Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No.3 September 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

THE APPLICATION OF E-MODULES TO IMPROVE THE LEARNING OUTCOMES OF PHASE F ON STUDENTS' KNOWLEDGE OF THE FUNCTION OF MILLING MACHINE PARTS.

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ARTICLE HISTORY
Received : 20-05-2026
Revised : 28-06-2026
Accepted : 10-07-2026

KEYWORDS
E-Module;
Learning Outcomes;
Knowledge;
Milling Machine;
Machining Engineering;

ABSTRACT
The low understanding of students in the Milling Machining Engineering competence regarding the function of milling machine parts is often caused by learning processes that are still dominated by conventional methods and less interactive print modules. This study aims to analyze the feasibility, improvement of learning outcomes, and effectiveness of implementing an interactive e-module compared to conventional lecture methods. This study is a quasi-experiment with a nonequivalent control group design. The subjects of this study were eleventh-grade Mechanical Engineering students at SMK Negeri 1 Semarang, divided into experimental and control groups. Data collection instruments included expert validation questionnaires and cognitive test instruments (pre-test and post-test). Based on the expert assessment, the developed e-module was declared highly feasible, valid, and reliable for instructional use. Furthermore, the effectiveness test through N-Gain proved that the experimental class using the e-module achieved a high-category increase in learning outcomes of 78.63%, significantly outperforming the control class. In conclusion, the application of this e-module serves as an effective learning innovation that successfully enhances students' cognitive achievement and provides a more interactive alternative for conceptual mastery in vocational machining education.

INTRODUCTION

Vocational education aims to prepare students to be ready to enter the world of work or continue to college by equipping them with relevant skills Cholik (2023.). In Vocational High Schools (SMK), especially the Machining Engineering Expertise Program, one of the core competencies that must be mastered is the milling machine. The understanding of the milling machine is not only theoretical, but also must be strong to be applied in direct practice, considering that the fresh machine is a very vital main tool in the production process of manufacturing components Hamid et al. (2025). Therefore, the mastery of cognitive theory regarding the function of machine components is the foundation for the safety and success of student practicum.

However, based on the data from observations at SMK Negeri 1 Semarang, a gap was found where many students experienced serious difficulties in understanding the function of each part of the milling machine. This is reinforced by the results of interviews with machining teachers who show that students are less able to identify machine parts during practicum activities. This problem is rooted in the theoretical learning process which is still dominated by lecture methods and static conventional print modules. This less interactive media makes the delivery of material monotonous, reduces student learning motivation, and leads to less than optimal absorption of information and low Learning Outcomes (CP) of student knowledge (Lukitasari et al., 2020).

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The phenomenon of low theoretical understanding of machining is also in line with various empirical findings in previous researches. For example, the research of Rahmadhani et al. (2021) showed that of the 30 students tested to start the milling machine, only 26.67% (8 students) were successful, while the other 73.33% (22 students) experienced operational failure. Likewise, the research of Setiyawan et al. (2023) found that out of 38 students, only 12 people were able to answer correctly about the calculation unit of the milling machine, while the other 26 people were not precise. These data are a strong signal that the update of learning media to improve basic knowledge of machining is at an urgent level.

The use of technology in the world of vocational education is actually growing rapidly to answer these challenges. Many previous researches, such as studies by Kismiati (2020), have proven that interactive-based digital learning media is very effective in helping students remember lessons and make the classroom atmosphere more lively. However, if you look at the trends of these various studies, the majority of researchers still focus on the product manufacturing stage (Research and Development). Their discussion flow usually stops after the product is completed, judged feasible by experts, and declared technically valid. Unfortunately, there is still very little research that goes further to test how the impact or effectiveness is when the digital product is actually implemented in classroom teaching and learning activities through experimental methods (Pratiwi et al., 2025).

The limitation of focus on previous studies is the main gap and novelty in this research. While other studies have more discussed how to model applications or electronic modules (e-modules) in general, this study takes a different step by focusing on testing how effective the use of e-modules is in the field using quasi-experiment methods. The focus of treatment in this study is also directed rigidly and specifically to the material on the analysis of the function of milling machine parts for grade XI (Phase F) students—a competency cluster that most often triggers practicum failures due to the limitations of still images in ordinary printed books.

