

Development of a PjBL-Based Technical Drawing E-Module Using Heyzine for Grade X Automotive Engineering Students at Vocational High School

Hairul Ummah¹, Sigit purnomo², Nurcholish Arifin Handoyono³

^{1,2,3}Mechanical Engineering Vocational Education, Faculty of Teacher Training and Education, Universitas Sarjanawiyata Tamansiswa, Jl. Batikan, Tuntungan UH III/1043 Umbulharjo, Yogyakarta, 55165, Indonesia

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ABSTRACT

This study aimed to develop a Project-Based Learning (PjBL)-based technical drawing e-module for tenth-grade Automotive Engineering students at SMK AAG Penerbangan Adi Sutjipto and to determine its feasibility level. This research employed a Research and Development (R&D) approach using the 4D model, which consists of the define, design, develop, and disseminate stages. The research subjects included media experts, material experts, and 20 tenth-grade Automotive Engineering students as product users, while the object of the study was a PjBL-based technical drawing e-module. Data were collected through questionnaires and observations and then analyzed quantitatively. The results of the study show that the developed e-module contains introductory materials on various drawing tools, standardization in drawing creation, as well as practice in drawing and reading technical drawings, and determining the location and position of automotive components based on manual opening, arranged systematically, and equipped with text, images, and videos that can be accessed via smartphone or laptop through the Heyzine website. This product allows students to learn independently anytime and anywhere. The validation results indicated that the e-module was highly feasible for use, with validation percentages of 91% from media experts, 84.45% from material experts, and 86% from student responses. Therefore, the PjBL-based technical drawing e-module is considered suitable for use as a learning medium to support students' independent learning.

Corresponding Author:

Nurcholish Arifin Handoyono

Mechanical Engineering Vocational Education, Faculty of Teacher Training dan Education, Universitas

Sarjanawiyata Tamansiswa, Jl. Batikan, Tuntungan UH III/1043 Umbulharjo, Yogyakarta, 55165, Indonesia

Email: arifin@ustjogja.ac.id

INTRODUCTION

Education is a fundamental need in human resource development and serves as a lifelong process in shaping individuals' knowledge, skills, and values (Lisa & Susilowibowo, 2016). Education is also understood as a process of facilitating learning that encompasses knowledge, skills, values, and habits through various methods (Andromeda et al., 2023; Maurer, 2021). However, the quality of education in Indonesia remains relatively low compared to that of other countries. According to the

Sumiyaty et al., (2023) report, Indonesia ranked 69th out of 80 countries in literacy, mathematics, and science, indicating that significant challenges remain in improving educational quality.

In vocational education, Vocational High Schools play a strategic role in preparing graduates to be work-ready. SMKs are educational institutions designed to provide training and skills that enable students to enter the workforce (Khan et al., 2022; Pujining Nugraheni et al., 2022). However, data from *Badan Pusat Statistik* (2025) show that vocational high school (SMK) graduates continue to record the highest open unemployment rate among all educational levels, reaching 8.00% in February 2025 (Zulfikar, 2025). This indicates a persistent gap between graduates' competencies and industry needs. One of the essential competencies in vocational technical education is the ability to understand technical drawing, as it serves as a fundamental skill in industrial work (Handoyono et al., 2020).

Based on observations conducted at SMK AAG Penerbangan Adi Sutjipto, Technical Drawing instruction in Grade X was still dominated by lecture and question-and-answer methods without adequate instructional materials. The lecture method is teacher-centered, causing students to be relatively passive and focused mainly on memorizing the material (Amin et al., 2020). This condition has contributed to students' low level of understanding, as approximately 40% of students had not yet achieved the minimum mastery criterion. In addition, the lack of variation in instructional strategies made students easily bored and less active during the learning process.

Learning media play an important role in improving the quality of instruction as they can clarify the delivery of materials, increase learning motivation, and support independent learning (Handoyono, 2019; Komaro et al., 2022). Learning media also serve as intermediary tools for conveying ideas or information so that they can be more easily understood by students (Roemintoyo & Budiarto, 2025). One form of technology-based learning media relevant to addressing these needs is the e-module. An e-module is a systematically organized digital teaching material that can be used independently and supports more engaging and interactive learning processes (Sumarmi et al., 2021). In addition, e-modules are characterized by independence, systematic structure, and adaptability to technological developments, making them suitable for 21st-century learning (Purwaka et al., 2020). In this context, e-modules offer a potential solution because they not only present learning materials but also encourage students' active involvement in understanding concepts more flexibly.

