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EXPLORING THE USE OF E-MODULES IN BUILDING UTILITY CONSTRUCTION LEARNING WITHIN VOCATIONAL BUILDING ENGINEERING EDUCATION: INSIGHTS INTO LEARNING PRACTICES AND SUSTAINABILITY

Ahmad Yudi Mubarroq[1*], *Muhammad Aris Ichwannto*[2], *Eko Suwarno*[3], *Tee Tze Kiong*[4]
[1,2,3] Pendidikan Teknik Bangunan, Fakultas Teknik, Universitas Negeri Malang
Jl. Cakrawala No.5, Sumbersari, Kec. Lowokwaru, Kota Malang, Jawa Timur, 65145, Indonesia
[4] Departemen Pendidikan Profesi dan Pascasarjana, Pendidikan Teknik dan Vokasi, Universiti Tun Hussein Onn Malaysia
Universiti Tun Hussein Onn Malaysia, 86400, Johor, Malaysia
[*1]ahmadmubarroq098@gmail.com, [2]muh.aris.ichwanto.ft@um.ac.id, [3]eko.suwarno.ft@um.ac.id, [4]tktee@uthm.edu.my

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Abstract

This study explores the implementation of e-modules in Building Utility Construction learning within vocational building engineering education, particularly in relation to classroom practices, learning flexibility, and sustainable educational development. This study employed a qualitative approach involving five informants consisting of teachers and students from a vocational high school. Data were collected through interviews, classroom observations, and documentation, then analyzed using the Miles and Huberman interactive model. The findings indicate that the implementation of e-modules remains limited and has not yet been systematically integrated into routine classroom instruction. Students demonstrated positive responses toward the use of e-modules, particularly in improving conceptual understanding, learning motivation, and independent learning practices. Teachers also perceived e-modules as beneficial for improving instructional efficiency and reducing reliance on printed teaching materials. However, several barriers were identified, including inconsistent implementation practices and limited pedagogical readiness for digital integration. Overall, this study demonstrates that e-modules have significant potential to support flexible and sustainable vocational learning, particularly in promoting learning efficiency and reducing paper consumption in vocational education environments.

Keywords: Limited Integration, Improved Learning, Vocational Education, Sustainability, Learning Media

Introduction

At all levels of education, there is a growing need for broader digital integration within the global education ecosystem, which can drive a paradigm shift in learning. Fuadiy et al. (2025) explained that the structure of learning resources has been significantly transformed by digitization. Supported by Jitsupa et al. (2024) regarding these changes in students' interaction patterns during the learning process. Setiyawan et al. (2023), reinforced this finding by arguing that these changes are essential for adapting to the high and diverse demands of the digital era. In this context, teaching materials can be delivered more easily and efficiently through the integration of technology tailored to students needs (Guaña-Moya et al., 2024). Zhao Ma et al. (2024) explained that with the growing diversity of the student population, such accessibility is essential to enhance students' learning opportunities. This view is supported by Priante & Tsekouras (2025), who explains that conventional methods are no longer sufficient to foster active interaction among students today.

In the context of vocational education, a study by Lukitasari et al. (2025) that technological integration has become increasingly important in responding to current educational and industrial challenges. Today's industrial demands require vocational students to master practical skills that align with industry needs and technological developments (Nuryanto & Eryandi, 2020). Learning materials are a key factor in achieving optimal learning. A study by Mubarroq et al. (2024), (Anindya et al., 2026) and Prasetya, Rofiudin, et al. (2025), stated that high quality technical content stems from effective teacher communication, which can provide a systematic framework for creating effective learning materials. This vocational pedagogy is essential, particularly for tasks that require meticulous attention to detail (Ningsih, 2024). Not only that, Muslimah et al. (2025) emphasized that advanced learning materials are very helpful for students in understanding the material in detail and in context.

E-modules are designed as a sophisticated digital learning tool that surpasses conventional learning materials and is also integrated with technology. (Meilina & Afriyah, 2024) believes that the use of e-modules in learning greatly simplifies the process and helps students achieve independent learning and a more systematic approach to learning (Sholihah & Wulandari, 2023). Damayanti et al. (2020) and Prasetya, Widiyawati, et al. (2025) emphasized that the use of visual learning materials can improve the organization of instructional content. This finding is also supported by (Prasetya et al., 2024) who highlights the long-term cognitive benefits of integrating technology into learning. In one study by Staneviciene & Žekienė (2025) emphasizes that visual learning materials can significantly improve student learning outcomes. In the context of vocational education, e-modules play a crucial role in enhancing applied learning through well-designed procedural simulations (Fajar et al., 2023). Novianti et al. (2023) and Widiyawati et al. (2024) reinforced this point by explaining that modern technical training can be demonstrated by students' ability to present complex concepts.

