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Development and Implementation of Flipbook-Based E-Modules to Enhance the Mastery of Welding Symbols

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Abstract

The limited mastery of welding symbols among students is a significant challenge in the instruction of basic welding and metal fabrication techniques, which adversely affects the quality of the resulting products. This study aims to develop a flipbook-based e-module to improve the understanding of welding symbols, with its effectiveness assessed through observation, feedback, and testing. The research utilizes the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). An experimental design was employed, comparing an experimental group with a control group, consisting of 72 students from the Welding Engineering and Metal Fabrication program in grade 10th. The findings indicate that the flipbook-based e-module significantly enhanced the mastery of welding symbols. This research highlights the positive impact of integrating technology into education, reinforcing the importance of innovative teaching methods to improve learning outcomes in the field of welding engineering.

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INTRODUCTION

Vocational education must maintain high quality and continue evolving to meet industrial demands while supporting sustainable development. Graduates of vocational high schools are required to master knowledge and practical skills relevant to technological advancements. The principles of vocational education, as articulated by Dr. Charles Allen Prosser in his 16 Theorems, emphasize several key concepts. Mastery of welding symbols, according to the second theorem, provides learners with clear conceptual knowledge that can be applied in the workplace. The effectiveness of e-modules, highlighted in the tenth theorem, demonstrates that introducing welding symbols through flipbook-based e-modules fosters more effective comprehension compared to conventional methods.

The basic technical welding and metal fabrication competencies at SMK N 1 Adiwerna remain suboptimal. This is evident from the average daily test scores of Grade 10th Welding and Metal Fabrication students, which stand at 72.2%, below the Minimum Mastery Criterion. This affects 26 students. Classroom observations reveal an absence of student feedback during teacher explanations of material. This aligns with research by Pretiwi et al. in 2024, which reported that challenges in classroom learning, such as insufficient interaction between teachers and students, contribute to boredom.

Technology facilitates collaboration between students and teachers through tools such as e-modules. Compared to printed modules, e-modules are interactive, offering ease of navigation and integration of images, audio, videos, animations, and formative assessments. Research by Devkota et al. in 2023 emphasizes these advantages. Studies by Levett-Jones et al. in 2024 and Nasbey et al. in 2024 explain that e-modules are designed in alignment with curriculum standards and structured as digital teaching materials accessible via electronic devices such as smartphones. These tools represent flexible, interactive, and self-directed learning media.

Developing e-modules often involves supplementary software, such as flipbooks. Flipbooks are animated, book-like resources that present material in various output formats, enriched with features like hyperlinks, videos, animations, audio, job sheets, and evaluations systematically packaged for interactive learning. Research by Rini et al. in 2021 highlights these advantages. Oronce and Manalo in 2021 also emphasize that flipbook-based e-modules remain viable learning tools adaptable to rapidly evolving technology.

E-modules are electronic learning resources accessible via computers, laptops, tablets, or smartphones. In this study, e-modules were developed using Canva as a learning medium for students. Research by Dismarianti et al. in 2020 states that e-modules are systematically designed and can incorporate elements such as audio and animation. The use of Canva in e-module development facilitates learning by effectively achieving instructional goals. Research by Sari et al. in 2024 supports this by highlighting Canva as a widely used tool due to its ease of use and accessibility.

A flipbook is a digital learning module resembling an album or magazine, measuring 21 by 29 centimeters (A4). Research by Ashari and Puspasari in 2024 describes flipbooks as professional software enabling the creation of electronic books with interactive features such as animations, audio, and videos. Flipbook-based e-modules actively engage students in the learning process. Research by Rukmi and Wibawa in 2023 explains that flipbooks are designed to attract student interest and enable independent comprehension of material, even without teacher explanations. The use of flipbooks positively influences both student learning interest and outcomes.

Based on the challenges outlined above, achieving effective learning outcomes requires innovations in teaching and learning processes. This study aims to investigate the functionality and effectiveness of flipbook-based e-modules in enhancing mastery of welding symbols in the Basic Welding and Metal Fabrication subject at SMK. Additionally, this study evaluates improvements in student mastery of welding symbols through the use of flipbook-based e-modules.

