

Development of Electronic Modules in the Subject of Milling Machining Techniques Class XII Vocational High School in Magelang

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ABSTRACT: This study aims to: (1) Testing the feasibility of electronic modules in class XII milling technique learning; (2) Evaluating user responses to electronic modules in class XII milling technique learning; (3) Analyzing the effect of electronic modules on student learning achievement in class XII milling technique. This research uses the ADDIE development model with stages: (1) Analysis, (2) Planning, (3) Development, (4) Implementation, and (5) Evaluation. The research subjects included one material expert validator, one media expert validator, one teacher of Vocational High School Magelang, one teacher of Vocational High School Windusari, 40 students of class XII of machining engineering of Vocational High School Magelang and 40 students of class XII of machining engineering of Vocational High School Windusari. Internal trials were conducted through the validation of material experts and media experts, while external trials were conducted by testing student and teacher responses to electronic modules. Data were obtained from questionnaires, observations, and interviews, then analyzed descriptively qualitative and quantitative. The results showed that: (1) The electronic module of milling technique is very feasible with the percentage of material expert assessment 96.36%, media expert 93.33%; (2) Teacher and student responses to the module are feasible to use with the percentage of Vocational High School Magelang teachers 81.82%, Vocational High School Windusari teachers 93.64% and students 79.1%; (3) The use of the module improved the learning outcomes of students of Vocational High School Magelang by 19.15% and Vocational High School Windusari by 30.30%; (4) The results of the effectiveness test with the *Indepindeint T Teist* showed a significance value of 0.000 at Vocational High School Magelang and a significance value of 0.024 at Vocational High School Windusari, this shows that there is a significant difference ($p < 0.05$). The conclusion of the research is that the electronic module of milling technique is very feasible and effective to use in learning Frais technique.

KEYWORDS: ADDIE, Electronic Module, Framing Technique

I. INTRODUCTION

Education is a conscious and planned effort to create a learning atmosphere that allows students to develop their potential in spiritual aspects, personality, intelligence, noble character, and skills needed by society and the state (National Education System Law No. 20 of 2003). Education can be carried out formally and non-formally, where formal education includes basic, secondary and higher education, while non-formal education is a structured and tiered education path outside formal education (Government Regulation No. 17 of 2010).

One form of formal education in Indonesia is Vocational High School, which aims to prepare students to become productive, independent, and professional workers in accordance with their chosen competencies (Law No. 20 Year 2003). Mechanical engineering study programs in Vocational High School teach various competencies, including milling machining techniques. Based on Perdirjen Dikdasmen No. 464/D. D5/KR/2018, there are 22 basic competencies that students must master in milling machining techniques, which include understanding machines, analyzing rotational speed and cutting tools, and applying defraving procedures.

However, learning milling machine techniques has not yet achieved the expected competencies due to several obstacles, such as the ratio of milling machines that are not balanced with the number of students, ineffective learning methods, and limited practical time allocations. Teachers still use the lecture method and evaluation with multiple choice questions, while students are often not active and independent in learning.

The insufficient availability of milling machines hampers the learning process. Data shows that the ratio of milling machines in several VOCATIONAL HIGH School in Magelang is not ideal, with one machine being used by several students. This reduces sufficient practice time for each student, which has an impact on less-than-optimal understanding of the material. Practical tools must be available in sufficient quantities so that each student has an adequate opportunity to use the tool, in the book "Modern Instructional Design: A Guide for Education and Training Practitioners" by Suparman, M. A. (2014), the ideal

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ratio for the availability of practical tools is 1 tool for every 2-3 students to ensure each student has adequate opportunities to learn and practice.

Teachers at Vocational High School Magelang want learning media that can help understand the mathematical calculation of straight and bevel gears and increase students' learning independence. E-modules as electronic learning media are expected to answer this need, by providing more flexible access to learning and motivating students to learn independently.

The development of e-modules in the form of android applications, it is hoped that the learning process of milling machining techniques can be more effective, and the sub-competencies of making straight and oblique gears can be mastered by all students. This e-module will assist teachers in delivering material, so that students can learn and practice anytime and anywhere.

