Appropriate learning media can facilitate the transmission of abstract concepts into concrete understanding, especially in technical subjects that require both theoretical and practical mastery (Arifah et al., 2025; Zamzuri & Hasan, 2024). One such innovation is the electronic module (e-module), which has emerged as a technological transformation of printed modules into digital, multimedia-based materials accessible anytime and anywhere (Laili et al., 2019; Ratnawati et al., 2020). E-modules combine text, audio, video, graphics, and interactive features that allow students to study independently, control their learning pace, and review complex materials repeatedly when needed (Fadhilah & Thahir, 2023; Manggala et al., 2024; Putra et al., 2023).

Research on e-module implementation in vocational education has reported positive impacts on students' learning engagement and outcomes. Kusumayanti & Astuti (2023) found that Android-based e-modules developed for computer and networking subjects met high validity and practicality standards, demonstrating strong usability in vocational contexts. Similarly, Ambiyar et al. (2023) found that e-modules designed for flipped classroom instruction increased student engagement and mastery of competencies. Nurita et al. (2025) highlighted that e-modules can foster creative thinking skills among prospective teachers by integrating design-oriented and reflective tasks into digital materials. Other studies, such as Rahmatunisa et al. (2022) and Nisa et al. (2023), confirmed that project-based and problem-based e-modules were rated as very feasible, practical, and contributed to increased learning outcomes and motivation in various vocational subjects.

However, preliminary observations conducted at SMKN 4 Palembang indicated that learning in the Electrical Power Basic course still relied on teacher-centered methods. The available learning resources were limited to teacher handbooks and PowerPoint slides, leading in passive learning and low student motivation. This condition reduced opportunities for independent learning and deeper conceptual understanding of electrical power fundamentals. Therefore, it is necessary to introduce a more interactive and accessible learning medium to support student-centered learning in the subject.

To address these challenges, this study implemented a digital learning medium in the form of an Electrical Power Basic e-module designed to facilitate students' understanding of key electrical concepts. The e-module was enriched with videos, background music,

worksheets, and descriptive text, enabling students to learn independently both in and out of the classroom. The focus of this research is to analyze learning outcomes improvement descriptively, which categorizes the degree of improvement between pretest and posttest results.

Accordingly, this study aims to describe the extent of students' learning improvement after the implementation of the Electrical Power Basic e-module in vocational education. The research results hopefully to provide empirical evidence on how digital learning media, particularly e-modules, can enhance conceptual understanding and promote flexible, self-directed learning among vocational high school students.

METHOD

This study employed a pre-experimental One-Group pretest-posttest design (Sugiyono, 2013), to examine the effectiveness of an e-module in improving students' learning outcomes in the Electrical Power Basic course. The experimental procedure followed the structure illustrated in Figure 1, in which a single group received a pretest (O_1), the instructional treatment via the e-module (X), and then completed a posttest (O_2). Figure 2 illustrates the e-module interface used during the learning process. The participants were 32 tenth-grade students majoring in Electrical Power Installation at SMKN 4 Palembang. Data were collected using a multiple-choice test designed to measure students' conceptual understanding, consisting of equivalent pretest and posttest items aligned with the course's learning objectives. Both pretest and posttest were administered in class before and after the implementation of the e-module during regular learning sessions. The collected data were analyzed by calculating the N-Gain score, which was used to assess the degree of improvement in students' learning outcomes resulting from the e-module implementation.

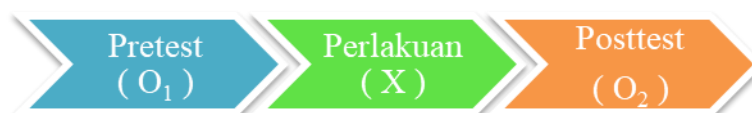


Figure 1. Research Design



Figure 2. E-module Interface

RESULT AND DISCUSSION

Result

In this study, the e-module was implemented as a digital learning resource to assist students in understanding and studying the material of Electrical Power Basics. The e-module included various learning components, such as background music, student worksheets, and descriptive text, that facilitated students' comprehension and supported the acquisition of essential knowledge. Moreover, the e-module enabled students to engage in self-paced, flexible learning, allowing them to study independently anytime, anywhere.