In line with this, the implementation of the Project Based Learning (PjBL) model is also relevant to support Technical Drawing learning because it emphasizes students' active involvement in completing complex real-world projects related to life contexts. According to Čavić et al., (2022); Guo et al., (2020), PjBL is a tool for organizing classroom learning through project activities that focus on students' active and independent engagement. PjBL is considered effective in integrating theory and practice as well as in developing problem-solving skills, collaboration, and meaningful learning products. The syntax of PjBL includes determining essential questions, designing project plans, arranging schedules, monitoring project progress, testing results, and evaluating experiences, thereby

making the learning process more systematic and structured (Handoyono et al., 2020; Wardah et al., 2022).

The implementation of Project Based Learning (PjBL) has several advantages, including increasing learning motivation, developing problem-solving skills, enhancing collaboration abilities, promoting more meaningful learning, and connecting learning with real-life situations (Thomas, 2000). However, this model also has several limitations, such as requiring a longer time allocation, careful preparation, adequate facilities, and teachers' ability to manage projects effectively (Kokotsaki et al., 2016). The success of PjBL implementation is influenced by the alignment of projects with learning objectives, relevance to real-world contexts, active student engagement, the teacher's role as a facilitator, and the availability of supporting media and learning resources. Therefore, the implementation of PjBL will be more optimal when supported by systematic and interactive e-modules.

The integration of digital learning resources in vocational education has been widely explored, particularly through the development of electronic modules to support independent learning. Previous studies have demonstrated that e-modules can improve students' learning motivation, conceptual understanding, and learning outcomes by providing flexible, interactive, and self-paced learning experiences (Sung et al., 2016). Likewise, PjBL has been widely recognized as an effective instructional approach for developing students' problem-solving, collaboration, creativity, and higher-order thinking skills, particularly in vocational education where authentic tasks and real-world projects are essential for competency development (Guo et al., 2020; Kokotsaki et al., 2016). However, most existing studies have focused on general science, mathematics, or theoretical vocational subjects, while relatively few have investigated the development of PjBL-based electronic modules specifically for Technical Drawing, a foundational competency in Automotive Engineering programs that requires spatial visualization, procedural understanding, technical communication, and project-oriented practice.

Furthermore, previous e-module development studies have predominantly utilized platforms such as Canva, FlipHTML5, Sigil, or PDF-based interactive media to develop digital learning materials (Malik et al., 2026; Nindita et al., 2025). These platforms effectively facilitate the presentation of digital content; however, they generally emphasize content visualization rather than providing an immersive digital-book experience that integrates multimedia elements, realistic page-flipping, intuitive navigation, and cloud-based accessibility within a single environment (Clark & Richard E, 2016). Consequently, there is still limited empirical evidence regarding the effectiveness and practicality of alternative digital publishing platforms, such as Heyzine, in supporting PjBL in vocational technical education, particularly for Technical Drawing instruction.

This study addresses these gaps by developing a PjBL-based electronic module for Grade X Automotive Engineering students using the Heyzine platform. Unlike conventional digital learning media, Heyzine was selected because it offers several features that support vocational learning, including (1) a realistic flipbook interface that promotes a more engaging reading experience; (2)

seamless integration of multimedia elements such as instructional videos, hyperlinks, embedded documents, and interactive content within a single learning resource; (3) cloud-based accessibility without requiring software installation, enabling students to access learning materials anytime and from various devices; and (4) responsive compatibility across desktop and mobile platforms, facilitating both classroom and independent learning (Clark & Richard E, 2016; Fatonah et al., 2025; Putri & Hakim, 2025). These features align with multimedia learning principles, which emphasize that combining verbal and visual information in an interactive digital environment can enhance students' understanding, engagement, and knowledge retention (Clark & Richard E, 2016). Such characteristics are particularly appropriate for Technical Drawing instruction, where students require visual demonstrations, step-by-step procedural guidance, and project documentation to develop technical competencies.

