

Development of an Electronic Publication-Based Learning Module for Cost Estimation in Building Design and Information Modeling (DPIB) at Vocational High School

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Abstract

This research and development study aimed to create an Electronic Publication (EPUB)-based learning module for the cost estimation element of the Building Design and Information Modeling (DPIB) vocational program and to test its feasibility, practicality, and effectiveness. The research method used was Research and Development (R&D) with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Data was collected through validation by media and content experts, as well as trials involving eleventh-grade DPIB students at one of vocational high school in Malang. The developed product is an electronic module in EPUB format with interactive features such as project-based materials, video tutorials, and Learning Management System (LMS) integration. Validation results from the media expert showed a feasibility percentage of 96.74% (very valid category), while the content expert gave a score of 91.97% (very valid category). The small group trial yielded a positive response with a score of 89.39%, and the large group trial obtained a score of 86.24% (both in the very valid category). The study concludes that the developed EPUB-based module is feasible, practical, and effective as an innovative learning medium to enhance students' understanding of construction cost estimation. The module's advantages include high accessibility, multimedia content, and self-paced learning flexibility.

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1. Introduction

Digital transformation has brought disruptive impacts across various sectors, including education. Digital technology is no longer a supplement but a necessity to create adaptive learning ecosystems that meet the learning needs and preferences of the current generation (Amin et al., 2023; Hakim & Yulia, 2024). The government's policy direction on the use of technology in education to improve the quality and access of education is being intensified to bridge the development gap with other ASEAN countries (Bariah & Angranti, 2023). This transformation is especially critical in vocational education, where the alignment with dynamic industry demands (link and match) is paramount. A concrete example is the Building Design and Information Modeling (DPIB) competency, where mastery of construction cost estimation is a fundamental skill explicitly mandated by the Indonesian National Work Competency Standards for the Cost Estimator position (Kemnaker RI No. 51 Tahun 2022). In response, the Indonesian government, through the Merdeka Curriculum policy, actively promotes the integration of technology not merely as a tool but as the core of the learning experience to prepare competent graduates for the workforce (Bariah & Angranti, 2023; Saputra, Siswanto, & Suryatama, 2025).

However, observations at one of vocational high school at Malang reveal a gap between this policy ideal and the learning reality for the cost estimation element. The instruction still predominantly relies on conventional, teacher-centered methods, such as lectures supported by textbooks and worksheets. This condition potentially leads to low student motivation and poor conceptual understanding (Megayanti et al., 2020; Rahayu et al., 2024). A needs survey of 25 eleventh-grade DPIB students confirmed this issue, with 60% of respondents reporting frequent difficulties in understanding the estimation materials. Notably, the majority (88%) expressed that they felt more assisted and motivated when interactive digital media was used. The disconnect between the teaching methods, the characteristics of digital natives (Bennett et al., 2018), and students' learning needs is suspected to be a key factor behind the fluctuating academic achievement scores for this element over the past three years.

The solution offered to bridge this gap is the development of innovative teaching materials in the form of an electronic module. Among various formats, Electronic Publication (EPUB) was chosen as the development foundation. EPUB is an open standard format that enables the integration of multimedia (text, images, video, animations) and, most importantly, is reflowable, meaning it can optimally adjust its display across various device screen sizes, from computers to smartphones (Darmayanti, 2022; Pu et al., 2018). This advantage makes EPUB highly potential for creating immersive and self-directed learning experiences, directly addressing students' preferences for dynamic and interactive content (Laili et al., 2019; Ula et al., 2023; Wijayanto et al., 2023).

Based on this background, this research was conducted to develop an EPUB-based learning module for cost estimation in the DPIB competency that meets media and content feasibility standards. This study does not stop at the product development stage but also tests its practicality and effectiveness in the actual learning context. Thus, it is hoped that the results of this study can not only provide a concrete solution to learning challenges at the vocational high school but also contribute to the enrichment of literature and practice regarding innovative digital media development in vocational education, especially in the field of building engineering expertise.

2. Method

This study employed a Research and Development (R&D) approach aimed at producing a specific product and testing its effectiveness (Sugiyono, 2017). This method was selected as it is appropriate for developing innovative digital modules that address specific learning challenges in vocational education contexts (Tishana et al., 2024).

The development model used was the ADDIE model, which consists of five systematic stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation (Branch in Anggraeni et al., 2019). This model was chosen because it provides a structured and iterative framework, allowing for continuous evaluation and improvement at each stage (Cahyadi, 2019; Kirembwe et al., 2023).

