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LEARNING USING E-MODULES TO IMPROVE LEARNING OUTCOMES TO UNDERSTAND TAPERED TURNING STUDENTS OF THE MACHINING ENGINEERING EXPERTISE PROGRAM CLASS XI SMKN 1 SEMARANG

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ABSTRACT
This study aimed to analyze the effect of using e-modules on students' learning outcomes in understanding tapered turning in the Machining Engineering Expertise Program at SMKN 1 Semarang. The study employed a quasi-experimental method with a nonequivalent control group design involving experimental and control classes. Data were collected through tests, observations, and documentation and analyzed using normality, homogeneity, independent sample t-test, and N-Gain analyses. The results indicated that the developed e-module met the validity and reliability criteria and was effective in improving students' learning outcomes. A significant difference was found between the experimental and control classes, with the experimental class showing a higher improvement in learning outcomes. These findings demonstrate that the e-module can serve as an effective digital learning medium to support the teaching and learning process in vocational education, particularly in tapered turning material.

INTRODUCTION

Vocational education has an important role in preparing competent human resources in accordance with industrial needs. In the era of digital technology development and the Industrial Revolution 4.0, vocational education is required to integrate innovative learning technologies so that students possess technical skills, critical thinking skills, and adaptability to modern industrial developments. Rosyidin et al., (2023) explained that vocational education should be able to produce graduates who have competencies according to industry needs. In addition, Ardana, (2023) stating that learning in vocational education needs to be supported by digital learning media so that the learning process becomes more effective and relevant to technological developments. Therefore, the use of digital-based learning media is one of the solutions that can support improving the quality of learning in vocational schools.

In the Machining Engineering expertise program, one of the basic competencies that students must master is tapering turning. This competency requires an understanding of tapered geometry concepts, angle calculations, and the accuracy of work procedures in the turning process. However, learning process on tapered turning material still predominantly uses conventional methods, such as lectures, live demonstrations, and printed modules. (Hamdi et al., 2022) stated that conventional learning makes students less active and causes difficulties in understanding machining work procedures optimally. In addition, Fatriyanto et al., (2024) explained that the limited use of visual learning media in learning machining techniques cause low motivation and student learning outcomes. Consequently, students often

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experience difficulties in understanding both the concepts and procedural steps comprehensively, particularly in materials requiring work-process visualization, such as tapered turning.

Learning media play an important role in helping students understand learning materials, particularly in vocational practical learning. (Arsyad, 2017) explained that learning media are tools used to deliver learning messages that can stimulate students' attention, interest, and understanding. One of the digital learning media currently developing in vocational education is the electronic module (e-module). E-modules are digital teaching materials systematically arranged and integrated with multimedia elements such as text, images, videos, animations, and interactive exercises. The integration of these multimedia components enables students to learn independently and flexibly while facilitating a better understanding of learning materials through attractive visualizations.

Several previous studies have shown that e-modules can improve learning effectiveness and students' learning outcomes in vocational education. (Hamdi et al., 2022) stated that e-modules in lathe machining techniques are highly feasible as learning media because they help students understand work procedures systematically. (Ardana, 2023) found that the use of electronic modules in lathe machining learning improved students' motivation and learning outcomes. Similarly, Fatriyanto et al., (2024) reported that the implementation of e-modules in lathe machining subjects resulted in higher learning outcomes compared with conventional learning. These findings indicate that e-modules have considerable potential to support machining learning in vocational schools.

However, previous studies have mainly focused on machining learning in general and have not specifically examined the implementation of e-modules for tapered turning competencies, which require more specific procedural and conceptual understanding. (Radhitya et al., 2025) explained that competency-specific learning media are more effective in improving students' procedural understanding. Furthermore, In addition, Mayer, (2001) through *the Cognitive Theory of Multimedia Learning*, emphasized that integrating text, images, and multimedia visualizations can enhance students' conceptual understanding. Therefore, this study offers novelty by developing and implementing an e-module specifically designed for tapered turning material for Grade XI students in the Machining Engineering Expertise Program at SMKN 1 Semarang.

Based on the aforementioned background, this study aimed to analyze the effect of e-module implementation on students' learning outcomes in understanding tapered turning among Grade XI students of the Machining Engineering Expertise Program at SMKN 1 Semarang. The findings of this study are expected to contribute to the development of digital learning media in vocational education, particularly in machining learning.

METHOD

This study adopted a quantitative approach using a quasi-experimental method to examine the effect of e-module implementation on students' learning outcomes in tapered turning material. (Scott, 2007) stated that experimental research aims to determine the influence of a treatment on other variables under controlled conditions. The study employed a nonequivalent control group design involving two groups, namely an experimental class and a control class. The experimental class was taught using e-modules, whereas the control class received conventional instruction. Both groups were given a pretest and a posttest to assess students' initial and final learning abilities following the treatment.

