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Development and Effectiveness of a K3LH E-Module to Improve Learning Outcomes and Industrial Work Culture in Vocational Education

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Abstract

Occupational Health, Safety, Environment, and Industrial Work Culture learning in vocational schools is often constrained by limited interactive teaching materials, resulting in low student engagement and suboptimal learning outcomes. This condition highlights the urgent need for innovative digital learning resources that align with industrial demands and vocational student characteristics. This study aimed to design, develop, and evaluate the effectiveness of a K3LH E-Module for vocational education students. The research employed a Research and Development approach using the 4D development model, consisting of define, design, develop, and disseminate stages. The research subjects were 60 tenth-grade students of the Automotive Engineering program at Vocational High School in Semarang. Effectiveness testing was conducted at the classroom scale using an experimental group and a control group. Data were collected through expert validation sheets, practicality questionnaires, and pretest–posttest assessments. The results showed that the E-Module was highly feasible, with media expert validation reaching 89.5% and material expert validation 88.9%. Practicality testing indicated a very practical category with a score of 91.3%. Effectiveness analysis using N-Gain yielded a score of 58%, categorised as sufficiently effective. These findings demonstrate that the developed E-Module enhances student learning outcomes and promotes more active participation in K3LH learning. In conclusion, the K3LH E-Module is feasible, practical, and sufficiently effective for use as a digital learning resource in vocational education, with potential for further optimisation to improve learning gains.

Keywords: Classroom Scale, Digital, Student Engagement, Sufficiently Effective, Teaching Materials.

INTRODUCTION

Education plays an important role in improving the quality of human resources who are competitive and capable of critical thinking (Budiarto et al., 2024; Sumual et al 2024). To achieve this quality, the learning process must take place optimally, supported by motivation and appropriate learning media. Modern technology has brought significant changes to the world of education, including learning media, such as e-modules (Holisoh et al., 2025; Pratama et al., 2024). These e-modules facilitate

broader access to information, increase learning independence, and improve student learning outcomes.

At Vocational High School in Semarang, the development of e-modules on K3LH and Industrial Work Culture materials has become a solution to improve student understanding, especially considering the limitations of traditional lecture methods. These e-modules are considered practical, flexible, and easily accessible, so they are expected to help students achieve better learning outcomes (Ananda & Usmeldi, 2023; Dini et al., 2023). Previous studies conducted by Sikumbang, (2025); Yuyun et al., (2022), show that E-Module-based learning media can effectively improve learning outcomes in various subjects, even with a high level of practicality in various class scales.

Based on the theoretical review and conceptual framework that have been developed, a hypothesis can be formulated in this study, namely that there is an increase in student learning outcomes after using E-Module-based learning media in K3LH and Industrial Work Culture materials. This study focuses on the development of E-Module-based learning media to improve student learning outcomes at Vocational High School in Semarang. Although previous studies have shown positive results, there are still gaps, such as incomplete material in the E-Module and a lack of media variety, including the absence of videos and audio as supplements.

The objectives of this study are to: (1) develop K3LH and Industrial Work Culture E-Modules that are suitable and practical for learning at vocational schools; (2) analyze the effectiveness of E-Modules in improving the learning outcomes of 10th grade Automotive Engineering students; and (3) evaluate the difference in learning outcomes between classes that use E-Modules (experimental) and classes that use conventional methods (control).

In this context, this study is a further development of previous studies, with differences including the research location at Vocational High School in Semarang, the research subjects consisting of 60 students in the 10th-grade Automotive Engineering class, and the use of the Heyzine platform in the development of E-Modules on K3LH and Industrial Work Culture material. It is hoped that the use of E-Modules in K3LH and Industrial Work Culture learning will not only increase students' interest in learning, but also help overcome the limitations of facilities and infrastructure available at the school.

METHOD

This study used the Research & Development (R&D) method to develop e-module-based learning media. R&D aims to produce new products and test their effectiveness. This approach was chosen because it supports the development of interactive media that suits the needs of students (Daryanes et al., 2023; Kustyarini et al., 2020).

The development of the K3LH and Industrial Work Culture E-Module uses 4D model, which consists of four stages: define, design, develop, and disseminate (Amini et a., 2020). This model was chosen because of its simplicity and relatively short implementation time, yet it remains effective in media development (Fau et al., 2025). The research procedure can be seen in Figure 1.

Research Subjects and Location

This research was conducted at Vocational High School in Semarang in the even semester of the 2023/2024 academic. Research design is shown in Table 1. The research subjects were 60 students in the 10th-grade Automotive Engineering class, divided

into two groups: the experimental class (X TO 2, n=30) using E-Modules and the control class (X TO 4, n=30) using conventional learning methods.

The trial was conducted using the Two-Group Pretest-Posttest Design (Sukarman et al., 2025). The pretest was conducted before the intervention, followed by a posttest to measure changes in learning outcomes, so that the effectiveness of the E-Module could be analysed accurately.