II. RESEARCH METHODS

This *research* method is *research and development (R&D)* with the ADDIE development model approach with stages: (1) Analysis, (2) Planning, (3) Development, (4) Implementation, and (5) Evaluation. The research was conducted at Vocational High School Magelang, especially in class XII students of Mechanical Engineering expertise concentration including students of class XII MA and XII MB and at Vocational High School Windusari class XII TP 1 and XII TP 2. The research time is from January 2024 to March 2024.

The research subjects included one material expert validator, one media expert validator, one teacher at Vocational High School Magelang, one teacher at Vocational High School Windusari, 40 students of class XII Machining Engineering Vocational High School Magelang and 40 students of class XII Machining Engineering Vocational High School Windusari. Internal trials were conducted through the validation of material experts and media experts, while external trials were conducted by testing student and teacher responses to electronic modules. Data were obtained from questionnaires, observations, and interviews, then analyzed descriptively qualitative and quantitative.

Data processing from the results of the study using quantitative descriptive, that is, analyzing quantitative data obtained from questionnaires / answers in the form of scores (numbers) and interpreted in sentences that are qualitative based on the assessment scale used. The data analysis method in this study used a *pre-test* and *post-test* approach with an experimental control design. Data were analyzed using various statistical techniques, including *univariate analysis* to describe the characteristics of separate variables, classical assumption tests such as Normality Test with *Shapiro-Wilk*, and Homogeneity Test of variance with *Levene's Test*. Furthermore, to compare the results between the control and experimental groups, the *Independent Sample T-Test* was used.

III. RESULTS AND DISCUSSION

Feasibility of Electronic Module Teaching Materials for Straight and Inclined Gear Materials in Grasp Machining Engineering Subjects

As a result of the evaluation, the electronic module received consistently high ratings in each aspect. For example, in the *Self Instruction* aspect, the module received an average score of 4.83 with an achievement percentage of 96.67%, indicating good and adequate instruction. Meanwhile, the *Stand Alone*, *Adaptive* and *User Friendly* aspects where the electronic module scored a maximum of 5 in all assessments, demonstrating the module's ability to stand alone and adapt to user needs optimally. Overall, with a total overall score of 106, an average score of 4.82, and an achievement percentage of 96.36%, the module is highly suitable for use in the context of education and training in mechanical engineering. This in-depth evaluation provides confidence that this electronic module not only meets technical standards and criteria, but is also able to provide effective and representative support for its use.

Table 1. Material Expert Validation Test Results

No.	Aspects	Frequency					Total	Average	Percentage	Description
		1	2	3	4	5				
1	Self Instruction	0	0	0	2	10	58	4.83	96.67%	Very Feasible
2	Self Contained	0	0	0	2	0	8	4.00	80.00%	Worth
3	Stand Alone	0	0	0	0	2	10	5.00	100.00%	Very Feasible
4	Adaptive	0	0	0	0	3	15	5.00	100.00%	Very Feasible
5	User Friendly	0	0	0	0	3	15	5.00	100.00%	Very Feasible
	Overall	0	0	0	4	18	106	4.82	96.36%	Very Feasible

Source: SPSS Data Processing (2024)

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Table 1 shows that the electronic module received very high ratings from the subject matter experts, with a total overall score of 106, an average of 4.82, and an achievement percentage of 96.36%, indicating that the module is generally considered "Very Appropriate" for use.

The results of the media expert validation showed that the learning media had a score of 93.33% in the very feasible category. Based on the verbal aspect, the electronic module is considered to have clear, concise, and consistent text, uses appropriate language, correct grammar, and complete information and is easily understood by users from various backgrounds. The module achieved a total score of 23 with an average of 4.60, indicating a percentage achievement of 92.00% which indicates a quality of "Very Feasible". The visual aspects of the e-module were evaluated for an attractive and professional design, with a neat layout, use of colors, fonts, and graphics that support the content without distracting the user's focus. The module achieved a total score of 70 with an average of 4.67, reaching a percentage of 93.33% and rated "Highly Feasible". On the programming aspect, the module was assessed based on its interactive features and functionality, such as buttons, hyperlinks, quizzes, and simulations that function properly and without bugs. The electronic module recorded a total score of 19 with an average of 4.75, achieving a percentage of 95.00% and also categorized as "Very Feasible". Overall, the results of this evaluation show that the e-module has met or even exceeded high quality standards in verbal, visual, and programming aspects. The electronic module is ready to be used in the context of education and training in mechanical engineering, providing an effective and supportive learning experience for its users.