The research was conducted during the even semester of the 2025/2026 academic year at SMKN 1 Semarang in the Machining Engineering Expertise Program. The research population consisted of students from class XI TP 1 and class XI TP 3. The sampling technique used was purposive sampling because the researcher selected classes with relatively similar academic characteristics and learning conditions. Class XI TP 1, consisting of 36 students, was assigned as the experimental class, whereas Class XI TP 3, consisting of 35 students, was assigned as the control class.

The variables in this study consisted of independent and dependent variables. The independent variable was the use of e-modules in tapered turning learning, whereas the dependent variable was students' learning outcomes in tapered turning material. The control variables included learning objectives, learning materials, instructional time, teacher, and evaluation instruments used in both classes. The learning treatment was implemented in four meetings, each lasting 45 minutes. The learning activities covered concepts of tapered turning, taper angle calculations, workpiece setting, and procedures for producing tapered workpieces using a lathe machine.

The data collection techniques used in this study included tests, observations, and documentation. The primary instrument was a cognitive learning outcomes test administered through pretest and posttest. In addition, the developed e-module was validated by material experts and media experts to determine its feasibility. The e-module was developed using Microsoft PowerPoint and Canva and was presented in digital format. It contained learning materials, illustrations, instructional videos, animations, practice exercises, and evaluation questions related to tapered turning material. Media validity was analyzed using the Content Validity Index (CVI) developed by (Polit & Beck, 2006). The validation process

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involved eight validators consisting of vocational school teachers and university lecturers with expertise in learning media, instructional materials, and assessment instruments. These validators assessed the relevance, clarity, presentation, and suitability of the e-module content. Meanwhile, the reliability of the assessment was analyzed using Percentage Agreement and Intraclass Correlation Coefficient (ICC) to determine the consistency level among validators (Fitriyanto et al., 2019; Khumaedi, 2012). Validity and reliability analyses were conducted to ensure that the learning instruments and media met academic standards and were appropriate for use in this study.

Data analysis was conducted in two stages, namely prerequisite testing and hypothesis testing. The prerequisite tests consisted of normality and homogeneity tests to examine whether the data satisfied the assumptions required for parametric statistics. The normality test was performed using the Shapiro-Wilk test, while the homogeneity test was carried out using Levene's Test. Furthermore, hypothesis testing was conducted using an independent sample t-test to identify differences in learning outcomes between the experimental and control classes. The effectiveness of the e-module was also evaluated through N-Gain analysis to measure the improvement in students' learning outcomes after the treatment. (Sundayana, 2016) N-Gain scores can be classified into low, moderate, and high improvement categories. The findings from these analyses were then used to evaluate the effectiveness of the e-module in enhancing students' understanding of tapered turning material.

RESULT AND DISCUSSION

Validity and Reliability Results

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

Results of CVR, I-CVI, and Percentage Agreement Analysis

Table 1. Results of the Validity of the Media Assessment Instrument

Indicator	CVR	I-CVI	Remarks
Item 1	1	1	Valid
Item 2	0,75	0,875	Valid
Item 3	0,75	0,875	Valid
Item 4	1	1	Valid
Item 5	1	1	Valid
Item 6	1	1	Valid
Item 7	1	1	Valid
Item 8	1	1	Valid
Item 9	0,75	0,875	Valid

Source : Excel Processing Results (2026)

Based on Table 1, all indicators in the media assessment instrument met the validity criteria, with CVR values ranging from 0.75 to 1.00 and I-CVI values ranging from 0.875 to 1.00. In addition, the reliability analysis yielded a Percentage Agreement value of 95.83%, indicating a very high level of agreement among validators. Therefore, the media assessment instrument was considered valid and reliable for use in this study.

The high validity scores indicate that the developed media assessment instrument adequately represents the aspects being measured, including content suitability, presentation, language, and graphical design. Moreover, the high agreement among validators demonstrates that the instrument provides consistent assessment results. This finding suggests that the instrument is appropriate for evaluating the feasibility of the developed e-module. According to Polit & Beck (2006) a high content validity index reflects strong agreement among experts regarding the relevance of instrument items. Therefore, the media assessment instrument can be used confidently in the research process.