Theoretically, efforts to optimize these competencies can be achieved through e-modules because of their characteristics that make it easier for students to learn material anytime and anywhere (Vikiyanto et al., 2023). E-modules provide flexible and independent access, as well as encourage knowledge engagement through engaging interactive multimedia content (Yudiono et al., 2019). The use of interactive e-modules has been proven to be able to significantly increase student enthusiasm and learning outcomes compared to print modules (Sidiq & Najuah, 2020). This is supported by research data by Afriansyah & Yanis (2021) regarding learning Lathe Practice using electronic modules on cutting parameter materials which obtained a very good student response score of 89.6%.

Based on all these problems and technological potential, the researcher applied an innovative learning tool in the form of an interactive e-module on the functional material of the milling machine at SMK Negeri 1 Semarang. This step is expected to provide significant added value in the teaching and learning process, both for educators and students. Through an experimental design that compares learning outcomes between experimental classes (using e-modules) and control classes (conventional lecture methods), this study aims to scientifically test the effectiveness of these e-modules in improving students' knowledge learning outcomes. Thus, the application of this media is expected to be able to be an effective solution that is interactive, objective, and oriented to the real needs of students in vocational schools.

METHODS

This study uses a quantitative approach with a quasi-experiment type. According to Sugiyono (2016), quasi-experiments are often referred to as pseudo-research, which is a type of research that has a control group but does not fully control external variables that have the potential to affect the implementation of experiments. The research design used in this study is a non-equivalent control group design. In this design, there are two research groups, namely the group that is given treatment (experimental class) using the application of e-modules, and the control group that uses conventional learning methods.

This research was carried out at SMK Negeri 1 Semarang, Central Java Province. The selection of location is based on the existence of a machining engineering expertise program that has infrastructure facilities that are relevant to the competence of milling machines. The research subjects are students of class XI Machining Engineering at SMK N 1 Semarang who are taking the subject of Mechanical Engineering in Phase F. The total population is 60 students who are distributed into two sample classes. The sample was selected using a purposive sampling technique based on existing intact classes (intact groups) to maintain the natural setting of the school environment, resulting in Class XI TP 3 as the experimental group and Class XI TP 1 as the control group. This group determination was carried out to ensure the internal and external validity of the experimental results (Maswar, 2017).

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The variables in this study use two types of variables, namely independent variables, namely the application of innovative teaching materials based on E-Module in the functional analysis material of milling machine parts. Meanwhile, the Bound Variable (Y) is the learning achievement of students' knowledge (cognitive aspect) in the competency material of analysis of various types of milling machine parts.

The learning process was conducted over 4 meetings for each group, with a duration of 4 x 45 minutes per meeting. The experimental group received treatment using the HTML-based interactive e-module, which was accessed by students through their respective devices. In this class, the e-module served as a self-directed learning tool integrated with high-resolution visual animations and structured cognitive exercises, allowing students to independently explore the functions of milling machine components before conducting discussions. Conversely, the control group was taught using conventional lecture methods supplemented by printed text modules, where the teacher dominated the material explanation using standard physical modules without interactive multimedia intervention.

The data collection techniques used in this study include tests, observations, and documentation. The main instrument used was a cognitive learning outcome test which was given through pre-test and post-test testing. In addition, the e-modules developed are validated by material experts and media experts to determine the feasibility level of learning media. To strengthen the methodological foundation of instrument development, several validation methods were applied based on specific statistical purposes: (1) Aiken's V was selected to evaluate the content validity of individual test items based on expert ratings because it effectively quantifies the level of agreement among raters for specific criteria. (2) Content Validity Ratio (CVR) and Content Validity Index (CVI) developed by Polit & Beck (2006) were utilized to assess the overall relevance and feasibility of the media and material items. CVR measures item-level essentiality, while CVI provides a robust aggregate index of the overall instrument validity. (3) Percentage Agreement and Intraclass Correlation Coefficient (ICC) were analyzed to determine the inter-rater reliability and consistency of assessment results between validators (Pamungkas & Khumaedi, 2021). The ICC was specifically chosen because it is highly reliable for measuring the degree of consistency and absolute agreement among multiple raters evaluating continuous scale data. These analyses ensure that the learning instruments and media met rigorous academic standards and are suitable for use in the research.

