JOURNAL OF TECHNICAL EDUCATION AND TRAINING
ISSN: 2229-8932 e-ISSN: 2600-7932

JTET

Vol. 17 No. 3 (2025) 189-203
https://publisher.uthm.edu.my/ojs/index.php/jtet

Effectiveness of E-Module and Learning Style on Self-Regulation Learning Model to Increase the Occupational Safety and Health Knowledge for Mechanical Education Students

Nurlaela Nurlaela[1], Mohd Zulfakar Mohd Nawi[2]*, Achmad Romadin[1]

[1] *Mechanical of Education, Faculty of Engineering, State University of Makassar, Makassar, INDONESIA*
[2] *Fakulti Pendidikan Teknikal dan Vokasional, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA*

*Corresponding Author: zulfakar@uthm.edu.my
DOI: https://doi.org/10.30880/jtet.2025.17.03.013

Article Info

Received: 3rd February 2025
Accepted: 1st October 2025
Available online: 14th October 2025

Keywords

E-module, learning style, self-regulated learning, learning achievements, occupational safety and health

Abstract

Vocational education is designed with learning that is relevant to the industrial sector. In learning activities, teaching materials are essential to support learning goals. The study aimed to identify the effectiveness of the E-module and learning style on application learning to increase the occupational safety and health knowledge for vocational education. This research is quantitative on variables bound between variables. The population of the study are all students of the education machine engineering faculty that have taken the Health and Safety course in the academic year 2023/2024. The methods used to collect the data needed in the research are R and D, which include developing instruments; lesson plans, practice questions, and quizzes; pre-test and post-test questions, learning style questionnaires, and E-module. The research results show that the E-module increases the effective health and safety work learning achievements, and with that, the style of learning lacking learning effectiveness in improving health and safety work depends on methods and the use of the E-module. Simultaneously, E-module and learning-style learning achievements effectively increase health and safety, especially for the visual learning style; the effectiveness of the E-module has a good outcome. Furthermore, the use of E-module and learning style development is needed.

1. Introduction

Knowledge, defined as the fact of knowing a state, thing, person, etc., encompasses the know-how to do something in a particular (Mahardika et al., 2021; Sanova et al., 2022). Within the knowledge economy, there are four distinct types of knowledge: Know-who, Know-why, Know-what, and Know-how. Each type pertains to understanding the processes necessary for various tasks (Mahardika et al., 2021; Turan & Koç, 2018). In the modern era, knowledge can be created, distributed, and accessed at unprecedented speeds. Instead, students need the appropriate tools to select, process, and apply knowledge effectively in response to the ever-changing demands of jobs, leisure activities, and family dynamics (Dewi et al., 2022). This shift highlights the growing trend in education to prioritize the development of competencies over the mere transmission of factual knowledge.

Originally, the French term for competence was used in vocational training contexts, referring to the ability to perform specific tasks (Arifin & Sukmawidjaya, 2020; Mufidah et al., 2023). Over the past few decades, the concept of competence in education has shifted towards denoting the 'capacity' or 'potential' to act efficiently within a given context. This evolution underscores the importance of the practical application and purpose of knowledge, rather than knowledge itself (Mukhopadhyay, 2019). Enhancing competence involves equipping learners with the ability to mobilize, apply, and integrate acquired knowledge in diverse and unpredictable situations.

Humans, in general, tend to be conservative, and teachers are no exception. Many educators prefer traditional methods of teaching because these methods are more familiar and easier to implement (Skovsgaard, 2018). Embracing new teaching methods requires additional thought and energy, making it a challenging transition for many. The reluctance to change is often rooted in the comfort and predictability of established routines (Koolivand et al., 2024). New approaches necessitate not only the learning of new content but also the adaptation to new ways of engaging students, which can be daunting for educators who have relied on conventional methods throughout their careers (Chiu et al., 2023).

Vocational education, as a sub-system of national education, holds significant responsibilities in human resource development and plays a crucial role in advancing national development (Ananta et al., 2023; Isa, 2020). This branch of education is specifically tasked with preparing students for specific trades and professions, ensuring that they are well-equipped with the skills and knowledge required in the workforce (Sauli, 2021). Vocational education must stay updated with industry standards and practices to remain relevant and effective. By doing so, it ensures that students are not only competent in their respective fields but also adaptable to technological advancements and changes within their industries (Tripopsakul, 2021).