Table 2. Results of Validity of Material Assessment Instruments

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Indicator	CVR	I-CVI	Remarks
Item 1	1	1	Valid
Item 2	1	1	Valid
Item 3	1	1	Valid
Item 4	1	1	Valid
Item 5	0,75	0,875	Valid
Item 6	1	1	Valid
Item 7	1	1	Valid
Item 8	1	1	Valid
Indikator	**CVR**	**I-CVI**	**Remaks**
Item 9	1	1	Valid
Item 10	0,75	0,875	Valid
Item 11	1	1	Valid
Item 12	1	1	Valid
Item 13	0,875	0,875	Valid
Item 14	0,75	0,875	Valid
Item 15	1	1	Valid

Source : Excel Processing Results (2026)

Based on Table 2, all indicators in the material assessment instrument met the validity criteria, with CVR values ranging from 0.75 to 1.00 and I-CVI values ranging from 0.875 to 1.00. In addition, the reliability analysis yielded a Percentage Agreement value of 96.67%, indicating a very high level of agreement among validators. Therefore, the material assessment instrument was considered valid and reliable for use in this study.

The high validity scores indicate that the material assessment instrument adequately represents the learning objectives and competencies to be achieved in tapered turning learning. The assessment aspects evaluated by the validators, including content accuracy, material organization, language clarity, and relevance to the curriculum, were considered appropriate for vocational learning. Moreover, the high agreement among validators demonstrates that the instrument provides consistent and dependable assessment results. According to Polit & Beck (2006), high content validity values indicate that the instrument items are relevant and representative of the construct being measured. Therefore, the material assessment instrument can be used confidently to evaluate the feasibility of the developed e-module.

Aiken's V Validity and ICC Reliability Results

Table 3. Results of the Validity of the Quality Assessment Instrument

Indicator	Aiken's V	Remarks
Item 1	0,667	Valid
Item 2	1	Valid
Item 3	0,875	Valid

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Item 4	0,833	Valid
Item 5	0,667	Valid
Item 6	0,917	Valid

Source : Excel Processing Results (2026)

The validity of the quality assessment instrument for test questions was analyzed using Aiken's V coefficient, whereas the reliability of the instrument was analyzed using the Intraclass Correlation Coefficient (ICC). Based on Table 3, the results indicate that the Aiken's V values ranged from 0.667 to 1.000, with an average value of 0.826. These findings demonstrate that all indicators in the test question assessment instrument met the validity criteria and were therefore considered appropriate for use in this study.

The high Aiken's V values indicate that the assessment instrument adequately represents the aspects required to evaluate the quality of test items. The validators agreed that the test questions were relevant to the learning objectives, clearly formulated, and suitable for measuring students' cognitive achievement in tapered turning material. According to Aiken (1985), a high Aiken's V value reflects strong agreement among experts regarding the relevance and appropriateness of instrument items. Therefore, the developed test question assessment instrument can be considered valid and capable of measuring students' learning outcomes accurately.

The validity of the assessment instrument is essential because it ensures that the collected data truly represent students' learning achievement. A valid instrument contributes to the credibility of research findings and strengthens the interpretation of the effectiveness of e-module implementation in vocational learning.

Table 4. Reliability Results of Quality Assessment Instrument Questions

Types of ICC	Value	Category
Single Measures	0,449	Moderate
Averange Measures	0,867	Good

Source: IBM SPSS Statistic 25 Processing Results (2026)

Based on Table 4, the ICC Single Measures value of 0.449 is categorized as moderate reliability, while the ICC Average Measures value of 0.867 is categorized as good reliability. Since this study involved eight validators and used the average scores from all validators, the ICC Average Measures value was used as the basis for determining instrument reliability. Therefore, the test question assessment instrument was considered reliable and suitable for use in this study.

The high ICC Average Measures value indicates that the validators had a consistent assessment of the quality of the test items. This consistency shows that the instrument can provide stable and dependable measurement results, so it is appropriate for evaluating students' learning outcomes in tapered turning material.

Descriptive Analysis

Tabel 5. Pretest Results

Classes	N	Minimum	Maximum	Mean	Std.Deviation
Control	35	24	64	45,37	10,480
Eksperimen	36	28	64	46	9,810

Tabel 6. Posttest Results

Classes	N	Minimum	Maximum	Mean	Std.Deviation
Control	35	56	92	78,29	7,131
Eksperimen	36	76	100	87,78	7,023

Source: IBM SPSS Statistic 25 Processing Results (2026)

Based on Tables 5 and 6, the pretest results showed that the average scores of the control and experimental classes were relatively similar, namely 45.37 and 46.00, respectively. The small difference of 0.63 points indicates that both classes had relatively equivalent initial abilities before the learning treatment was implemented.

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After the treatment, the posttest results revealed an improvement in learning outcomes in both classes. The control class obtained an average score of 78.29, while the experimental class achieved a higher average score of 87.78. The difference of 9.49 points indicates that students who learned using the e-module demonstrated better learning outcomes than those who received conventional instruction.