Data analysis in this study was carried out in two stages, namely pre-requisite data analysis and hypothesis data analysis. Pre-requisite data analysis includes normality tests and homogeneity tests to determine whether the data has met parametric statistical assumptions. The normality test was carried out using the Kolmogorov-Smirnov, while the homogeneity test used the levene test. Hypothesis testing was carried out using an independent sample t test to determine the difference in learning outcomes between the experimental class and the control class. In addition, the effectiveness of the use of e-modules was analyzed using N-Gain calculations to determine the improvement of students' learning outcomes after being given treatment. Gustati et al. (2025) states that the N-Gain results can be categorized into several levels, namely low, medium, and high. The results of the analysis were used to determine the effectiveness of the use of e-modules to improve students' learning outcomes of knowledge about the function of the parts of the milling machine.

RESULTS AND DISCUSSION

Validity and Reliability Test Results

Before being used for research, the research instrument was validated by 8 validators consisting of lecturers and teachers with expertise in machining techniques. The validation process is carried out on media assessment instruments, material assessment instruments, and question item quality assessment instruments.

CVR I-CVI and Approval Percentage Results

Table 1. Results of the Validity Test of Media Assessment Instruments

Indicator	CVR	I-CVI	Categories
1	0,75	1	Valid
2	0,75	0,875	Valid
3	0,75	1	Valid
4	0,75	1	Valid
5	0,75	0,875	Valid

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6	0,75	1	Valid
7	0,75	1	Valid
8	1	1	Valid
9	1	0,875	Valid
10	0,75	1	Valid

Source: SPSS Software (2022)

Based on the results of table 1, the results of the analysis show that all indicators in the media assessment instrument meet the valid criteria with a CVR value ranging from 0.75 to 1.00 and an I-CVI value ranging from 0.875 to 1. The results of the reliability test obtained a Percentage Agreement (PA) value of 90%, which indicates a very high level of agreement between validators. Thus, the media assessment instrument was declared valid and reliable for use in the research.

Table 2. Results of the Validity Test of the Material Assessment Instrument

Indicator	CVR	I-CVI	Categories
1	1	1	Valid
2	1	1	Valid
3	1	1	Valid
4	1	1	Valid
5	1	1	Valid
6	1	1	Valid
7	1	1	Valid
8	1	1	Valid
9	1	1	Valid
10	1	1	Valid
11	1	1	Valid
12	1	1	Valid
13	1	1	Valid
14	1	1	Valid
15	1	1	Valid

Source : SPSS Software (2022)

Based on Table 2, the results of the analysis show that all indicators in the material assessment meet the valid criteria with a CVR value ranging from 0.75 to 1.00 and an I-CVI value ranging from 0.875 to 1. The results of the reliability test obtained a percentage value of 100% agreement, which shows that the level of agreement between validators is in the very high category.

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Aiken's Validity and ICC Reliability

Table 3. Results of the Validity Test of Quality Assessment Instruments

Indicator	Aiken's V	Categories
1	0,94	Valid
Indicator	**Aiken's V**	**Categories**
2	0,78	Valid
3	0,83	Valid
4	0,89	Valid
5	0,89	Valid
6	0,83	Valid

Source : Microssoft Excel (2026)

Based on the calculations in table 3, all instruments have an Aiken's V value ≥ 0.75, therefore it can be concluded that the test instruments used in this study are declared valid and appropriate to measure student learning outcomes.

Table 4. Reliability Results of Quality Assessment Instrument Questions

Type of ICC	Value	Categories
Single Measures	0,728	Good
Averange Measures	0,842	Excellent

Source : Microssoft Excel (2026)

Based on the results of the analysis in Table 4, the value of Single Measures is 0.728 which is included in the category of good reliability, while the results of the ICC Averange Measures value of 0.842 which is included in the category of reliability are very good. Thus, the question quality assessment instrument was declared reliable and suitable for use for research.