Vocational Education or Technical and Vocational Education and Training (TVET) is an important pillar in preparing a workforce that is adaptive to the demands of the global era and the 4.0 industrial revolution. TVET not only emphasizes technical skills, but also 21st-century skills such as communication, collaboration, creativity, and critical thinking. Research by (Pharamela & Singh-Pillay, 2025) confirms that while TVET instructors recognize the importance of 21st-century skills, their implementation remains limited due to rigid curricula, inadequate facilities, and insufficient professional training. On the other hand, studies by Moreno et al. (2025); Romadin et al. (2022); Yoto, Suyetno, et al. (2024) highlight that TVET curricula still face significant challenges in adapting to industry needs, particularly in the field of digital technology. Therefore, curriculum reform, the addition of new fields such as innovation and sustainability, and improvements in pedagogical quality are urgent needs to strengthen the role of TVET in enhancing the competitiveness of graduates in the global job market. Research by Saputra et al. (2025) on vocational students' technological literacy shows that most students only have a basic understanding of using Computer-Aided Design (CAD) software, necessitating innovative learning interventions, teacher training, and access to up-to-date learning resources. Therefore, TVET must be designed to be more inclusive, adaptive, and technology-based to ensure graduates are not only technically competent but also prepared to face the dynamics of the modern industry.

TVET should not only focus on mastering technical skills and 21st-century skills but also instil awareness of the importance of occupational safety and health (OSH). The objective of imparting knowledge about the basic concepts of OSH in vocational education is to ensure that students understand the foundational principles that can be applied in various technical fields such as machining, cooling systems, and welding (Liu et al., 2020; Najib, 2020). Understanding OSH basics is critical in preventing workplace accidents and illnesses, thereby promoting a safe and efficient work environment (Rînjea et al., 2022). This focus on practical applications means that vocational education not only provides factual knowledge but also develops the practical skills necessary for students to thrive in their respective fields (Hussain et al., 2021). By integrating OSH principles into their training, students become more aware of the importance of safety and health in their professional practices, leading to more responsible and effective workforce members (Ahmad Razali et al., 2020; Aram, 2021; Michaelis et al., 2022).

This research builds upon previous studies where the self-regulation learning model was applied, revealing that motivation and learning achievement fell within medium to high categories. Despite these encouraging results, it became apparent that other factors influencing learning achievement needed further investigation (Al-hawamleh et al., 2022; Alt & Naamati-schneider, 2021; Bylieva et al., 2021; Stephen, 2021). Analysing the average scores in the Mechanical Engineering Education study program at the Faculty of Engineering, Universitas Negeri Makassar (UNM), particularly for the OSH subject, highlighted some concerning trends. For instance, during the academic year 2022/2023 (1), 33 students achieved an average score of 7.2, whereas in 2022/2023 (2), 35 students had an average score of 7.0, indicating a slight decline in performance. This trend underscores the necessity for enhanced research to identify and address factors that could improve learning outcomes.

Given these findings, the current study aims to explore the effectiveness of E-module and learning styles on the self-regulation learning model to enhance OSH knowledge among Mechanical Education students at Universitas Negeri Makassar. E-module serve as an independent learning medium, featuring digital instructions and interactive content, which makes learning more engaging and accessible (Nasir et al., 2022; Simatupang et al., 2020). The concept of learning styles, which refers to how individuals absorb, organize, and process information, is also critical to this research. Learning styles encompass various aspects such as visual, auditory, writing, and speaking preferences, as well as cognitive processing styles like sequential, analytical, and global or left-brain processing (Alfaro et al., 2019; Almulla, 2023). Additionally, learning styles involve how learners respond to their environment, whether they absorb information abstractly or concretely (Haruna et al., 2019; Turan & Koç, 2018).

Self-regulation learning is fundamental to this research, providing a conceptual framework to understand the cognitive, motivational, and emotional aspects of learning. This model involves repeated cycles of planning, monitoring, and reflecting on one's learning processes, which are applied systematically in experimental settings (Al-hawamleh et al., 2022; Stephen, 2021). By incorporating E-module and tailored learning styles into the self-regulation model, this study aims to foster a more personalized and effective learning experience for students. The goal is to improve their OSH knowledge significantly, which is crucial for their future professional success in various technical fields.

Learning achievement, in this context, is measured by the degree to which students master the teaching material. A score greater than 76 is considered indicative of effective learning (Ashfahani et al., 2020; Hermansyah & Pammu, 2023). By leveraging the interactive nature of E-module and accommodating diverse learning styles, this research seeks to enhance students' engagement and comprehension, thereby improving their academic performance. The anticipated outcome is a more profound understanding of OSH principles, equipping students with the knowledge and skills necessary to ensure safety and efficiency in their professional practices. This approach not only addresses the immediate educational needs but also contributes to the broader goal of developing competent and responsible professionals in the field of mechanical engineering.