Not only in the context of vocational education, this e-module also frees learning from dependence on physical resources (Irnissa et al., 2023). Rohmatulloh et al. (2022) explained that this situation can make it easier for students to access and understand the course material without being constrained by time. Güntem & Kılıç (2025) believes that the use of e-modules can reduce the paper waste typically associated with printed modules or conventional teaching materials. According to Bond et al. (2021) Prasetya, Frima, et al. (2025), e-modules serve as an excellent strategy for promoting sustainable education. Sumarna et al. (2019) stated that effective visualization is also essential in the learning process. In particular, this applies to the building utilities course in vocational high schools, which requires students to understand both the theory and the practical aspects. Recent demonstrations by Lase et al. (2025) explained that students often experience difficulties in understanding and classifying building components when the learning process is not supported by interactive and well-illustrated learning materials.

Conceptual understanding has been derived from significant contributions made by several studies, though many of these studies still focus on specific fields. A study by, Nadir et al. (2022)

describe the development of a soil mechanics module focused on conceptual aspects at the university level. Heryadi et al. (2023), also integrates building modeling into road planning. However, these studies are still very narrowly focused on roads and land, and none have addressed the construction of building utilities. Fatmawati et al. (2024) provides evidence that current research is dominated by the higher education community. Learning practices with their own unique characteristics in vocational high schools are underrepresented. Previous studies on e-modules in vocational education have primarily focused on module development, effectiveness testing, or implementation within higher education contexts. In contrast, empirical studies examining the actual implementation of e-modules in vocational high school learning environments, particularly in Building Utility Construction subjects, remain limited. In practice, the integration of e-modules in vocational schools is still not systematically implemented and often depends on teacher readiness and classroom learning conditions. Therefore, the novelty of this study lies in its exploration of the actual implementation of e-modules in vocational high school learning, including classroom practices, student responses, implementation barriers, and their potential contribution to sustainable vocational education practices. Although e-modules are expected to support flexible and interactive vocational learning, their implementation in vocational high schools remains limited and has not yet been systematically integrated into routine classroom instruction. In practice, learning in Building Utility Construction subjects still relies heavily on conventional teaching materials and teacher-centered instruction, while the use of e-modules is generally situational and depends on classroom needs. In addition, previous studies have primarily focused on e-module development or higher education contexts, whereas empirical studies examining the actual implementation of e-modules in vocational high school learning environments remain limited. Therefore, this study aims to explore the implementation of e-modules in Building Utility Construction learning at vocational high schools to provide insights into digital learning practices and sustainable vocational education development.

Research Methods

This study employed a qualitative research approach to explore the implementation of e-modules in Building Utility Construction learning within vocational building engineering education at SMK Negeri 1 Ngasem. A qualitative design was selected because this study aimed to examine learning practices, implementation conditions, user experiences, and barriers encountered during the integration of digital learning media in authentic vocational classroom settings. The study was conducted in the Design and Building Information Modeling (DPIB) program, where digital learning media had begun to be integrated into classroom instruction. However, the implementation of e-modules was still limited and depended on teacher readiness, classroom learning needs, and supporting learning facilities. The participants consisted of five informants, including two vocational subject teachers and three Grade XI students. Participants were selected purposively based on their direct involvement and experience in using e-modules during classroom learning activities. Teachers were selected because they had experience implementing e-modules in vocational instruction, while students were selected because they actively used the e-modules during classroom learning and independent assignments. To maintain research ethics and participant confidentiality, all informants were anonymized using codes such as G1, G2, S1, S2, and S3. Data were collected through semi-structured interviews, classroom observations, and documentation. Semi-structured interviews were conducted to explore participants' experiences, perceptions, implementation practices, learning benefits, and barriers related to the use of e-modules in vocational learning. Classroom observations were carried out during learning sessions involving the use of e-modules in Building Utility Construction subjects to identify the actual implementation of digital learning media, including projector-based instruction, teacher explanations, classroom interactions, student participation, and independent learning activities. Documentation analysis included e-module materials, classroom learning records, and related