Descriptive Analysis

Table 5. Pre-test Data Results

Classes	N	Minimum	Maximum	Mean	Std.Deviation
Control Class	30	30	75	49,33	11,351
Experimental Classes	30	40	65	54	8,030

Source : SPSS Software (2022)

Based on Table 5, the results of the descriptive analysis of pre-test data showed that the initial ability of students in the control class and the experimental class was relatively the same before being given the learning method treatment.

Table 6. Post-test data results

Classes	N	Minimum	Maximum	Mean	Std.Deviation
Control Class	30	65	80	70	4,472
Experimental Classes	30	80	95	90,17	4,822

Source : SPSS Software (2022)

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Based on Table 6, the results of descriptive analysis of post-test data showed that the average post-test score of the experimental class was higher than that of the control class

Normality Test

Table 7. Normality Test Data Results

Classes	Statistic	df	Sig.
Control Class Pre-test	0,149	30	0,089
Control Class Post-test	0,153	30	0,072
Pre-test Experimental Class	0,150	30	0,081
Post-test Class experiment	0,138	30	0,147

Source : SPSS Software (2022)

Based on the results of Table 7, that is, all significance values are more than 0.05 so that it can be stated that the pre-test and post-test data in both classes are distributed normally.

Homogeneity Test

Table 8. Homogeneity Test Data Results

		Levene Statistic	df1	df2	Sig.
Pre-test Class	Based on Mean	0,073	1	68	0,788
Post-test Classes	Based on Mean	0,125	1	58	0,727

Source : SPSS Software (2022)

Based on Table 8, the results of the homogeneity test are that both classes get a significance value greater than 0.05 (Sig. ≥ 0.05) so that it can be concluded that the data variance of the two classes is homogeneous.

Independent Sample T-Test

Table 9. Independent Sample T-Test Results

		Levene's Test for Equality of Variances		T-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Results	Equal variances assumed	0,011	0,917	-0,062	58	0,042
	Equal variances not assumed			-0,62	57,96	0,042

Source : SPSS Software (2022)

Based on Table 9, the significance value on the levane test is 0.917 which is greater than 0.05. The results of the t-test showed a significance value (2-tailed) of 0.042, the value was less than 0.05 so that it could be stated that Ho was rejected and Ha was accepted.

N-Gain Test

Table 10. N-Gain Test Results

Classes	Averange	Median	Variations	Std. Deviation	Minimum	Maximum	Distance

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Control Class	70	50,45	229,51	15,15	45,50	85,50	40
Experimental Classes	90,17	76,92	435,14	13,45	55,33	100	44,67

Source : SPSS Software (2022)

Based on Table 10, the N-Gain score in the control class is in the medium category, while the N-Gain score in the experimental class is in the high category. These results show that the use of e-modules can increase students' learning outcomes of knowledge about the functional material of fresh machine parts more effectively than using conventional learning methods.

DISCUSSION

E-Module Eligibility Based on Expert Validation

The results of the Validation show that the implementation of e-modules to improve students' learning outcomes has met the feasibility both from the media and material aspects. In the media assessment instrument, a CVR value of 0.75 to 1.00 was obtained and in the I-CVI value of 0.875 to 1.00 with a percentage of approval between validators of 90%. Then, the material assessment instrument received a CVR value of 1.00 and obtained a score of I-CVI 1 with a percentage of approval between validators of 100%.

The high validity value shows that the learning media in the form of e-modules has been developed in accordance with the objectives of the learning process and the competencies that must be achieved in the material of the function of the parts of the milling machine. Therefore, according to Lawshe (1975) the Content Validity Ratio (CVR) value is used to show the level of agreement among experts about the relevance of the assessed component. In addition, Polit & Beck (2006) stated that a high Content Validity Index (CVI) value can indicate that the content of the instrument has a good level of conformity with the level of thinking being measured.

Aiken's Validity and ICC Reliability

The results of the validity and reliability test using Aiken's validity coefficient showed values between 0.78 and 0.94 with an average value of 0.83. The results of the study showed that all question items met the criteria that could be declared valid and could represent the measured learning indicators. Aiken (1985), stated that the validity of content can be used to determine the extent to which an instrument is able to represent competencies that will be measured through expert assessments.