Table 2: Media Expert Validation Test Results

No.	Aspects	Frequency					Total	Average	Percentage	Description
		1	2	3	4	5				
1	Verbal	0	0	0	2	3	23	4.60	92.00%	Very Feasible
2	Visual	0	0	0	5	10	70	4.67	93.33%	Very Feasible
3	Programming	0	0	0	1	3	19	4.75	95.00%	Very Feasible
	Overall	0	0	0	8	16	112	4.67	93.33%	Very Feasible

Source: SPSS Data Processing (2024)

The results of the feasibility study from the teachers also indicate that in terms of feasibility, the electronic module teaching materials that are balanced have a very high feasibility with a feasibility score of 81.82% from teachers at Vocational High School Mageilang and a score of 93.64% from teachers at Vocational High School Winduisari. Based on the quality aspect of the material, the electronic module is considered very suitable for learning competencies, with clear explanations and structured steps to facilitate student understanding. Vocational High School Magelang teachers gave an average rating of 4.11 or 82.22%, while Vocational High School Windusari teachers gave an average rating of 4.67 or 93.33%, both of which were included in the "Very Appropriate" category. The media display format aspect was also evaluated for attractive and well-organized visual design, using graphs, diagrams, and animations that support the understanding of concepts and technical processes. Vocational High School 1 Magelang teachers gave an average rating of 4.00 or 80.00%, while Vocational High School Windusari teachers gave an average rating of 4.89 or 97.78%, indicating a higher preference from Vocational High School Windusari teachers towards the visual aspects of the module. The use of language in the module was rated as very clear and appropriate, with an average score of 4.25 or 85.00% from both teachers. Overall, the electronic module received positive evaluations from the subject teachers, with an overall average score of 4.09 or 81.82% from Vocational High School Magelang and 4.68 or 93.64% from Vocational High School Windusari, all of which were categorized as "Very Appropriate". These evaluations indicate that the module has successfully met or exceeded expectations in terms of material quality, media display format, and language use, with minor differences in perception between the two teachers in certain aspects.

Table 3. Feasibility Test Results by Subject Teachers

Aspects	Teacher At Vocational High School Magelang			Teacher At Vocational High School Windusari		
	Average	Percentage	Category	Average	Percentage	Category
Material Quality	4.11	82.22%	Very Feasible	4.67	93.33%	Very Feasible
Media Display Format	4.00	80.00%	Worth	4.89	97.78%	Very Feasible
Language Usage	4.25	85.00%	Very Feasible	4.25	85.00%	Very Feasible
Overall	4.09	81.82%	Very Feasible	4.68	93.64%	Very Feasible

Source: SPSS Data Processing (2024)

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User Response to Electronic Module Teaching Materials for Straight and Beveled Gear Materials in Grasp Machining Engineering Subjects

The large group trial involving 80 students from VOCATIONAL HIGH SCHOOL Magelang and Vocational High School Windusari allowed researchers to gain a broader and more representative view of the effectiveness of the electronic module.

Table 4. User response to the Electronic Module of Grasp Machining Technique

No.	Assessment Aspect	Average	Percentage	Category
1	Presentation of Material	4.00	80.1%	Worth
2	Media Display	3.92	78.4%	Worth
3	Benefits of Using Electronic Modules	3.93	78.5%	Worth
	Overall	3.95	79.1%	Worth

Source: SPSS Data Processing (2024)