These findings suggest that the use of e-modules contributed positively to students' understanding of tapered turning material. The integration of text, illustrations, and learning activities in the e-module enabled students to learn more independently and systematically, thereby improving their learning achievement.

Normality Test

Tabel 7. Normality Test Results

Classes	Statistic	df	Say.
Control Class Pretest	0,973	35	0,519
Posttest Kelas Kontrol	0,942	35	0,066
Experimental Class Pretest	0,956	36	0,159
Posttest Kela's experiment	0,946	36	0,077

Source: IBM SPSS Statistic 25 Processing Results (2026)

Based on Table 7, the results of the normality test show that the significance values of the pretest and posttest data in both the control and experimental classes are greater than 0.05. Specifically, the significance values ranged from 0.066 to 0.519. Since all significance values are higher than 0.05 (Sig. > 0.05), it can be concluded that the pretest and posttest data in both classes are normally distributed.

The fulfillment of the normality assumption indicates that the data are appropriate for further analysis using parametric statistical tests, particularly the independent sample t-test. Therefore, hypothesis testing can be conducted to determine the effect of e-module implementation on students' learning outcomes.

Homogeneity Test

Tabel 8. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	0,073	1	68	0,788
Posttest	Based on Mean	0,210	1	68	0,648

Source: IBM SPSS Statistic 25 Processing Results (2026)

Based on Table 8, the homogeneity test results indicate that the significance values for both pretest and posttest data exceed 0.05. The significance value for the pretest data was 0.788, whereas the posttest data yielded a significance value of 0.648. As all significance values were greater than 0.05 (Sig. > 0.05), it can be inferred that the variances of the experimental and control classes were homogeneous.

The fulfillment of the homogeneity assumption indicates that the two classes have relatively similar variance characteristics. Therefore, the data meet the requirements for conducting further parametric analysis using the independent sample t-test to examine differences in learning outcomes between the experimental and control classes.

Independent Sample T-Test

Tabel 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	0,081	0,777	-2,100	68	0,039
	Equal variances not assumed			-2,102	67,962	0,039

Source: IBM SPSS Statistic 25 Processing Results (2026)

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Based on Table 9, the significance value obtained from Levene's Test was 0.777 (Sig. > 0.05), indicating that the assumption of equal variances was met. Consequently, the interpretation of the independent sample t-test was based on the "Equal variances assumed" row. The analysis revealed that the significance value (2-tailed) was 0.039, which was lower than 0.05 (Sig. < 0.05). Therefore, H0 was rejected and H1 was accepted, indicating that there was a significant difference in learning outcomes between students taught using e-modules and those who received conventional instruction.

The higher learning outcomes achieved by the experimental class indicate that the use of e-modules contributed positively to students' understanding of tapered turning material. The integration of text, images, videos, and structured learning activities in the e-module enabled students to study independently and understand the procedures more systematically. In addition, the interactive features provided opportunities for students to review the material repeatedly according to their learning pace. These findings suggest that e-modules are more effective than conventional learning in improving students' learning outcomes in vocational education.

N-Gain Analysis

Tabel 10. N-Gain Analysis Results

Classes	Mean	Median	Variance	Std. Deviation	Minimum	Maximum	Range
Control Class	60,26	61,29	107,53	10,36	33,33	83,33	50
Experimental Classes	78,35	76,92	131,14	11,45	57,14	100	42,86

Source: IBM SPSS Statistic 25 Processing Results (2026)

Based on Table 10, the control class obtained an average N-Gain score of 60.26, while the experimental class obtained an average N-Gain score of 78.35. According to the N-Gain criteria, the improvement in learning outcomes of the control class was categorized as medium, whereas the experimental class achieved a high category. These results indicate that the use of e-modules in learning tapered turning was more effective in improving students' learning outcomes compared to conventional learning methods.

The higher N-Gain score in the experimental class indicates that students experienced greater learning improvement after using the e-module. This improvement may be attributed to the characteristics of the e-module, which provides systematic learning materials, visual illustrations, instructional videos, and interactive exercises that facilitate students in understanding the concepts and procedures of tapered turning. In addition, students could access and review the learning materials repeatedly according to their individual learning pace, allowing them to strengthen their understanding more effectively. Therefore, the findings demonstrate that the developed e-module has significant potential to enhance learning outcomes in vocational education, particularly in tapered turning material.