Therefore, the novelty of this study lies in integrating the PjBL approach with a Heyzine-based electronic module specifically designed for Technical Drawing instruction in Grade X Automotive Engineering vocational education. Unlike previous studies that have generally focused on developing e-modules for theoretical subjects or using more conventional digital publishing platforms, this study employs Heyzine to deliver multimedia-rich, project-oriented learning materials that support visualization, procedural learning, and independent study. The integration of interactive multimedia with project-based activities is consistent with the principles of multimedia learning and constructivist learning, which suggest that meaningful learning is enhanced when students actively construct knowledge through authentic tasks supported by multiple representations of information. Based on these considerations, this study develops a PjBL-based Technical Drawing e-module using the Heyzine platform for Grade X Automotive Engineering students at SMK AAG Penerbangan Adi Sutjipto and evaluates its feasibility as a digital learning medium. It is expected that the developed e-module will provide an engaging and practical learning resource that supports students' conceptual understanding, project implementation, and independent learning while contributing to the advancement of digital learning media in vocational education.

METHOD

This study employed the Four-D (4D) development model proposed by Thiagarajan et al., (1974), which consists of four stages: Define, Design, Develop, and Disseminate. Due to the scope of the study, the dissemination stage was conducted on a limited scale by introducing the developed e-module to Technical Drawing teachers and Grade X Automotive Engineering students at SMK AAG Penerbangan Adi Sutjipto for initial implementation and feedback. Therefore, this study focused primarily on the Define, Design, and Develop stages while carrying out limited dissemination as the final stage of product development.

The research subjects consisted of subject matter experts and media experts. The subject matter experts assessed the content alignment with the Merdeka Curriculum (learning outcomes/CP and learning objectives/ATP), while the media experts evaluated the aspects of appearance, readability, and

design feasibility of the e-module. The limited field trial was conducted with 20 Grade X students of the Automotive Engineering Department at SMK AAG Penerbangan Adi Sutjipto, selected through purposive sampling to evaluate the practicality and usability of the developed e-module.

Data were collected using validation questionnaires for media experts, material experts, and student response questionnaires. The media validation instrument consisted of 20 items covering aspects of appearance, language use, and layout. The material validation instrument consisted of 36 items assessing teaching materials, completeness of materials, independence, adaptability, and ease of use. The student response questionnaire comprised 25 items evaluating presentation of material, provision of media, and learning aspects of the e-module. All instruments employed a five-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Prior to data collection, all research instruments underwent content validation by experts in instructional media and vocational education to ensure the relevance and clarity of each item. Revisions were made based on the experts' suggestions before the instruments were administered to participants. Data analysis was conducted by calculating the percentage of feasibility scores using a Likert scale, which was then converted into feasibility categories (ranging from very feasible to very unfeasible) as the basis for drawing conclusions.

RESULTS AND DISCUSSION

The data in this study were obtained from assessments conducted by media experts, material experts, and students' responses to the Technical Drawing e-module based on Project Based Learning (PjBL) developed using the 4D development model proposed by Thiagarajan and Sivasailam. This model consists of four main stages: define, design, develop, and disseminate.

Based on the research objectives, the product developed in this study is a Technical Drawing e-module based on Project Based Learning (PjBL) for Grade X Automotive Engineering students at SMK AAG Penerbangan Adi Sutjipto. The results show that the developed e-module is not only feasible to use but also able to address previous learning problems, which were predominantly teacher-centered and lacked independent learning media for students.

a. Define Stage

The define stage aims to identify the initial needs in the development of learning media. The results of observations and interviews indicate that the teaching process of Technical Drawing at SMK AAG Penerbangan is still dominated by lecture methods and teacher-centered instruction, resulting in students' low understanding of the material and the learning process not yet promoting independent learning.

These findings indicate a gap between the ideal learning conditions and the actual classroom situation. Students do not yet have independent learning resources that can be accessed anytime, resulting in a high dependence on the teacher. This condition is in line with learning media theory, which states that the appropriate use of instructional media can improve learning effectiveness and students' learning independence.

Further analysis was conducted based on three aspects, namely curriculum, content, and media characteristics. In the curriculum aspect, learning refers to the Merdeka Curriculum with a focus on learning outcomes (CP) and learning objectives (ATP) relevant to the Technical Drawing subject.

Table 1. Learning Objectives of Technical Drawing subject

No	Learning Objectives
1	The Learning Outcomes (CP) and Learning Objectives (ATP) include the introduction of drawing tools, standard lettering and numbering, and orthographic projection. Theoretically, this requires learning that is strongly practice-based and visually oriented.
2	The material analysis shows that Technical Drawing content includes basic skills in using drawing instruments, producing standard technical drawings, and orthographic projection of simple objects. This indicates that the material is procedural in nature and requires clear visual representation to facilitate student understanding.
3	The media characteristics analysis indicates that the e-module should be independent, flexible, and interactive. Therefore, the development of a Project-Based Learning (PjBL) e-module was selected as it is considered capable of facilitating active and collaborative learning while encouraging students' independent learning.