instructional documents supporting the learning process. The research instruments consisted of semi-structured interview guidelines, classroom observation sheets, and documentation checklists. The interview guidelines focused on identifying participants' perceptions and implementation experiences regarding e-module use in vocational learning. Observation sheets were used to record classroom learning activities, teacher-student interactions, the integration of e-modules during instruction, and student engagement throughout the learning process. Documentation checklists were used to examine digital teaching materials and instructional documents related to e-module implementation. The credibility of the data was strengthened through source triangulation and technique triangulation. Source triangulation was conducted by comparing information obtained from different participants, including vocational subject teachers and Grade XI students involved in the implementation of e-modules during classroom learning. Meanwhile, technique triangulation was carried out by comparing findings derived from semi-structured interviews, classroom observations, and documentation analysis. Interview findings regarding classroom learning practices, student participation, learning independence, and the effectiveness of e-modules were further validated through direct classroom observations and supporting instructional documents, including e-module materials and classroom learning records. These triangulation procedures were applied to ensure the consistency, credibility, and trustworthiness of the research findings. Data were analyzed using the Miles and Huberman interactive analysis model consisting of data reduction, data display, and conclusion drawing. Relevant findings related to the implementation of e-modules in vocational learning were categorized into thematic patterns and interpreted descriptively to identify implementation practices, learning implications, barriers to integration, and contributions toward sustainable vocational education. Prior to data collection, all participants were informed about the objectives of the study and voluntarily agreed to participate in the research. Participant anonymity and confidentiality were maintained throughout the study by using informant codes instead of real names in all research findings and discussions. Figure 1 presents the overall research procedure flowchart used in this study.

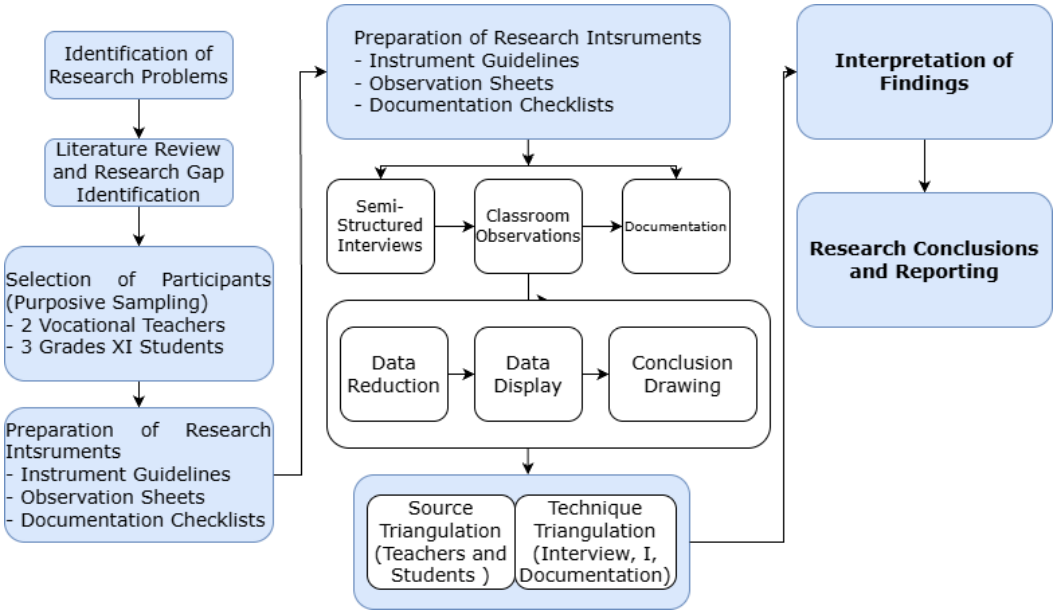

Figure 1. Research Diagram Flowchart

Research Results and Discussion

As described in the research methodology, data were collected from several subjects and informants at the relevant school to ensure high data credibility. These included e-module users as well as teachers who used the e-module to teach the material. The researcher assigned codes to the

subjects and informants to facilitate the classification of the interviews. The following are the results of the interviews conducted by the researcher.