DISCUSSION

E-Module Eligibility Based on Expert Validation

The validation results show that the e-module understands tapered turning that has been developed has met the eligibility criteria both from the media aspect and the material aspect. The media assessment instrument obtained a CVR value between 0.75–1.00 and an I-CVI value between 0.875–1.00 with a consensus rate between validators of 95.83%. Meanwhile, the material assessment instrument obtained a CVR value between 0.75–1.00 and an I-CVI value between 0.875–1.00 with a consensus rate between validators of 96.67%.

The high validity value shows that the components of the e-module developed are in accordance with the learning objectives, characteristics of students, and competencies that must be achieved in tapering turning material. According to Lawshe, (1975)The Content Validity Ratio (CVR) value is used to indicate the level of agreement among experts on the relevance of a component being assessed. In addition, Polit & Beck, (2006) explains that a high Content Validity Index (CVI) value indicates that the content of the instrument or product has a good level of conformity to the constructed being measured.

Validity and Reliability of Test Instruments

The results of the analysis of the validity of the test instrument using the Aiken's V coefficient showed values between 0.667 to 1.000 with an average of 0.826. The results show that all question items have met the valid criteria and are able to represent the measured learning indicators. According to Aiken (1985), content validity is used to determine the extent to which an instrument is able to represent a construct or competence that will be measured through expert assessments.

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In addition to being valid, the test instrument also shows a good level of reliability. The test results using the Intraclass Correlation Coefficient (ICC) obtained an Average Measures value of 0.867. According to Koo & Li (2016), the ICC value in the range of 0.75–0.90 is included in the category of good reliability which indicates the consistency of good assessment between validators. Thus, the test instruments used in this study are able to produce consistent and reliable data to measure student learning outcomes.

The Effectiveness of E-Modules on Student Learning Outcomes

The findings of this study indicate that the implementation of e-modules in learning tapered turning positively affected students' learning outcomes. Prior to the treatment, the average pretest scores of the control and experimental classes were 45.37 and 46.00, respectively. The relatively small difference between these scores suggests that both groups had comparable initial abilities.

Following the learning intervention, the average posttest score of the experimental class increased to 87.78, whereas the control class achieved an average score of 78.29. The results of the independent sample t-test revealed a significance value of 0.039 ($p < 0.05$), indicating a significant difference in learning outcomes between the experimental and control groups.

The improvement in learning outcomes observed in the experimental class may be attributed to the characteristics of the e-module, which allows students to learn independently and flexibly according to their individual learning pace. The learning materials were systematically organized and supported by illustrations, examples, summaries, and practice exercises that facilitated students in gaining a deeper understanding of tapered turning concepts. These findings are consistent with the Multimedia Learning theory proposed by (Mayer, 2009), which suggests that the integration of verbal and visual information can enhance students' understanding and retention of learning materials.

Improved Learning Outcomes Based on N-Gain Analysis

The results of the N-Gain analysis showed that the control class obtained an average N-Gain of 60.26 which was in the medium category, while the experimental class obtained an average N-Gain of 78.35 which was in the high category. These results show that the increase in student learning outcomes in the experimental class is higher than in the control class.

The high increase in learning outcomes in the experimental class shows that the developed e-modules are not only able to increase students' final grades, but also increase concept understanding more effectively. Students can relearn material that has not been understood, repeat exercises, and access the material independently according to their individual learning needs. This condition provides a more active learning experience than conventional learning.

The results of this study are in line with the research (Rusdi & Khumaedi, 2025) which states that the use of interactive e-modules is able to improve students' learning outcomes in the fields of engineering and mechanics. In addition, Rahmagandi et al. (2024) Explaining that e-modules that combine visual elements and learning evaluation can help students understand engineering concepts more effectively. Thus, the results of the N-Gain analysis strengthen the hypothesis test findings that the e-module understanding tapered turning is effectively used to improve the learning outcomes of students in the Machining Engineering Expertise Program.

CONCLUSION

The e-module for learning tapered turning developed through the ADDIE model was found to be valid, reliable, and appropriate for implementation in vocational education. The use of the e-module significantly enhanced students' learning outcomes compared to conventional instruction, demonstrating that digital learning media can effectively facilitate students' mastery of machining competencies.

This study provides a contribution to vocational education by introducing an interactive and competency-oriented e-module that may be utilized as an alternative digital learning resource in machining engineering courses. The incorporation of well-structured learning materials, visual illustrations, and self-directed learning features encourages students to learn more actively and systematically, which ultimately contributes to improving learning outcomes in vocational schools.

However, this study was limited to one vocational school and focused only on tapered turning material with a relatively short treatment duration. Therefore, future studies are recommended to involve larger samples, longer implementation periods, and broader machining competencies to further examine the effectiveness of e-modules in vocational education.

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