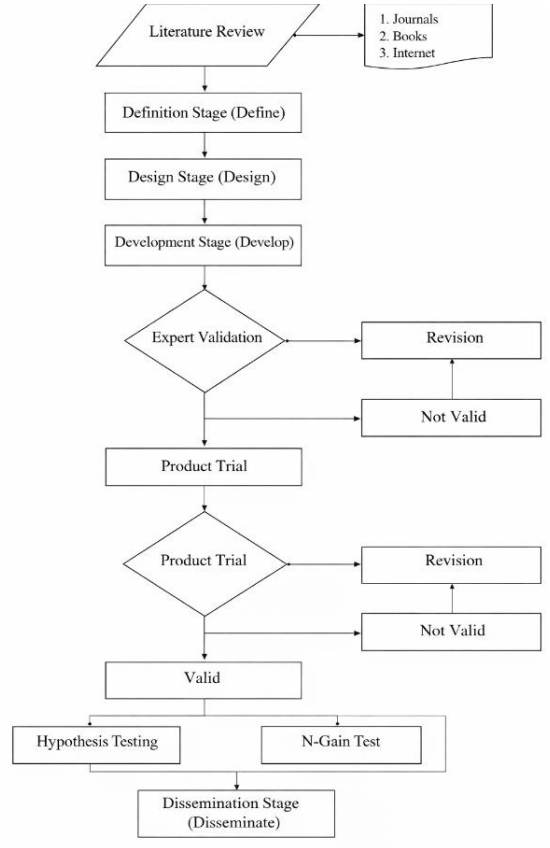

Figure 1. Research Flow Chart

Table 2. Population Numbers from X Automotive Engineering

Class	Number of Students
1	30
2	30
3	30
4	30

In this study, the researcher used Purposive Sampling based on specific considerations, where each member of the population had an equal chance of being selected. In this study, there were two classes used as samples, namely the experimental class (Automotive Engineering X 2, 30 students) with E-Module learning media and the control class (Automotive Engineering X 4, 30 students) without E-Modules.

Stages of *E-Module* Development

The definition stage in the development of learning media at Vocational High School in Semarang included preliminary analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. In the preliminary analysis stage, various obstacles were found, such as limited teaching materials and lack of e-learning utilization. The results of the student analysis showed that students in class X TO tended to be passive and unmotivated in learning, so innovations such as E-Modules were needed to improve their focus and understanding. Concept analysis identified important points related to K3LH and industrial work culture, including safe work practices, the use of personal protective equipment (PPE), and work ethics. In the task analysis, basic competencies were adjusted to achievement indicators to support effective learning. Finally, the formulation of learning objectives focused on students' ability to identify potential hazards, apply safety procedures, use PPE, and demonstrate discipline and work ethics in accordance with industry standards (Dolinina, & Kushnaryova, 2016; Ludwika & Rifai, 2024).

The design stage in the development of learning media at Vocational High School in Semarang involved several main steps. First, constructing criterion-referenced tests to link the definition stage with the design and

measure the feasibility of the developed media. Second, media selection was carried out by choosing online learning media that was in line with K3LH and Industrial Work Culture material and the characteristics of the students. Third, the format selection determines that the media developed is E-Module-based. Fourth, the initial design is made based on the previous analysis, including the compilation of content such as the home page, instructions for use, introduction, material, summary, formative tests, and discussion. All compiled content is then validated by media and material experts to ensure quality and suitability for learning objectives (Supena et a., 2021; Leite et al., 2018).

The design stage in the development of learning media at Vocational High School in Semarang included the preparation of criteria tests to measure the feasibility of the media, the selection of online learning media in accordance with K3LH and Industrial Work Culture material and student characteristics, the determination of an E-based format-Module format, and the creation of a preliminary design that includes the compilation of content such as the home page, instructions for use, introduction, material, summary, formative tests, and discussions. This entire process is validated by media and material experts to ensure that the learning media developed meet the desired educational objectives as shown in Figure 2.

The development stage of E-Module-based learning media for K3LH and Industrial Work Culture materials includes several steps: feasibility testing, revision, trial, and product finalization. In the feasibility test, media and material experts provided input for adjustments to the E-Module structure and the use of terms in accordance with the independent curriculum (Sholihah & Wulandari, 2023; Elistiana et al., 2024). After revision, trials were conducted in small and large classes with very feasible results (scores of 89.2% and 86.7%) (Munthe et al., 2019). After the trials, the product was revised again to improve its practicality. The final product is an E-Module that can be accessed on smartphones and laptops/PCs, ready for use in learning.