Table 4 displays the results of the feasibility test of the electronic module on a large group scale, where the evaluation was carried out on three main aspects: Presentation of Materials, Media Display, and Benefits of Using the Electronic Module. Presentation of Material obtained an average score of 4.00 or about 80.1% percentage, which puts it in the "Appropriate" category. This shows that the majority of participants in the large group considered the presentation of the material in the module to be quite good and in accordance with the learning needs. The second aspect, Media Display, obtained an average score of 3.92 or about 78.4% percentage, also categorized as "Feasible". This indicates that there is a slight decrease from expectations in terms of visual design and graphic presentation in the module, but it is still considered sufficient to meet the eligibility standards. The Benefits of Using the Electronic Module received an average score of 3.93 or about 78.5% percentage, also categorized as "Feasible". This indicates that participants in the large group saw sufficient benefits from using the module in supporting their learning process, although there are areas that may need to be improved to increase its effectiveness.

The Effect of Using Electronic Modules on Student Learning Achievement in Class Xii Frais Technique Learning Outcomes

Based on the results of the effectiveness test of the electronic module in the learning of Frais Machining Technique, this study shows that the use of the electronic module of Frais Machining Technique is effective in improving student learning outcomes at Vocational High School Magelang and Vocational High School Windusari. Statistical tests using the *pretest-posttest control group design* approach with *Independent Sample T-Test* analysis showed a significant difference between the control group and the experimental group.

Table 5. Descriptive Analysis Results

	Vocational High School Magelang				Vocational High School Windusari			
	Control		Experiment		Control		Experiment	
	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test
Average	62.64	67.84	66.40	79.12	57.36	75.52	60.24	78.48
Standard Deviation	6.80	5.47	8.70	3.37	10.78	4.09	9.68	4.84
Minimum	46.00	52.00	50.00	72.00	44.00	70.00	42.00	70.00
Maximum	80.00	80.00	80.00	86.00	78.00	86.00	76.00	86.00
Mode	58.00	70.00	64.00	80.00	44.00	74.00	46.00	76.00
Median	62.00	68.00	64.00	80.00	56.00	74.00	60.00	80.00

Source: SPSS Data Processing (2024)

Table 5 presents the results of univariate analysis of pre-test and post-test data from two groups of students, namely the control and experimental groups at Vocational High School Magelang and Vocational High School Windusari. In Vocational High School 1 Magelang, the control group had an average pre-test score of 62.64 and post-test score of 67.84, with an increase in the median from 62.00 to 68.00. The experimental group showed a more significant increase, with an average pre-test score of

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66.40 and post-test of 79.12, and a median from 64.00 to 80.00. At Vocational High School Windusari, the control group had an average pre-test score of 57.36 and post-test of 75.52, with the median increasing from 56.00 to 74.00. The experimental group also showed a significant increase, with an average pre-test score of 60.24 and post-test of 78.48, and a median from 60.00 to 80.00. Overall, the analysis showed that the experimental group in both schools experienced a more significant increase in post-test scores compared to the control group, indicating that the electronic module used was effective in improving student learning outcomes.

The Shapiro-Wilk normality test results show that all research variables are normally distributed, allowing the use of parametric tests. The *Levene homogeneity* test shows that the variance of the research data is homogeneous, supporting the validity of using the *Independent Sample T-Test* test. The selection of the *Shapiro-Wilk* method as a normality testing method is based on the argument put forward by Dahlan (2010: 48) which explains that if the sample size is less than 50 then the *Shapiro-Wilk* method is more recommended than *Kolmogorov Smirnov*. The results of the *Shapiro Wilk* normality test can be seen in the following table:

Table 6. Normality Test Results

	Group	Statistic	Sig.	Description
Pre Test Vocational High School Magelang	Control	0.936	0.118	Normal
	Experiment	0.951	0.258	Normal
Post Test Vocational High School Magelang	Control	0.932	0.096	Normal
	Experiment	0.944	0.186	Normal
Pre Test Vocational High School Windusari	Control	0.930	0.085	Normal
	Experiment	0.949	0.238	Normal
Post Test Vocational High School Windusari	Control	0.931	0.090	Normal
	Experiment	0.943	0.178	Normal

Source: SPSS Data Processing (2024)

Homogeneity test is a process to determine the extent to which the variances of two or more groups of data or samples are similar or homogeneous. The assumption of homogeneity of variance is one of the important classical assumptions in parametric statistical analysis, especially in analysis of variance (ANOVA) and independent t test. The assumption of homogeneity of variance states that the variance of each data group is comparable or equal. In other words, all groups being compared have relatively uniform variances. If this assumption is not met, then the results of statistical analyses involving group comparisons, such as ANOVA or t-test, may be inaccurate.