RESEARCH METHOD

The instructional development model applied in this study is the ADDIE model. The ADDIE model is an instructional design approach centered on individual learning, using simple and systematic steps for developing educational materials. According to Yuni Kartika et al. in 2022, the ADDIE model is designed in a structured manner with a systematic sequence of activities to address issues related to learning resources that align with the needs and characteristics of the learning process. The ADDIE development model consists of five stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation.

The subjects of this study were Grade 10 students in the Welding and Metal Fabrication Technology (WMFT) Department at SMK N 1 Adiwerna Tegal, comprising two classes: WMFT 1 and WMFT 2, with a total of 72 students. Class WMFT 2, consisting of 36 students, was designated as the control group, while class WMFT 1, with 36 students, was assigned as the experimental group. The sampling technique used was Simple Random Sampling, which involves selecting samples randomly from the population without considering existing strata, ensuring that every member of the population has an equal chance of being selected as a sample.

The data collected in this study included evaluations by material experts and media experts, student responses, and trial results. According to Ardiansyah et al. in 2023, data collection instruments are tools selected and used by researchers to facilitate systematic and efficient data collection.

RESULTS AND DISCUSSION

Following data analysis, the study describes the development and evaluation of a flipbook-based e-module to enhance mastery of welding symbols in the Basic Welding and Metal Fabrication subject. Based on the material expert validation, the total score achieved was 193 from five experts, with an average of 96%, classified as "very feasible." Meanwhile, the media expert validation achieved a total score of 186 from five experts, with an average of 93%, also classified as "very feasible." Thus, the evaluations from both material and media experts indicate that the flipbook-based e-module is highly feasible for use in terms of both content and media design.

Table 1. Results of Material and Media Expert Feasibility Analysis

Material Experts	Score	Media Experts	Score
Rater 1	39	Rater 1	37
Rater 2	38	Rater 2	36
Rater 3	39	Rater 3	38
Rater 4	39	Rater 4	38
Rater 5	38	Rater 5	37
Total Score	193	Total Score	186
Maximum Score	200	Maximum Score	200
Percentage	96%	Percentage	93%
Category	Very Feasible	Category	Very Feasible

The functionality of the flipbook-based e-module was assessed through three parameters: observation results, student and teacher responses, and trial evaluations. Observations conducted by two observers demonstrated that the e-module is effective, with a score of 89.6%; efficient, with a score of 87.5%; and highly practical, with a score of 91.6%. These results confirm that the flipbook-based e-module is effective, efficient, and practical for teaching welding symbol mastery. Additionally, the implementation trial results analyzed using the percentage of agreement (PA) method indicated an average implementation score of 85% over three sessions, classified as "excellent."

Table 2. Teacher and Student Response Evaluation Results

Respondent	Number of Respondents	Assessment Items			Total	Maximum Score	%
		1	2	3			
Teachers	5	18	16	16	50	60	83
Students	36	138	132	128	398	432	91

Based on the questionnaire results shown in Table 2, the average teacher response to the flipbook-based e-module was 83%, indicating that the media functions well according to their perspective. Meanwhile, the average student response reached 91%, also indicating that the media performs effectively in the experimental class. Overall, the combined average response from teachers and students was 87.5%, suggesting that the flipbook-based e-module is well-functioning and effective.

Furthermore, pretest and posttest assessments were conducted among Grade 10 Welding and Metal Fabrication Technology (WMFT) students at SMK N 1 Adiwerna Tegal, consisting of 36 students in the control group and 36 students in the experimental group. Pretest results for both groups underwent normality, homogeneity, and t-tests, which concluded that the initial abilities of the experimental and control groups were similar. This indicates that both groups had comparable prior knowledge before the implementation of the flipbook-based e-module.

Posttest results for the control and experimental groups yielded normality test values of 0.090 and 0.168, respectively. As the Asymp Sig. (2-tailed) values were greater than 0.05, the data distribution for both pretest groups was normal. The homogeneity test produced a significance value of 0.370, which is greater than 0.05, confirming that the data were homogeneous. Independent sample t-tests on posttest scores indicated a t-value greater than the t-table value (8.837 > 1.994) and a significance level (Sig. 2-tailed) of 0.000, which is less than 0.05. These results reveal a significant difference in posttest performance between the experimental and control groups.