Expert Validation

a. Media

The E-Module-based learning media used in this study was assessed by three expert media validators who are lecturers from the Faculty of Engineering, Department of Mechanical Engineering, Semarang State University. Based on the assessment results by media experts using a validation questionnaire consisting of 19 questions, a score percentage of 89.5% was obtained, which is classified as "Very Good" as shown in Table 3.

Figure 2. Initial Design of E-Module

Table 3. Results of Expert Media Validation

Respondents	Assessment Score	Maximum Score	%	Average
Media Expert 1	65		85.5	
Media Expert 2	70	76	92.1	89.5
Media Expert 3	69		90.7	

Table 4. Results of Expert Material Validation

Respondents	Evaluation Score	Maximum Score	%	Average
Subject Matter Expert 1	32		88.8	
Subject Matter Expert 2	34	36	94.4	88.9
Subject Matter Expert 3	30		83.3	

b. Data Analysis of Material Expert

The E-Module-based learning media used in this study was also assessed by three material expert validators, consisting of one lecturer from the Faculty of Engineering, Department of Mechanical Engineering, Semarang State University, and two teachers from Vocational High School in Semarang who teach the material presented in the learning media. Based on the assessment results by subject matter experts using a validation questionnaire consisting of 9 questions, a score percentage of 88.9% was obtained, which is classified as "Very Good" as shown in Table 4.

c. Disseminate

This dissemination stage is the final step in the research and development of E-Module-based learning media for K3LH and Industrial Work Culture materials. At this stage, the E-Module link was distributed to 10th grade TO students at Vocational High School in Semarang through the teachers who taught the material.

Instruments and Data Analysis Techniques

a. Hypothesis Testing (T-Test)

According to Fiandini et al., (2024), the t-test is used to test the partial effect of independent variables on dependent variables. In this study, the Paired Sample T-Test and Independent Sample T-Test were applied to assess whether the proposed hypothesis could be accepted and to evaluate the difference in learning quality between the experimental class and the control class using SPSS 27.0. Adhelacahya et al., (2023) explain that decision making in the Paired Sample T-Test is based on the significance value (Sig.) obtained from the SPSS output, where if the significance value (Sig.) < 0.05, the hypothesis is accepted, while if the significance value (Sig.) > 0.05, the hypothesis is rejected. For decision making in the Independent Sample T-Test, Rafiola et al., (2020) state that if the significance value is < 0.05, there is a significant difference between the experimental class and the control class, while if the significance value is > 0.05, there is no significant difference between the two classes.

b. N-Gain Test

The normalized gain (N-Gain) test was employed to quantitatively evaluate the magnitude of improvement in both the learning process and students' cognitive learning outcomes by comparing their performance before and after the instructional intervention (Triyono et al., 2024). The analysis of pretest and posttest scores was specifically intended to determine the extent of enhancement in students' thinking abilities in both the experimental and control groups. The N-Gain analysis was performed using the SPSS

27.0 statistical software, and the gain scores were calculated in accordance with the formulation proposed by Hake, R. R. (1999), as presented in Table 5.

Table 5. Categories of N-Gain Effectiveness Interpretation

Percentage	Interpretation
< 40	Not Effective
40 – 55	Less Effective
56 – 75	Fairly Effective
>76	Effective

RESULT AND DISCUSSION

Hypothesis Testing (T-Test)

a. Paired Sample T-Test

In this study, hypothesis testing was conducted using the Paired Sample T-Test method. This method was chosen because it is considered appropriate for comparing mean values in a single sample group that was measured twice, namely before and after treatment. The use of the Paired Sample T-Test makes it possible to evaluate whether there is a significant difference in the pretest and posttest mean values, thereby indicating the effectiveness of the treatment given (Shivaraju et al., 2017; Dankel & Loenneke, 2021). The results of the hypothesis analysis using the Paired Sample T-Test are described in Table 6, which presents a comparison of the mean scores and the significance level of the changes that occurred.

The results of the analysis of the average scores of students using the Paired Sample T-Test show a Sig. (2-tailed) value of < 0.01. This value is smaller than the significance level of 0.05, which means that the hypothesis in this study is accepted. Thus, these results indicate a significant increase in student learning outcomes after using E-Module-based learning media for K3LH and Industrial Work Culture material. This finding indicates that E-Modules as learning media are capable of improving students' understanding and achievement in the material taught, in line with the module development objectives to support more effective and engaging learning (Afifah et al., 2022).

b. Independent Sample T-Test

In this study, the Independent Sample T-Test was used to determine whether there was a significant difference in learning effectiveness between the control class and the experimental class. This test helped evaluate whether the E-Module-based learning method in the experimental class produced significantly different learning outcomes compared to the method used in the control class. The results of the Independent Sample T-Test analysis are further explained in Table 7, which includes a comparison of the average scores of the two groups and the level of significance obtained. These results are expected to reinforce the conclusion regarding the effectiveness of E-Modules in improving learning outcomes in K3LH and Industrial Work Culture materials.