Reliability testing also shows good results. Using the Interclass Correlation Coefficient (ICC) a value with an average of 0.842 was obtained. According to Guo et al. (2020), ICC values that are included in the range of 0.75 to 0.90 are included in the category of good reliability by showing good assessment consistency between validators. Therefore, the testing of the instruments used in this study is able to produce reliable and consistent data to measure students' knowledge learning outcomes.

The Effectiveness of the Implementation of E-Modules to Improve Students' Learning Outcomes

The application of learning carried out using e-modules is able to help students to master the material easily regarding the function of the parts of the milling machine. This research is corroborated by the results of research by Badara et al. (2024) who stated that the results of the SPSS 21 paired t-test data analysis showed that the learning outcomes of students using e-modules were higher than students who used conventional modules. Just like Ayuningtyas et al. (2024) who stated that the learning process carried out using electronic-based modules can increase students' interest in being active in learning activities and improve their learning outcomes.

The application of modules using image, audio and video media has a positive impact on the experimental class by increasing students' ability to absorb the learning process so that students get more experience during the teaching and learning process and can also make students more interactive and focus on the learning process (Nur et al., 2021). Therefore, in the alternative research hypothesis, there is an increase in learning outcomes of knowledge of the function of fresh machine parts through the application of e-modules.

Improved Learning Outcomes Based on N-Gain Testing Analysis

The results of this study can be obtained after comparing the average value of post-test results between experimental classes that were given learning treatment using e-modules and control classes that were given learning using printed books or conventional modules. These results concluded that the increase in learning outcomes in the experimental class was higher than in the control class. This is evidenced by the percentage increase in learning outcomes

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in the experimental class in the high category, compared to the control class which only experienced an increase in learning outcomes in the medium category.

Based on the admission criteria, Sugiyono (2017) stated that the results of the N-Gain test showed a significant increase in the average score of post-test learning outcomes between the experimental class and the control class. This increase is in accordance with the results of research conducted by Logan et al. (2021) which stated that the increase in learning outcomes of students who use e-modules is higher than the learning outcomes of students who only use conventional modules.

CONCLUSION

The e-module function of fresh engine parts was declared suitable for use after the test results of the validation sheet data by 8 experts concluded that the e-module is valid and reliable. The test results showed the validity of the e-module with a CVR value of ≥ 0.75 and a CVI value of ≥ 0.78 while based on the opinion of experts, the e-module was declared feasible and reliable after obtaining an expert approval score of 90%. The application of learning using e-modules of the functions of fresh machine parts has been proven to improve students' learning outcomes. Based on the results of the N-Gain test using SPSS software, it showed that there was a significant increase in the average post-test learning outcomes between the experimental class and the control class.

Based on the results of the N-Gain test, the increase in learning outcomes in the experimental class was higher than that of the control class. This is evidenced by the percentage increase in learning outcomes in the experimental class of 78.63% with a high improvement category, compared to the control class which only experienced an increase in learning outcomes of 40.80% which was included in the medium category.

The use of e-modul in the subject of machining engineering has been proven to have a real impact in changing the way teachers teach and increasing the knowledge understanding of grade XI (Phase F) students in vocational schools. This research confirms that digital learning media that is designed in an interactive and innovative way is able to overcome weaknesses in teaching methods using conventional printed books, such as convoluted explanations and static images that confuse students. This e-module successfully helps learners imagine and understand the functions of complicated machine parts more easily. For vocational schools, this media offers an independent learning model that is very suitable for the character of the digital generation at this time, as well as being the right solution to teach work competency standards requested by the business world and the industrial world (DUDI).

Although it provides positive results, this study still has some limitations. The scope of the trial in this study is still limited to one specific material and is carried out in one school only. In addition, this study only measured learning outcomes shortly after the experiment was carried out and did not see the extent to which students could remember the material in the long term. The impact of the use of this media on direct practice skills (psychomotor aspects) in machine shops has also not been studied in depth. Therefore, the recommendation for the next research is to expand the test to several vocational schools that have more diverse student characteristics. The next researcher is also advised to look at the influence of e-modules on the non-cognitive aspects of students, such as the level of learning independence and critical thinking skills, and start developing more advanced technologies such as Augmented Reality (AR) so that the visualization of machine components looks more real in person.

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