The results of this study revealed an improvement in students' learning outcomes after the implementation of the e-module in the Electrical Power Basic course. As shown in Table 1, the mean pretest score for the 32 students was 68.9, while the mean posttest score increased to 81.1 following the e-module learning sessions. These results indicate a positive change in students' conceptual understanding of the subject matter. The increase in posttest performance demonstrates that integrating the e-module helped students engage more actively with the learning content and facilitated better comprehension than conventional learning methods.

Table 1. Mean pretest and posttest score

Tes	N	Mean	N-gain	Category
Pretest	32	68.9	0.392	Moderate
Posttest		81.1		

Further quantitative analysis was conducted using the N-Gain score to determine the level of improvement in students' learning outcomes. The calculated N-Gain value was 0.392, which falls within the moderate effectiveness category. According to the N-Gain interpretation scale, this result indicates that implementing the e-module produced a measurable and meaningful improvement in learning achievement. However, there is potential to optimize the instructional design further. These findings suggest that the e-module serves as an effective supplementary tool for supporting independent learning and reinforcing students' mastery of fundamental concepts in electrical power.

Discussion

The findings of this study revealed that implementing the Electrical Power Basic e-module improved students' learning outcomes. The mean pretest score increased from 68.9 to 81.1 after using the e-module, with an N-Gain of 0.392, categorized as moderate. This result suggests that students' understanding of the material improved meaningfully after learning with the e-module, even though the learning gains were not at the highest level. The increase in posttest performance indicates that integrating digital learning media can enhance students' comprehension and engagement in vocational education settings.

E-modules are effective learning media that support student-centered learning. Previous studies have shown that e-modules are feasible and practical to implement because they allow students to manage their own learning both in and outside the classroom (Erdi & Padwa, 2021; Laili et al., 2019; Rahayu & Sukardi, 2021). The present finding aligns with Martias & Effendi (2023), which demonstrated that e-modules were effective in classroom implementation, achieving 86.6% completeness, exceeding the minimum mastery criteria. Similarly, Ramadhani & Yudsono (2020) found that Android-based e-modules were valid, practical, and effective in improving students' learning outcomes, while Mahendra &

Mariono (2020) reported that e-modules developed using Android applications significantly enhanced students' understanding of theoretical material. Other studies, such as Ramadhan et al. (2021) and Cahyani et al. (2020), also concluded that the use of e-modules in learning activities could increase students' comprehension and creativity, with N-Gain values generally falling in the moderate to high category.

The moderate category obtained in this study is consistent with findings reported by Dermawan & Fahmi (2020) and Octavianis et al. (2022), where e-modules developed with problem-based and project-based learning designs yielded N-Gain values ranging from medium to high, depending on instructional duration and student readiness. Likewise, Menrisal et al. (2019) and Agustian et al. (2024) found that project-based learning (PjBL) e-modules achieved an effectiveness level of 90.06%, indicating very effective classroom use. These results indicate that although the e-module used in this study achieved a moderate level of gain, the direction of improvement aligns with the general trend observed in previous research.

Supporting evidence from recent previous literature also strengthens these results. Studies by Kusumayanti & Astuti (2023) confirmed that Android-based e-modules are valid and practical for vocational learning, Ambiyar et al. (2023) found that flipped-classroom e-modules improved student activity and performance, and Nurita et al. (2025) reported that interactive e-modules fostered creative and critical thinking skills among teacher education students. Likewise, Rahmatunisa et al. (2022) and Nisa et al. (2023) found that project-based e-modules developed with the Sigil platform were highly feasible and effective, supporting both cognitive achievement and independent learning. The moderate N-Gain score obtained in the current study, therefore, still indicates an acceptable and meaningful level of learning improvement, consistent with these prior findings.