The Independent Sample T-Test data analysis show that the Sig. (2-tailed) value obtained is < 0.01, which is smaller than the significance threshold of 0.05, indicating a strong level of statistical significance. This indicates a significant difference between the learning outcomes in the experimental class and the control class. Thus, these results indicate that the use of E-Module-based learning media in K3LH and Industrial Work Culture material has a significant impact on improving learning outcomes in the experimental class compared to the control class that did not use E-Modules during the learning process. These findings reinforce the effectiveness of E-Modules as an innovative and relevant learning method in improving the overall quality of student learning outcomes and academic achievement (Kwak & Park, 2019).

Table 6. Paired Sample T-Test Results

Pretest-Postest	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 - Kontrol	18.36667	7.70348	1.49646	-21.24320	-15.49014	-13.059	29	<.001
Pair 2 - Eksperimen	27.63333	8.26494	1.50896	-30.71951	-24.54715	-18.313	29	<.001

Table 7. Independent Sample T-Test Results

	Levene's Test for Equality of Variances		t	df	Sig. (2-tailed)	t-test for Equality of Means		95% Confidence Interval of the Difference	
	F	Sig.				Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	9.601	.003	-5.704	58	<.001	<11.00000	2.16795	-15.33962	-6.66038
Equal not assumed			-5.704	49.852	<.001	<11.00000			-6.64324

N-Gain Test

To analyse the extent of the influence of E-Module-based learning media on K3LH and Industrial Work Culture material on improving student learning outcomes, an N-Gain test was conducted. This test aims to measure the difference in learning outcomes before and after the implementation of E-Modules, with a focus on the level of improvement in student understanding in the experimental class. The results of the N-Gain test are presented in detail in Table 8.

Based on the N-Gain calculation results, the Standard Deviation values for the control class and the experimental class were obtained. In the experimental class, the N-Gain percentage reached 58%, which is included in the "Quite Effective" category. These results indicate that the application of E-Module-based learning media has a stronger influence on improving student learning outcomes compared to the approach used in the control class. Thus, the learning treatment using E-Modules on K3LH and Industrial Work Culture material proved to be quite effective in significantly improving student understanding. These findings support the relevance of using E-Modules as a tool that can enrich the learning experience of students, especially in the context of industrial learning and work safety.

In addition to improving cognitive learning outcomes, the use of K3LH E-Modules also encourages student activity in the learning process. This can be seen from the increase in student participation in accessing materials, doing independent exercises, and discussing during the learning process. The interactive, flexible, and digitally accessible nature of E-Modules allows students to learn independently and be more actively involved than in conventional learning. These findings are in line with the research by Laili, (2019) and Gunawan et al., (2024), which states that E-Modules can increase student engagement in learning through the systematic and accessible presentation of material.

Table 8. N-Gain Percentage (%)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Control	40	46	36	6	38	20	21	46	26	30	25	36	68	43	30	23	30	26	38	26	51	36	37	57	35	54	35	41	58	75
Experinmental	57	58	60	41	65	74	51	60	25	64	60	52	65	64	63	50	37	50	68	72	57	57	46	55	60	54	64	77	68	73

The improvement in students' learning outcomes after the implementation of the K3LH E-Module can be attributed to several key factors. First, the E-Module provides interactive and structured learning content that supports better conceptual understanding compared to conventional teaching materials. The integration of multimedia elements such as visuals, contextual examples, and systematic explanations helps students process information more effectively and reduces cognitive load (Yu & Huang, 2025)

Second, the E-Module promotes learner-centered learning, allowing students to learn independently, control their learning pace, and revisit materials when needed. This flexibility enhances students' learning autonomy and strengthens knowledge retention. In contrast to traditional methods that tend to be teacher-centered, the digital module encourages more active cognitive engagement (Yang et al., 2025).

Third, the increased student engagement and motivation also contributed to improved learning outcomes. The practicality results (91.3%) indicate that students perceived the E-Module as easy to use and interesting, which positively influenced their attention and participation during the learning process. Higher engagement is strongly associated with better learning performance (Akram & Abdelrady, 2025).

Finally, the alignment of the E-Module content with vocational and industrial contexts made the learning more relevant to students' needs, which facilitated deeper understanding and meaningful learning (Metreveli, et al., 2025). Therefore, the observed increase from pretest to posttest scores is not only a statistical improvement but also reflects a genuine enhancement in students' cognitive and motivational learning processes.

CONCLUSION

This study designed and developed a K3LH E-Module for vocational education students and evaluated its implementation in authentic classroom settings. The findings indicate that the developed E-Module is feasible and practical for instructional use. Its implementation contributed to improved student learning outcomes and promoted more active and independent learning. Overall, the study suggests that the K3LH E-Module represents an effective digital learning resource that can support the teaching and learning process in vocational education contexts.

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