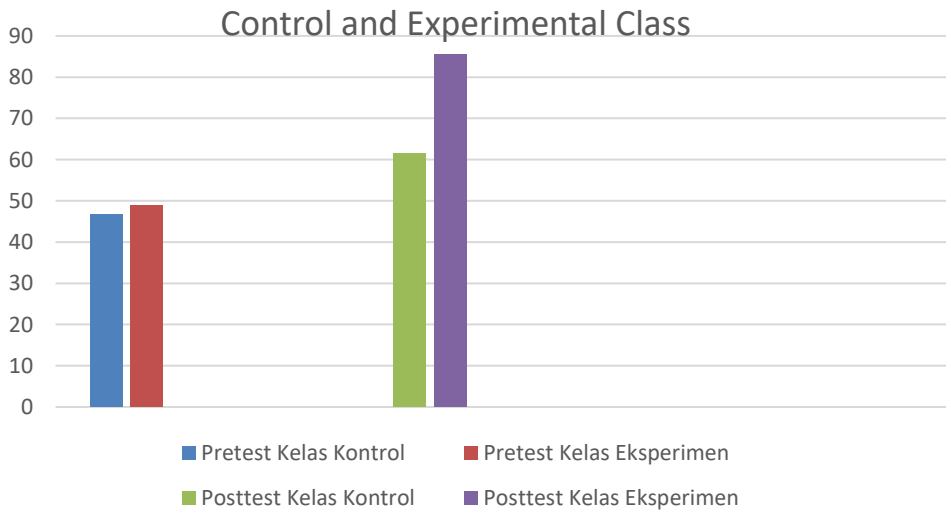

Figure 1. Learning Outcomes Diagram for Control and Experimental Classes

The results, illustrated in the diagram above, show differences in improvement between the control and experimental groups. In the control group, the pretest score was 46.54, while the experimental group achieved a pretest score of 48.83, confirming no initial differences between the groups. Posttest results for the control group reached 61.47, while the experimental group achieved 85.53. The improvement in learning outcomes for the control group was 14.93 or

32.08%, indicating progress in welding symbol mastery using conventional teaching methods. In contrast, the experimental group achieved an improvement of 36.7 or 75.14%, demonstrating a significant increase in welding symbol mastery through the use of the flipbook-based e-module.

Based on the N-gain test results, the mean score was 0.70167 or 70.21%, categorized as "high." The N-gain values ranged from a minimum of 18% to a maximum of 94%. The interpretation of these high N-gain results suggests that the use of the flipbook-based e-module effectively supports student mastery of welding symbols in the Basic Welding and Metal Fabrication subject. This indicates a positive impact on student learning outcomes and mastery of the material.

DISCUSSION

The flipbook-based e-module developed in this study aims to enhance students mastery of welding symbols in Grade 10 Welding and Metal Fabrication Technology (WMFT). The development process followed the ADDIE model, which consists of five stages: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation (Muljo et al., 2024: 118). The analysis stage involved identifying the needs and characteristics of the e-module, as well as conducting a curriculum and technology analysis. Observations revealed issues in the Basic Welding and Metal Fabrication subject, including low interest in learning materials, limited use of technology by teachers, and the need for self-directed learning media for students. The design stage included creating the e-module framework and selecting references, focusing on an attractive layout to boost students enthusiasm, particularly through the use of technology like smartphones. The attractive design was expected to support better mastery of welding symbols.

The e-module offers significant advantages, primarily its practicality and portability. With advancements in technology, particularly smartphones, students can access learning materials anytime and anywhere. This aligns with the characteristics of the millennial generation, who prefer technology over conventional textbooks. The flipbook-based e-module also provides an interactive and engaging learning experience, improving both motivation and mastery of the subject matter (Maulina & Shofiyah, 2021: 243).

Consistent with prior studies, Ulfah et al. (2024: 40) found that the use of technology in education enhances both effectiveness and efficiency, particularly in capturing students attention. Similarly, Ayuardini (2023: 270) reported that digital media, such as flipbook-based e-modules, improves learning outcomes and supports independent learning. Therefore, the development of this flipbook-based e-module is an appropriate solution to address the challenges in teaching welding symbols in Grade 10 WMFT. Feedback and evaluation from its implementation are expected to serve as a foundation for future improvements in instructional quality.