Pedagogically, the improvements achieved through e-modules are related to their multimodal design, which combines video, audio, worksheets, and descriptive text that appeals to a variety of learning styles. As explained by Arimbawa et al. (2025) and (Nurainy & Sujarwo (2025), such multimodal e-modules enhance learners' analytical and metacognitive skills by encouraging them to explore materials autonomously and reflectively. Supports students' ability to learn independently, as also emphasized by Erdi & Padwa (2021) and Laili et al. (2019), who noted that e-modules provide opportunities for self-directed learning and continuous practice.

Furthermore, the positive trend in students' learning gains aligns with research by Martias & Effendi (2023), which found that e-modules are effective learning media that produce large effect sizes, and by Dermawan & Fahmi (2020), which confirmed that web-based e-modules significantly improved learning performance. These findings also agree with Laili et al. (2019) and Menrisal et al. (2019), who highlighted that e-modules designed with PjBL and STEM approaches can improve students' creativity, motivation, and conceptual mastery. Although the N-Gain value in this study falls in the moderate range, it still demonstrates the e-module's contribution to promoting meaningful learning, independent study habits, and sustained engagement during the learning process.

Overall, this study supports the growing body of evidence that e-modules can serve as effective supplementary learning media in vocational education. Their flexibility allows students to access materials anytime and anywhere, supporting self-paced learning and reinforcing understanding of complex technical content. The moderate improvement observed suggests that the e-module successfully facilitated student comprehension but also points to potential for further enhancement, particularly through a longer implementation

duration, integration with project- or problem-based approaches, and the inclusion of interactive formative assessments. Future research should expand testing to multiple vocational schools and compare learning gains across instructional models to deepen understanding of how e-modules contribute to learning performance in electrical engineering education.

This study has several limitations that should be acknowledged. The research involved a relatively small sample size from a single vocational institution, which may restrict the generalizability of the results. The implementation period of the e-module was also short, potentially limiting students' engagement and long-term learning impact. Furthermore, the study primarily focused on quantitative data, without exploring students' perceptions, motivation, or experiences in depth. Future research should address these limitations by involving larger, more diverse samples, extending the duration of implementation, and employing mixed-methods approaches to capture more comprehensive insights into learning behavior and outcomes. Instructors are recommended to continuously refine e-module designs by incorporating interactive assessments, adaptive feedback, and project-based activities to foster higher-order thinking and sustained engagement. Practically, this study highlights the potential of e-modules as flexible and effective digital learning tools that support self-paced learning in vocational education, aligning with current trends in digital pedagogy. Theoretically, the findings contribute to the literature on technology-enhanced learning by emphasizing the importance of pedagogical design, learner readiness, and instructional duration in determining learning effectiveness. Future investigations could also explore integrating emerging technologies, such as augmented reality, artificial intelligence, and adaptive learning systems, to enhance personalization and engagement in digital learning environments.

CONCLUSION

The present study demonstrated that implementing an e-module in the Electrical Power Basics course effectively enhanced students' learning outcomes. The increase in posttest scores and a moderate N-Gain value of 0.392 indicate that the e-module contributed to meaningful improvements in students' conceptual understanding and engagement. These findings confirm that e-modules can serve as effective digital learning media that support self-paced, flexible, and independent learning in vocational education. Despite achieving moderate effectiveness, the results align with prior studies, suggesting that well-designed e-modules can foster active learning and strengthen mastery of technical concepts. Therefore, integrating e-modules into vocational curricula can be a valuable strategy to enhance students' cognitive development and digital learning skills. Continuous refinement of instructional design, supported by longer implementation periods and diverse learning activities, is expected to optimize its pedagogical impact in future applications further.

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