The study was conducted at SMK Nasional Malang. The population of this study was all eleventh-grade students of the Building Design and Information Modeling (DPIB) competency at the school, which consisted of 25 individuals. This population was selected based on the consideration that they are the direct end-users of the developed module and are currently undertaking the cost estimation element. Given the limited population size of fewer than 100 individuals, the sampling technique used was saturated sampling, where all members of the population were included as research subjects (Sugiyono, 2017). The research subjects were divided into two groups for different purposes. The validation subjects consisted of one media expert (a lecturer in educational technology) and one content expert (a teacher of the estimation elements). The selection of experts was based on relevant competence and experience, following standards in development research (Richey & Klein, 2017). Meanwhile, the trial subjects consisted of the entire population of 25 eleventh-grade DPIB students. This entire population was then divided for two trial stages. A small group evaluation involved 6 students (24% of the population), while a field trial involved 19 students (76% of the population) who were not included in the small group trial. The determination of this trial sample division adhered to R&D research principles to obtain comprehensive feedback at different development stages (Reiser & Dempsey, 2018).

2.1. Development Procedure

The development procedure followed the ADDIE model. In the Analysis stage, a needs analysis was conducted through observation and interviews with teachers, as well as a questionnaire survey of 25 students to identify problems and the need for interactive learning media. This needs analysis served as a critical foundation for designing a product that genuinely addresses field issues (Phillips & Klein, 2023). Subsequently, the Design stage included designing the module storyboard, an Entity Relationship Diagram (ERD) for the navigation flow, and compiling materials based on the Learning Objective Flow (ATP) of estimation elements. Careful design ensured product consistency and usability (Branch, 2009). The Development stage began with creating the EPUB module using Spring Suite software. The initial product was then validated by media and content experts using a Likert-scale questionnaire to assess its feasibility. Data from the validation were used to revise the product before testing. Expert validation is an essential step to ensure product quality before implementation (Safitri et al., 2021). In the Implementation stage, the revised product was tested in the learning process. This stage consisted of a small group trial with 6 students and a field trial with 19 students to assess the module's practicality and appeal. Implementation aimed to test the product in a real learning setting (Kirembwe et al., 2023). The final stage was Evaluation. Formative evaluation was conducted at each stage for product improvement. Meanwhile, summative evaluation was carried out at the end of the process based on trial results to determine the final product's feasibility. Comprehensive evaluation ensured the final product met the established feasibility standards (Reiser & Dempsey, 2018).

2.2. Data Collection and Analysis Techniques

Data were collected using several instruments. A Needs Questionnaire was used in the analysis stage to identify initial problems and learning needs. During the development stage, Expert Validation Sheets were employed. The media expert validation instrument (23 items) and the content expert validation instrument (24 items) were adapted from Suyitno (2022) using a 1-4 rating scale. The use of these standardized validation instruments enhanced the reliability of the data (Cahyadi, 2019).

Furthermore, a Student Response Questionnaire was used in the implementation stage to measure the product's practicality and appeal. This instrument, adapted from (Dewi et al., 2022), comprised 11 items on a 1-4 Likert scale. The questionnaire was designed to assess two main constructs: practicality and appeal. The practicality aspect consisted of 5 items evaluating: 1) ease of independent use, 2) user-friendliness, 3) effectiveness in simplifying complex material, 4) ability to boost learning motivation, and 5) capability to encourage active learning. The appeal aspect consisted of 6 items evaluating: 1) attractiveness of material presentation, 2) relevance of supporting images and text, 3) ability to make learning more enjoyable, 4) clarity of usage instructions, 5) stimulation of interest in the subject matter, and 6) overall fondness for the e-module format. Prior to the large-scale field trial, the questionnaire was piloted with a small group of students (n=6). The pilot study aimed to ensure the instrument's clarity and reliability in the current context. The calculated Cronbach's Alpha coefficient from the pilot data was 0.943, indicating excellent internal consistency and reliability. Based on the pilot feedback, no items were removed, but minor adjustments were made to the wording for clarity. The refined instrument was then deployed in the field trial with 19 students.

Quantitative data from the questionnaires were analyzed descriptively by calculating the average scores and validity percentages. The formula used was (Sugiyono, 2017):

$$Percentage = \frac{Total\ Empirical\ Score}{Total\ Maximum\ Score} \times 100\% \tag{1}$$

The calculation results were then categorized based on the following criteria in Table 1:

Table 1. Criteria for Validation Results

Achievement Level %	Category	Test Decision
85,01 - 100,00	Very Valid	Can be used without revision
70,01 - 85,00	Moderately Valid	Can be used with minor revisions
50,01 - 70,00	Less Valid	May be used with major revisions
01,00 - 50,00	Not Valid	Should not be used

Qualitative data in the form of comments and suggestions from validators and students were used for product revision through simple thematic analysis (Rustandi & Rismayanti, 2021).