Table 1. Characteristics of Research Informants

Informan Code	Role	Gender	Experience (Years)	Involvement in E-Modul
G1	Teacher	Male	12	Uses e-module in teaching
G2	Teacher	Male	8	Reads and uses the e-module
S1	Student (Grade XI DPIB)	Male	-	Uses the e-module during learning
S2	Student (Grade XI DPIB)	Female	-	Uses the e-module for assignments
S3	Student (Grade XI DPIB)	Male	-	Can work independently in the home

Conditions of E-Module Use in Learning

The implementation of digital learning materials in the context of vocational high schools can be categorized as still in its early stages. This is evidenced by the fact that the use of the designed e-modules has not yet been consistent, as their application in the learning process is quite minimal compared to the total number of class hours. E-modules are used only when the learning material requires a high degree of visualization to facilitate students' understanding of the various parts of a building. One informant, coded G1, who serves as the head of the study program, expressed this finding by stating that the use of e-modules in learning is quite minimal. From this, it can be concluded that digitization in schools has not yet increased significantly but requires a slightly longer process because it is still situational in nature.

This inconsistency in usage indicates that it depends on the teachers' pedagogical preparation and the nature of the material provided to students. A study by Habibi et al. (2023) explains that the digitization of learning materials in schools is not generally taking place or developing rapidly in line with the schools' technological proficiency. Latifah et al. (2024), supported this finding by noting that the implementation of technology requires a phased process and necessitates alignment between digitalization and the needs of vocational education. Given this, the design of the e-module can be said to help students better understand the instructional material and is being implemented as the primary learning medium, which is still in the development stage.

Implementation of E-Modules in Learning

Practical application of cognitive understanding can occur if students can implement e-modules properly and correctly. E-modules are an important factor in vocational education pedagogy, as explained by Delita et al. (2022). Improvement in student learning processes and theoretical understanding can continue to develop better if the integration is not only designed for course materials. Gunawan et al. (2024) explain that digitalization is tangible and provides improvements for students. Supported by Sari et al. (2024) and Saputra & Octavia (2024), emphasizing that the implementation of e-modules in the classroom is an initial stage that provides a positive response from users and has great potential for students to adapt and recognize their own abilities in achieving learning outcomes.

Responses to and Implications of the Implementation of E-Modules on Student Learning

High satisfaction was the primary response from this study. The implementation of the existing perception e-module among students is a facility that can increase enthusiasm for its use.

This satisfaction stems from the goal of enhancing learning, as evidenced by academic improvements observed before and after the implementation of digital learning materials. The content presented in the e-modules features high-quality visualizations, making technical concepts easily understandable for students. Not only that, the implementation of digital learning media also brought about changes in students' learning patterns, including increased focus, independence, and the structured completion of academic tasks. This is evidenced by a reduced reliance on printed textbooks among e-module users, with the e-module becoming the primary learning material. This independence aligns with Alshammary & Alhalafawy (2023), who emphasizes that digitalization plays a key role in improving learning outcomes through more flexible self-directed learning.

Based on interviews with teachers, reports indicate a high level of satisfaction with the use of e-modules. In addition to their use in the classroom, e-module users also reported significant improvements in efficiency and resource allocation due to the reduced need for large-scale book printing. This process demonstrates that e-modules contribute to an efficient learning environment while generating no waste. This is further supported by Dhameria et al. (2025), states that the digitization of learning materials in vocational education management enhances resource efficiency and accessibility. A synthesis of student and teacher perspectives demonstrates a shift in teaching strategies toward a more advanced vocational education system, characterized by greater learning efficiency and reduced student reliance on conventional methods.

The Contribution of E-Modules to Sustainable Learning

The contribution of e-modules to sustainable learning in the Building Utilities Construction program at a vocational high school is evident in the more efficient and flexible use of digital teaching materials. Based on interview results, teachers reported that the use of e-modules helps reduce reliance on printed teaching materials such as textbooks and photocopied handouts. This finding is reinforced by a teacher participant who stated that "with e-modules, teachers no longer need to print large amounts of paper or overuse textbooks" (G2). Additionally, digital access to learning materials offers students the opportunity to learn without the constraints of time and place (Mahendri et al. 2023). These findings indicate that the role of e-modules extends beyond their function as a learning medium, as they also promote efficiency in the learning process and more environmentally friendly educational practices. Reducing paper use in learning reflects efforts toward resource efficiency and waste reduction as part of sustainability principles. From a wider perspective, the integration of e-modules is consistent with the Sustainable Development Goals (SDGs), especially SDG 4, which focuses on improving equitable and flexible access to quality education, and SDG 12 in promoting resource efficiency through the reduction of conventional teaching materials.

Summary of Findings on the Implementation of E-Modules in Education

Conditions of e-module use in learning

Classroom observations revealed that the implementation of e-modules in Building Utility Construction learning was primarily conducted through projector-based classroom instruction and independent learning assignments. Teachers used the e-modules to explain technical concepts and visualize building utility components during classroom discussions, while students utilized the digital materials as references for completing assignments both inside and outside the classroom. Observation findings also indicated that students showed greater attention and participation during learning activities involving visual e-module presentations. In addition, students reported that the structured and accessible digital materials helped them review the learning content more independently without relying entirely on printed textbooks.