From an academic perspective, the findings at this stage indicate that the main problem in learning is not only related to the learning content but also to the limitations of learning media, which have not fully supported the needs of 21st-century learning.

Design Stage

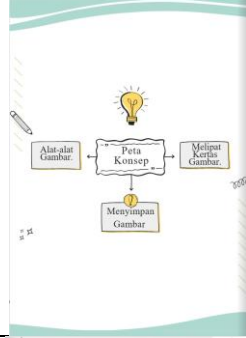
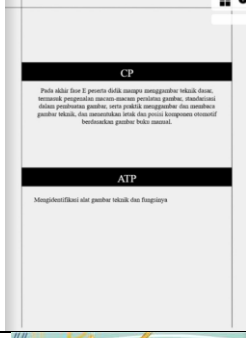
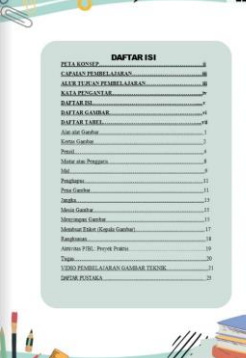
The design stage resulted in an initial e-module design based on the Heyzine website, which was developed in accordance with the Learning Outcomes (CP) and Learning Objectives (ATP). The e-module was designed to be interactive by incorporating text, images, learning videos, practice exercises, and evaluation activities.

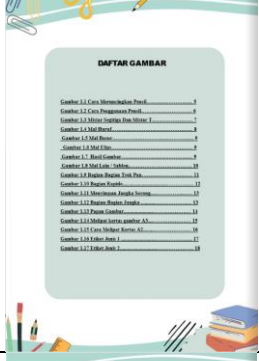
An important finding at this stage is that learning media should not only focus on content delivery, but also on providing a more visual and contextual learning experience. The learning videos used support the understanding of technical concepts such as the use of drawing instruments and orthographic projection.

From an interpretive perspective, this design indicates that the integration of multimedia in the e-module can enhance students' engagement in the learning process. This is consistent with multimedia learning theory, which states that the combination of text, images, and videos can improve the understanding of abstract concepts.

After completing several stages of development, the resulting learning media product is an e-module of Technical Drawing based on Project-Based Learning (PjBL), which consists of several components:

Table 2. Initial Draft of The E-Module of Technical Drawing

Part	Picture
a. E-module Cover The front cover of the e-module displays the title of the e-module along with the author's name. The cover should be designed with attractive colors and visuals to ensure overall harmony and consistency.	
b. Concept map This concept map includes a summary, illustrations, and key terms related to the Technical Drawing learning material in the e-module.	
c. Learning Outcomes and Learning Objectives Flow (ATP) Learning outcomes refer to learning targets that are clearly defined and can be easily understood and implemented by students throughout the learning process. Meanwhile, the learning objectives flow is designed to systematically structure and sequence learning activities.	
d. Preface This section of the preface conveys expressions of gratitude, thankfulness, as well as expectations and apologies to the readers.	
e. Table of Contents The table of contents consists of pages listing each chapter title that has been systematically arranged.	

Part	Picture
f. List of Tables The list of tables contains the titles of tables along with their page numbers, which have been systematically arranged.	
g. List of Figures The list of figures contains the titles of figures along with their page numbers, which have been systematically arranged.	
h. PjBL Activities Project-Based Learning (PjBL) functions to develop students' collaboration skills through role distribution in completing technical drawing projects, such as designing title blocks or other projects, training teamwork, and solving authentic problems through analysis and presentation of results. In addition, PjBL strengthens critical thinking skills, initiative, and independent responsibility in accordance with the Merdeka Curriculum.	
i. Learning Competency Test The learning competency test contains materials designed to assess students' learning achievement based on the e-module.	
j. Barcode Barcode for Technical Drawing Learning Videos	

Development Stage

Before being tested in the vocational school, the learning media product was first validated by experts to assess the feasibility of the initial product and to obtain feedback as a basis for improvement. The validation was conducted by one media expert lecturer and one subject matter expert teacher from SMK AAG Adisutjipto. The results of the product validation are presented as follows:

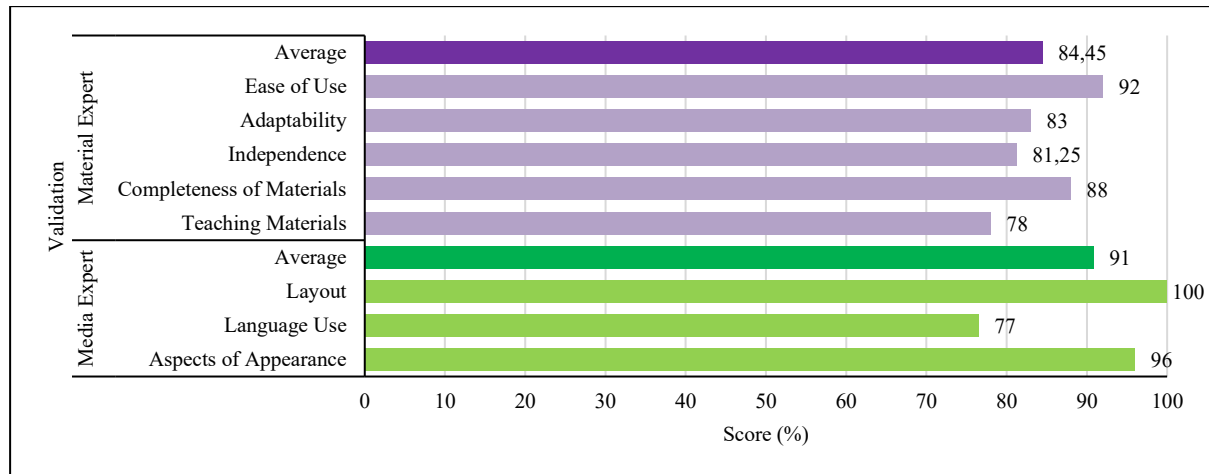


Figure 1. Validation Results from Media Expert and Material Expert

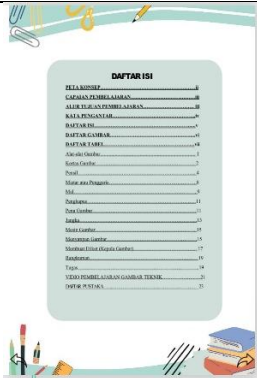
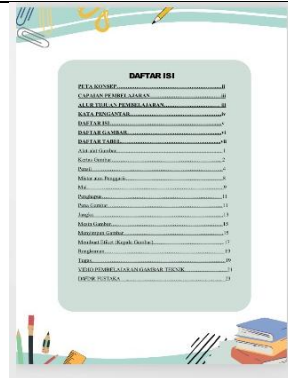
The results of the media expert validation showed that the e-module obtained an average feasibility percentage of 91%, categorized as very feasible. The feasibility results from the media expert are presented as follows. This means that in terms of appearance, image quality, layout, language, and media functionality, the product has met the standards of good instructional media. However, several suggestions were provided, such as simplifying the text, improving image size, and adding a developer profile.

Meanwhile, the subject matter expert validation obtained an average feasibility percentage of 84.45%, categorized as very feasible. This indicates that the presented material is aligned with the curriculum, sufficiently comprehensive, easy to understand, and supports students' independent learning. However, the subject matter expert provided feedback to improve the completeness of the material and to add system schematics to enhance students' understanding.

Scientifically, these findings indicate that the PjBL-based e-module demonstrates good content validity and design quality. The results also strengthen the notion that digital learning media can be well accepted by experts as long as it meets both pedagogical and technical requirements.

Based on these two results, the e-module is categorized as "very feasible" and has met the predetermined criteria, with a minimum category of "feasible." Therefore, the development of the e-module can proceed to the next stage, namely dissemination. Before entering the dissemination stage, several revisions were made to the e-module, and the improvements are presented in the following table 3.

Table 3. E-Module Improvement Results

Suggestions from	Suggestion Content	Before Revision	After Revision
Material Experts	The e-module is considered feasible for field implementation with revisions, particularly by adding hyperlinks to the table of contents.		
Media Experts	The e-module is feasible for field use with revisions, including clarifying the diagrams in the material.		

If compared with previous studies, these findings are consistent with results showing that PjBL-based media and interactive multimedia tend to obtain high feasibility categories because they can enhance student learning engagement. However, this study provides an additional contribution through the integration of the Heyzine platform, which enables flexible access via digital devices.