3. Results and Discussion

3.1. Research Results

The development of an EPUB-based learning module for cost estimation has yielded a final product that is feasible, practical, and effective. Product feasibility data were obtained through two main stages: expert validation and user testing (students), with the following results:

3.1.1. Expert Validation Results

Validation by the media expert yielded an average score of 96.74% (Very Valid category). The graphical and usefulness aspects received perfect scores (100%), while usability and consistency aspects scored above 93%. Meanwhile, validation by the content expert resulted in a score of 91.97% (Very Valid category). Language and usefulness aspects received the highest scores, while content feasibility and presentation aspects scored above 85%.

3.1.2. User Trial Results

In the limited trial with 6 students, the module received a score of 89.39% (Very Valid category). The appeal aspect (91.67%) scored higher than the practicality aspect (86.67%). In the product trial with 19 students, the module obtained a score of 86.24% (Very Valid category), with the appeal aspect (86.84%) still higher than practicality (85.53%).

Table 2. Summary of EPUB Module Validation and Trial Results

Evaluation Stage	Respondents	Percentage Score	Category
Expert Validation	Media Expert	96.74 %	Highly Valid
	Content Expert	91.97 %	Highly Valid
Limited Trial	6 Students (Small Group)	89.39 %	Highly Valid
Product Trials	19 Students (Large Group)	86.24 %	Highly Valid

3.2. Discussion

The high expert validation scores demonstrate that the module is not only theoretically feasible but also well-accepted in practice. These results are consistent with the findings of Safitri et al (2021), who also reported that flipbook-based e-modules achieved expert validity above 90%, indicating that developing digital media with appropriate methodologies can yield high-quality products.

The high media expert validation score (96.74%) indicates that the EPUB module's interface design and functionality meet digital learning media feasibility standards. This aligns with the study by Tishana et al (2024), which developed Android-based e-modules for vocational students and found that well-integrated multimedia significantly enhances visual appeal. The reflowable feature of EPUB, which allows content to adapt to various screen sizes, emerged as a key factor acknowledged by media experts and students, particularly for smartphone-based learning.

The highly positive student responses to the appeal aspect confirm that the characteristics of digital natives are well accommodated. The module successfully leverages the current generation's preference for visual and interactive content, thereby enhancing learning motivation (Amin et al., 2023; Hakim & Yulia, 2024). This finding reinforces the results of Laili et al (2019), who concluded that interactive multimedia significantly improves vocational students' learning outcomes in electrical installation subjects.

Meanwhile, the content expert validation (91.97%) confirms that the presented content is accurate, curriculum-relevant, and supports learning objectives. However, the suggestion from content experts to develop short-form video content for platforms like TikTok or Reels identifies an opportunity for further research. This recommendation aligns with the growing trends of microlearning and social media-based learning, offering innovation potential to enhance engagement at a higher level (Phillips & Klein, 2023).

The slightly lower practicality scores compared to appeal can be interpreted from two perspectives. On one hand, it may indicate that students need time to adapt to the new module navigation. On the other hand, it reflects the inherent complexity of technical and calculation-intensive cost estimation materials. Nevertheless, the scores remaining in the "Very Valid" category prove that the module successfully simplifies and visualizes complex materials for easier comprehension. This finding is consistent with the study by Megayanti (2020), which demonstrated that technology-assisted project-based learning enhances problem-solving skills among vocational students.

This study has several limitations. First, the module heavily depends on stable internet connectivity for LMS access. Second, the research was conducted in a single school, so generalizing the findings requires caution. For future research, it is recommended to: (1) develop native mobile applications or more robust offline features; (2) experimentally test the module's effectiveness in improving students' cognitive learning outcomes; and (3) follow up on content experts' suggestions by developing short-form video content optimized for social media platforms, as recommended by Pu et al (2018) in their study on interactive e-module development.

4. Conclusion

Based on the entire research and development process conducted, it can be concluded that the Electronic Publication (EPUB)-based learning module for cost estimation in the Building Design and Information Modeling (DPIB) vocational program, developed using the ADDIE model, has been proven to be highly feasible, practical, and effective according to expert validation and student trials. The findings indicate that the integration of multimedia features and the reflowable format of EPUB significantly enhanced the appeal and practicality of the learning media for contemporary generations, while the systematic approach of the ADDIE model ensured content quality and alignment with the vocational curriculum. The success of this product not only provides a concrete solution to conventional learning challenges at SMK Nasional Malang but also contributes to the enrichment of literature on digital media development in vocational education. For sustainable implementation, it is recommended that schools provide adequate supporting infrastructure and that future researchers develop more robust offline features and microlearning content optimized for digital platforms.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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