Implementation of e-module in learning

The implementation of e-modules in Building Utility Construction learning was carried out both during classroom instruction and through independent student assignments. In classroom activities, teachers generally used e-modules as visual learning media displayed through projectors to explain technical concepts and building utility components more clearly. This learning process encouraged students to participate more actively during discussions and helped them understand the material more easily through structured visual explanations. Outside classroom activities, students also used the e-modules as references for completing assignments independently. Several students stated that the digital materials allowed them to revisit the learning content more flexibly without depending entirely on printed textbooks, particularly when completing assignments at home.

Student responses

Based on the semi-structured interviews conducted with teachers and students, the implementation of e-modules received generally positive responses during the learning process. Students explained that the visual presentation contained in the e-modules helped them understand Building Utility Construction material more easily, especially when learning technical concepts related to building components. During classroom learning, teachers used the e-modules through projector-based explanations, which encouraged students to pay more attention and participate actively in discussions. Several students also stated that the e-modules could be accessed again outside classroom hours, allowing them to study more independently and complete assignments without relying entirely on printed textbooks. Teachers similarly viewed the use of e-modules positively because the digital materials simplified the delivery of learning content and supported more efficient classroom instruction.

Learning implications

The use of e-modules in Building Utility Construction learning also influenced students' learning habits and classroom learning efficiency. Based on the interview results, several students felt more confident studying independently because the learning materials could be accessed repeatedly whenever needed. Students were not only dependent on teacher explanations during classroom sessions, but also began reviewing the material independently while completing assignments. Teachers also explained that the use of e-modules helped simplify the delivery of technical material, especially when explaining building utility components that required visual illustrations. This condition created a more practical and flexible learning process, while also helping reduce the use of printed learning materials in classroom activities.

Contribution to sustainable learning

The implementation of e-modules in Building Utility Construction learning also contributed to more sustainable learning practices within the vocational school environment. Based on the semi-structured interview results, teachers explained that the use of digital learning materials reduced the need for excessive printing of textbooks and handouts during classroom activities. Students also stated that the e-modules could be accessed repeatedly through digital devices, making learning more flexible without being limited by time and place. In addition to supporting learning efficiency, the reduced use of printed materials reflects efforts toward more environmentally conscious educational practices. These findings indicate that the integration of e-modules not only supports learning effectiveness in vocational education but also contributes to sustainable educational practices through more efficient resource use and reduced paper consumption.

Table 2. Categories of Research Findings

Main Category	Sub-Category	Description of Findings
E-module usage conditions	Usage intensity	Limited use of e-modules
	Nature of use	Not the primary learning tool, but a supplementary one
E-module implementation	Classroom learning	Displayed via projector and explained collaboratively
	Independent assignments	Used as a reference for student tasks
Student Responses	Satisfaction	Students express high satisfaction with the e-module
	Understanding	The material is easier to understand
Learning Implications	Learning independence	Students become more independent in learning
	Learning efficiency	Teachers deliver material more efficiently
Contribution to sustainability	Paper reduction	Reduces the use of printed learning materials
	Flexible access	Materials can be accessed anytime

The findings of this study indicate that the implementation of e-modules in Building Utility Construction learning at the vocational high school level is still in the early stages and has not yet been fully integrated into routine classroom instruction. The use of e-modules was generally limited to certain learning situations that required visual explanations and independent student assignments. Nevertheless, the findings demonstrate that the integration of digital learning media provides positive implications for both teachers and students. Students showed better engagement and understanding during learning activities involving visual presentations, while teachers perceived e-modules as helpful in simplifying the delivery of technical material. In addition, the availability of digital learning materials encouraged students to learn more independently outside classroom hours without relying entirely on printed textbooks. These findings also reflect the potential contribution of e-modules toward more flexible and sustainable vocational education practices through reduced paper usage and more efficient learning resource utilization(Xu et al. 2024 ,Handayani et al., 2023).