2. Method

This research is a quantitative study aimed at uncovering knowledge through data represented numerically. The study examines the interplay of three types of variables: the independent variables (E-module and learning style), the moderating variable (Self-Regulated Learning), and the dependent variable (Learning achievement in Occupational Safety and Health). The research involved mechanical engineering education students, specifically selecting a sample size of 48 students divided into two experimental classes due to the impracticality of contacting the entire participant pool.

The process of developing this interactive learning module began with a preliminary study to understand the needs of learners and available facilities, followed by planning and collecting materials (refer to Figure 1). Several methods were used to collect the necessary data, including the development of research instruments such as lesson plans, practice questions, quizzes, pre-test and post-test questions (refer to Table 1), learning style questionnaires, and E-module. The developed instruments were then validated by experts, after which a pre-test was conducted on both groups to collect baseline data on learning styles. In the experimental phase, the learning model was applied to both classes, followed by a post-test to measure learning achievement after E-module implementation. The data collected from these activities were analysed, and the module was revised and refined based on the trial results and feedback obtained. After the module was declared feasible, it was produced as a final product ready to be used as a learning resource.

The analysis utilized two primary instruments: a multiple-choice test to gauge students' understanding and a questionnaire to gather non-test data. Descriptive statistical analysis was performed to interpret the pretest and post-test results and questionnaire responses, using SPSS software for assistance. Inferential statistical analysis was also employed to compare the mean scores of the experimental classes before treatment and to test the study's hypotheses. This comprehensive approach aimed to provide robust evidence on the effectiveness of E-module, learning styles, and Self-Regulated Learning models in enhancing learning achievement in the context of Occupational Safety and Health education. In collecting research data guided by the research instrument lattice consisting of: (1) Pre-test and Post-test Instrument Indicators (refer to Table 1), (2) learning style instrument (refer to Table 2) and (3) Module trial instrument to users (refer to Table 3).

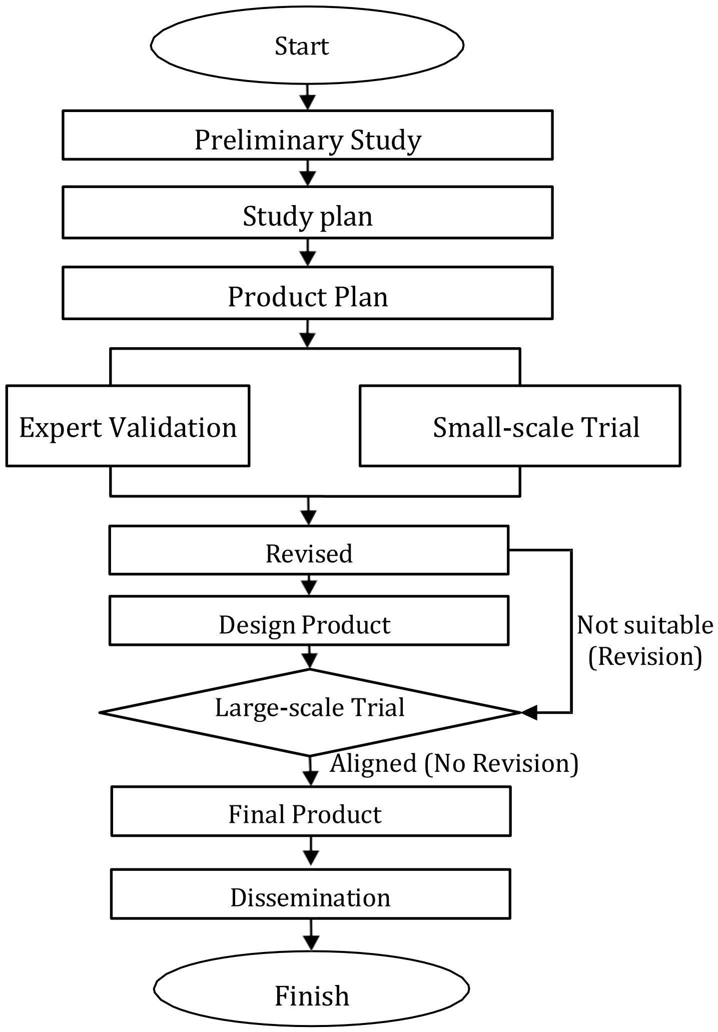

Fig. 1 *Flow of research and development steps*

Table 1 *Pre-test and post-test instrument indicators*

No	Competency Indicators	Cognitive Level	Number of Questions
1	Explain the basic concepts of occupational safety and health (OSH)	C1 (Remembering)	4
2	Identify potential hazards in the work environment	C2 (Understanding)	4
3	Determine the appropriate personal protective equipment (PPE)	C3 (Applying)	4
4	Analyse the causes of workplace accidents	C4 (Analysing)	4
5	Conclude safe work procedures in accordance with OSH standards	C5 (Evaluating)	4
	N		20