Table 7. Homogeneity Test Results

	Levene Statistic	Sig.	Description
Pre Test Vocational High School Magelang	3.322	0.075	Homogeneous
Post Test Vocational High School Magelang	2.206	0.144	Homogeneous
Pre Test Vocational High School Windusari	0.947	0.335	Homogeneous
Post Test Vocational High School Windusari	1.218	0.275	Homogeneous

Source: SPSS Data Processing (2024)

The results of *Levene Statistic* homogeneity testing show that all research variables have homogeneous data because they have a significance value greater than 0.05. The research data is entirely homogeneous, indicating that the research data can be carried out with parametric *independent sample T Test* testing.

Table 8. Independent Sample T Test Results

School	Group	Average Value	Sig.	Description
Vocational High School Magelang	Control	67.84 ± 5.47	0.000	Significant
	Experiment	79.12 ± 3.37		
Vocational High School Windusari	Control	75.52 ± 4.09	0.024	Significant
	Experiment	78.48 ± 4.84		

Source: SPSS Data Processing (2024)

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The results testing the effectiveness of using electronic modules as learning media in the subject of Frais Machining Techniques at Vocational High School 1 Magelang using the *Independent Sample T Test* showed that there were significant differences ($p < 0.05$) between the control group and the experimental group. The control group is a group that does not get electronic module treatment has an average value that tends to be smaller (67.84 ± 5.47) compared to the group that gets electronic module treatment (79.12 ± 3.37). This indicates that the electronic module developed is effective for improving student learning outcomes in the lesson Frais Machining Technique at Vocational High School 1 Magelang.

The results of testing the effectiveness of using electronic modules as learning media in Frais Machining Engineering subjects at Vocational High School Windusari using the *Independent Sample T Test* test show that there are significant differences ($p < 0.05$) between the control group and the experimental group. The control group is a group that does not get electronic module treatment has an average value that tends to be smaller (75.52 ± 4.09) compared to the group that gets electronic module treatment (78.48 ± 4.84). This indicates that the electronic module developed is effective for improving student learning outcomes in Frais Machining Engineering lessons at Vocational High School Windusari.

IV. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the developed electronic module has a very high level of feasibility in supporting the learning of milling machining techniques in VOCATIONAL HIGH SCHOOL. The feasibility test results from the teaching teacher and expert validation show that this module is effective and in accordance with learning needs, with significant potential to improve student understanding and learning achievement. The assessment of material and media experts gave scores of 96.36% and 93.33% respectively, while the assessment of teaching teachers gave scores of 81.82% and 93.64%. In addition, this electronic module is not only considered feasible by students but also effective in improving their understanding and learning achievement. Student response to the module was very positive, with the large group feasibility test showing a score of 79.1%. The positive responses and good evaluation indicate that this module is able to support the learning of milling machining techniques well, providing an interactive, interesting, and useful learning experience for students. Univariate analysis of pretest and posttest data from two schools, namely VOCATIONAL HIGH SCHOOL 1 Magelang and VOCATIONAL HIGH SCHOOL Windusari, showed a significant increase in scores in the experimental group using electronic modules compared to the control group. Students of VOCATIONAL HIGH SCHOOL 1 Magelang in the experimental group experienced an increase in learning achievement of 19.15%, and students of VOCATIONAL HIGH SCHOOL Windusari experienced an increase of 30.30%. The results of testing effectiveness with the Independent Sample T-Test test showed a significance value of 0.000 at VOCATIONAL HIGH SCHOOL 1 Magelang and 0.024 at VOCATIONAL HIGH SCHOOL Windusari, showing a significant difference ($p < 0.05$). So that the development of electronic module of Framing Technique is proven to be effective and improve students' learning achievement.

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