Discussion

The findings of this study indicate that the implementation of e-modules in Building Utility Construction learning at SMK Negeri 1 Ngasem is still in the early stages and has not yet been systematically integrated into routine vocational classroom instruction. Based on classroom observations and semi-structured interviews, the use of e-modules was generally limited to learning situations requiring visual explanations and independent student assignments. Teachers tended to use e-modules through projector-based instruction to explain technical building utility components more clearly, while students used the digital materials to review lessons and complete assignments independently outside classroom hours. These findings show that the implementation of e-modules in vocational education is influenced not only by the availability of digital learning media, but also by teachers' pedagogical readiness and digital competencies in adapting technology into classroom practices. This finding supports (Yanriko et al., 2024), who explain that digital transformation in vocational education often develops gradually due to differences in technological readiness and instructional adaptation among teachers and institutions.

This study also found that vocational learning environments have specific characteristics that influence the implementation of digital learning media. In Building Utility Construction learning, students require visual and contextual explanations to understand technical concepts related to building utility systems and building components. Interview findings revealed that students responded positively to the visual presentation contained in the e-modules because the materials were easier to understand compared to relying only on conventional textbooks. Classroom observations also showed that students were more engaged during learning activities involving projector-based visual explanations. These findings reinforce the argument of (Alenezi,

2023), who emphasize that visual-based digital learning media can improve conceptual understanding and student learning engagement. However, the findings also indicate several limitations during implementation, including inconsistent classroom integration, dependence on teacher initiative, and limited adaptation to fully digital learning practices. Therefore, the implementation of e-modules in vocational education should not be viewed solely as a technological transition, but also as a pedagogical transformation that requires gradual adaptation within vocational learning environments.

From a practical perspective, the findings of this study provide several implications for vocational teachers, curriculum developers, and educational policymakers. Vocational teachers require continuous support in developing digital pedagogical competencies, particularly in integrating visual digital learning media into technical vocational subjects. Curriculum developers should also consider integrating digital learning practices more systematically into vocational learning structures to ensure that e-modules are not only used as supplementary learning media, but also as part of structured instructional strategies. In addition, educational institutions and policymakers need to support digital learning implementation through adequate infrastructure, teacher training programs, and sustainable educational policies. Beyond improving learning flexibility and student independence, the implementation of e-modules also contributes to sustainable educational practices through reduced paper consumption and more efficient use of learning resources. In this context, the findings of this study demonstrate that the integration of e-modules has the potential to support the achievement of SDG 4 regarding quality education and SDG 12 concerning responsible consumption and production within vocational education environments.

Despite these positive findings, this study still has several limitations. The research was conducted in only one vocational school with a limited number of participants, which may restrict the broader generalization of the findings to different vocational education contexts. In addition, the implementation of e-modules observed in this study was still limited to several classroom learning situations and had not yet fully represented long-term digital learning integration practices. Therefore, future studies are expected to involve broader institutional contexts, larger participant groups, and more diverse vocational learning environments to further examine the sustainability and effectiveness of e-module implementation in vocational education.

Conclusion

This study concludes that the implementation of e-modules in Building Utility Construction learning at vocational high schools has demonstrated positive potential in supporting more flexible, visual, and sustainable vocational learning practices, although its integration into routine classroom instruction remains limited and inconsistent. Based on classroom observations and semi-structured interviews, e-modules were primarily implemented through projector-based classroom instruction and independent student assignments, allowing students to understand technical building utility concepts more easily through structured visual explanations. The findings also indicate that the use of e-modules contributed to increased student learning independence, improved classroom learning efficiency, and reduced dependence on printed learning materials. However, this study found that the successful integration of e-modules in vocational education is strongly influenced by teachers' digital pedagogical competencies, classroom readiness, and the gradual adaptation process within vocational learning environments. These findings suggest that the implementation of e-modules in vocational education should not only be viewed as a technological innovation, but also as part of a broader pedagogical transformation toward more adaptive and student-centered vocational learning practices.

Beyond the instructional context, the implementation of e-modules also contributes to sustainable educational practices through reduced paper consumption and more efficient use of learning resources, which aligns with the objectives of SDG 4 regarding quality education and

SDG 12 concerning responsible consumption and production. This study contributes empirically to the limited discussion regarding the actual implementation of e-modules in vocational building engineering education, particularly in Building Utility Construction subjects at vocational high schools. Nevertheless, this study has several limitations. The research was conducted in only one vocational school involving a limited number of participants, and the observed implementation was still restricted to several classroom learning situations that may not fully represent long-term digital learning integration practices in vocational education. Therefore, future studies are recommended to involve broader institutional contexts, larger participant groups, and longer observation periods to further examine the effectiveness, sustainability, and long-term implementation of e-modules within vocational education environments

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