Table 2 *Learning style instrument grid*

Aspects	Indicator	Question Number
Visual Learning Styles	Students understand information more easily through pictures, diagrams, maps and graphs.	1, 4, 7
	Students tend to take notes full of symbols and pictures.	2, 5
	Students prefer to learn by watching videos, presentations or reading picture books.	3, 6
	Use colours or visual cues to organize information.	8, 9
Auditory Learning Styles	Students understand information better when they hear it, such as through lectures or discussions.	10, 13, 16
	Students prefer to learn through group discussions or listening to recordings.	11, 14
	Students often repeat information verbally to understand it.	12, 15
	Recall information by listening to explanations or recordings.	17, 18
Kinaesthetic Learning Styles	Students understand information through hands-on experience or practice.	19, 22, 25
	Students prefer to learn by using movement or physical activity.	20, 23
	Students tend to remember information by doing or touching things.	21, 24
	Students prefer a hands-on or laboratory approach to learning.	26, 27
	N	**27**

Table 3 *Module user test instrument*

Aspects	Indicator	Number of Instrument Items	Question Number
Display	Attractiveness of the module	1	1
	Image attractiveness	1	2
	Image suitability with material	1	3
Presentation	Ease of understanding the material	2	4,5
	Systematic accuracy of material presentation	3	6,7,8
	Clarity of sentences	1	9
	Clarity of terms	1	10
Benefits	Ease of learning	2	11,12
	Interest in using teaching materials in the form of modules	2	13,14
	Increased learning motivation	1	15
	N		15

The validity of the OSH learning achievement test instrument was tested through construct validity using Pearson product moment correlation between each item score and the total test score. The validity analysis results showed that of the 42 items tested, 42 items had a correlation value greater than 0.30, so they were declared valid. Two other items had correlations below 0.30 and were excluded from the instrument. Thus, this instrument is considered valid and capable of accurately measuring mastery of OSH material. The reliability of the instrument was measured using Cronbach's Alpha to determine the internal consistency of the test. The results of the instrument reliability calculation showed a Cronbach's Alpha value of 0.83, which means that the instrument has a high level of reliability and can be trusted to consistently measure students' abilities in K3 material.

Before conducting inferential statistical analysis, the pretest and post-test data for both classes were first tested for normality using the Kolmogorov-Smirnov test with a significance level of 0.05. The results of the normality test showed that the p-values for the pretest and post-test in Class A were 0.200 and 0.150, respectively, while in Class B they were 0.200 and 0.180, respectively. Since the p-values were greater than 0.05 for all data, it can be concluded that the data were normally distributed and met the assumptions for parametric analysis such as the t-test.

The test results were then analysed descriptively and inferentially, including the maximum, minimum, mean, and standard deviation values on the pretest and post-test for both classes. Inferential analysis using a mean comparison test (t-test) was conducted to determine the significance of the increase in scores from the pretest to the post-test. A significant increase in the percentage of students in the "good" score category on the post-test compared to the pretest serves as an indicator of the success of using the E-module. The effectiveness of E-module usage is interpreted using percentage criteria, namely 0%–20% = Very Ineffective; 21%–40% = Ineffective; 41%–60% = Moderately Effective; 61%–80% = Effective; and 81%–100% = Very Effective.

3. Result and Discussions

Based on the research design, hypothesis testing was conducted to determine the effect of E-module use and learning styles on improving OSH knowledge among Mechanical Engineering students. In this testing, two hypotheses were formulated, namely: (1) H_0, which states that the use of E-module and learning styles together do not have a significant effect on improving OSH knowledge, and (2) H_1, which states that the use of E-module and learning styles together have a significant effect on improving OSH knowledge among students.

3.1 Data on student achievement tests

Data on student achievement tests for Occupational Health and Safety are presented in the table 4:

Table 4 *Description of the data on the results of the occupational health and safety learning achievement test*

Description	Class A		Class B	
	Pretest	Post-test	Pretest	Post-test
Maximum	80	97	86	98
Minimum	53	60	58	60
Mean	69.83	80.45	69.54	76.95
Standard deviation	7.39	11.77	7.25	10.58

Based on the data in the table above, the overall highest post-test score achieved by students is 98, while the lowest score is 60. This range indicates a significant variance in student performance. Nevertheless, despite this variation, the average student learning outcomes for both classes have met the criteria for a minimum category B score. According to the assessment criteria, a score within the Good (B) category is defined as greater than 76. Therefore, it can be inferred that the majority of students performed well in their post-tests, demonstrating a satisfactory level of understanding and mastery of the material taught.