The flipbook-based e-module underwent a validation process to determine its feasibility before being tested with students. Validation involved several validators, including material and media experts. Results from five material experts showed an average score of 96%, classified as very feasible. Similarly, the average score from five media experts was 93%, also classified as very feasible.

Hermawan et al. (2024: 42) stated that validation aims to evaluate the extent to which a product meets feasibility standards. Research by Febriana et al. (2024: 445) found that e-modules developed using Flipbuilder achieved an average validity of 97%. Waidah & Sawitri (2020: 109) also noted that the feasibility of electronic modules received high evaluations, with percentages of 84% from media experts and 90.69% from material experts, classifying them as very feasible.

Observers assessed the effectiveness, efficiency, practicality, and implementation of the flipbook-based e-module over three sessions. The results indicated an average effectiveness score of 89.6% (effective), efficiency score of 87.5% (efficient), practicality score of 91.6% (very practical), and implementation score of 90%, proving that the flipbook-based e-module was implemented very successfully. Observational analysis highlighted that the e-module significantly improved students understanding

and engagement. The e-module was deemed efficient, yielding good results while optimizing time and resources. Furthermore, its practicality demonstrated ease of application in daily learning, facilitating both teachers and students in the teaching-learning process.

These findings are consistent with previous studies showing that flipbook-based e-modules are valid, practical, and effective. Research by Erniwati et al. (2022: 69) revealed that flipbook-based e-modules increase students motivation and learning outcomes, receiving high practicality ratings and positive responses from both teachers and students. Similarly, Nisa et al. (2023: 18) explained that e-modules not only enhance student engagement but also improve efficiency in the learning process.

Febrianty et al. (2023: 22) reported an implementation score of 84.6% for project-based e-modules in digestive system topics, which was classified as highly implemented. This demonstrates that flipbook-based e-modules show a high level of implementation and support their effective use in learning. The use of technology in the form of e-modules enhances the quality of education and provides students with a more interactive learning experience.

The module trial showed a positive impact on learning outcomes, as demonstrated through the t-test and learning completeness using the N-gain test. Normality and homogeneity tests conducted prior to analysis confirmed that the data were normally distributed and homogeneous. The pretest t-test results showed no significant difference between the experimental and control groups (t-value = 0.695; t-table = 1.994; Sig. = 0.489). However, the posttest results indicated a significant difference (t-value = 8.837; t-table = 1.994; Sig. = 0.00), suggesting that the flipbook-based e-module significantly improved students mastery of welding symbols.

The improvement in learning outcomes was 32.08% for the control group and 75.14% for the experimental group. The N-gain test results showed an average score of 0.70167 (70.21%), classified as high. The N-gain values ranged from 18% to 94%, indicating good learning completeness when using the flipbook-based e-module.

Overall, the development of the flipbook-based e-module proved to be highly effective in meeting students needs for mastering welding symbols. This conclusion is supported by observations, feedback from teachers and students, and trial results showing a positive impact on learning outcomes. A response rate of 87.5% in the good category, t-value = 8.837 > t-table = 1.994, and Sig. = 0.00 < 5% confirm a significant improvement in welding symbol mastery using the flipbook-based e-module, with an average learning completeness score of 0.70167, classified as high.

CONCLUSION

Based on the analysis of this thesis research, the following conclusions can be drawn:

1. The development of a flipbook-based e-module to enhance mastery of welding symbols in the Basic Welding and Metal Fabrication subject at vocational high schools was conducted using the Research and Development (R&D) method with the ADDIE development model. During this study, challenges were encountered at each stage of development, but these challenges were successfully addressed. The evaluation by media experts resulted in a score of 93%, categorized as "very feasible." Meanwhile, the evaluation by material experts yielded a score of 96%, also categorized as "very feasible." Thus, the flipbook-based e-module can be classified as highly feasible for use in the learning process.
2. The developed flipbook-based e-module has been proven to function effectively, as evidenced by observation parameters, feedback from teachers and students, and trial results showing a positive impact on learning outcomes. With an overall feedback score of 87.5% in the "good" category, t-value = 8.837 > t-table = 1.994, and Sig. = 0.00 < 5%, the e-module significantly improved mastery of welding symbols. Additionally, the average learning completeness score of 0.70167 is categorized as "high."

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