Dissemination Stage

The dissemination stage was conducted on a limited basis at SMK AAG Penerbangan Adisutjipto involving Grade X Automotive Engineering students. Following expert validation, the PjBL-based Technical Drawing e-module was distributed to students to obtain their responses regarding its usability and feasibility as a learning medium. The limited trial also provided feedback to support the evaluation of the developed product. The results of the limited trial are presented as follows.

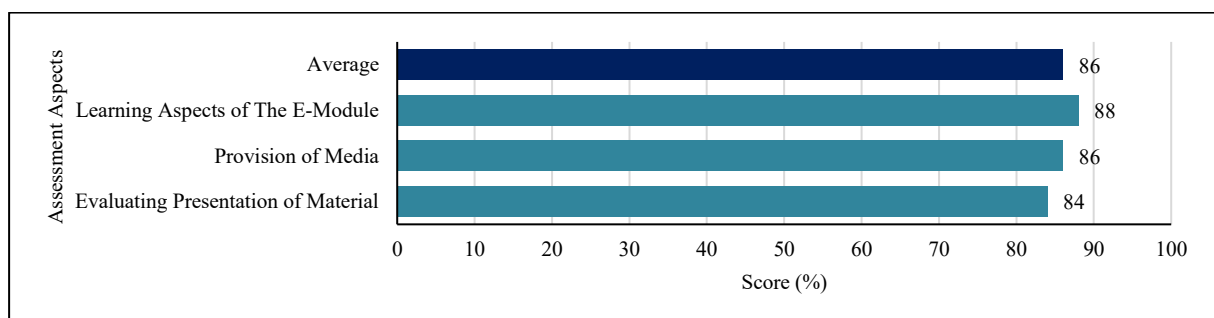


Figure 2. The Results of the Limited Trial

The student response test, involving 20 Grade X students, yielded a feasibility score of 86%, which falls into the very feasible category. This result indicates that the developed e-module was positively perceived by students in terms of its attractiveness, ease of use, clarity of presentation, and support for independent.

The e-module also provides students with greater flexibility in accessing learning resources and exploring Technical Drawing materials through digital technology. Its interactive features encourage students to independently navigate the learning content and utilize digital resources as learning tools. These findings suggest that the e-module is well accepted by students and has the potential to support digital-based learning in vocational education.

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The positive student responses are consistent with previous studies indicating that well-designed digital learning media can enhance students' learning experiences, engagement, and motivation by providing interactive and flexible learning environments (Bond et al., 2020; Clark & Richard E, 2016). Furthermore, the integration of the PjBL model provides opportunities for students to engage in project-oriented activities, collaboration, and problem-solving, which are essential characteristics of the PjBL approach (Guo et al., 2020; Kokotsaki et al., 2016). In vocational education, integrating interactive digital media with PjBL can support student-centered learning and better align learning activities with workplace-oriented competencies.

In the context of vocational education, these findings are relevant to Sudira (2024), who emphasizes the importance of integrating technology and student-centered learning approaches to support competency development aligned with workforce demands. However, it should be noted that this study evaluated the feasibility of the e-module through expert validation and student responses only. The effectiveness of the e-module in improving learning outcomes was not examined and therefore requires further investigation through experimental studies using appropriate learning outcome measures.

CONCLUSION

This research and development study produced a Technical Drawing e-module based on PjBL for Grade X students of SMK AAG Penerbangan Adisutjipto, developed using the 4D model. The findings indicate that the developed e-module incorporates interactive features, including instructional videos, animations, hyperlinks, project-based learning activities, exercises, and competency tests, which enhance student engagement and support learning. The validation results demonstrate that the e-module is very feasible, as evidenced by media expert validation (91%), subject matter expert validation

(84.45%), and student responses (86%). These results indicate that the e-module is suitable for use as a digital learning medium that promotes independent and active learning.

Practically, the e-module can serve as an alternative instructional medium for teachers while enabling students to learn more independently and interactively. Nevertheless, this study has several limitations. The product trial was conducted in only one vocational school with a limited number of participants, which may restrict the generalizability of the findings. In addition, each validation category involved only one expert, limiting the breadth of expert perspectives in evaluating the product. Future research should involve multiple experts for each validation aspect, conduct large-scale implementation across different vocational schools, and evaluate the effectiveness of the e-module through experimental or quasi-experimental designs that measure its impact on students' learning outcomes, motivation, and technical drawing competencies.

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