Furthermore, the data on the percentage of completeness for both the pretest and post-test of the two experimental classes are detailed in Tables 5 and 6. These tables provide insights into the students' progress and improvement over time. By comparing the pretest and post-test results, it is possible to evaluate the effectiveness of the instructional methods used and to identify any areas that may require further attention or intervention. The improvement in scores from pretest to post-test suggests that the students have benefited from the instructional strategies employed, resulting in enhanced learning outcomes.

Table 5 *Percentage of completeness of the experimental class A pretest and post-test*

Score	Category	Pretest		Post-test	
		F	%		%
91 - 100	A	0	0	4	16.67
86 - 90	A-	0	0	5	20.83
81 - 85	B+	0	0	7	29.16
76 - 80	B	0	0	3	12.5
Score < 76	Not effective	24	100	5	20.83
Total		24	100	24	100

Table 6 *Percentage of completeness of the experimental class B pretest and post-test*

Score	Category	Pretest		Post-test	
		F	%		%
91 - 100	A	0	0	8	33.33
86 - 90	A-	0	0	5	20.83
81 - 85	B+	0	0	4	16.67
76 - 80	B	0	0	3	12.50
Score < 76	Not effective	24	100	4	16.67
Total		24	100	24	100

Based on the comparison of pretest and post-test results, it is evident that there has been a significant improvement in learning achievement for Occupational Health and Safety in the experimental classes. The data indicates that the implementation of the E-module has had a positive impact on student performance. Specifically, in experimental class A, 83.33% of the students achieved a score that falls within the "good" category. This marks a considerable increase in their learning outcomes compared to their pretest scores.

In experimental class B, the results were similarly positive, with 79.16% of the students reaching the "good" category on their post-test. This demonstrates that the E-module was effective in enhancing the learning achievement of students in both experimental groups, although class A had a slightly higher percentage of students meeting the good category criteria. The consistency in these findings across both classes reinforces the conclusion that the E-module is a valuable tool in improving students' understanding and performance in Occupational Health and Safety.

Overall, the increase in the number of students achieving good scores in their post-tests signifies a successful intervention through the use of the E-module. This improvement highlights the importance of incorporating digital learning tools and tailored learning styles to foster better educational outcomes. It also underscores the potential for such modules to be integrated into broader curriculums to enhance student engagement and achievement in various subjects.

3.2 Learning Style Questionnaire Results Data

The learning style data of the experimental class is presented in the table 7:

Table 7 *Description of the results of the questionnaire learning styles*

Learning Style	Class A		Class B	
	F	%	F	%
Visual	13	54.16	9	37.50
Audio	6	25.00	10	41.67
kinaesthetic	5	20.83	5	20.83

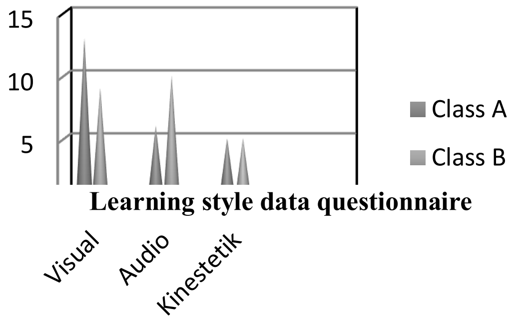

Fig. 2 *The results of the questionnaire learning styles*

The data after treatment is used to test the research hypothesis, which is to find out the effectiveness of the E Module and Learning Style in self-regulated learning model learning to improve occupational health and safety learning achievement.

3.3 Test Assumptions Before Treatment

Test assumptions before treatment is presented in the table 8:

Table 8 *Kolmogorov Smirnov assumption of normality test results before treatment*

Experiment Class	Variable	Significance
A (class with visual dominant learning style)	Pretest	0.345
B (class with audio dominant learning style)	Pretest	0.126

Table 8 shows that the significance value of each variable in the two experimental classes is greater than 0.05 (sig. > 0.05), leading to the acceptance of H0. The acceptance of H0 implies that there is no significant difference between the distributions of the variables, which in turn suggests that the data is normally distributed. This normal distribution is a crucial assumption for many statistical tests, ensuring that the results are reliable and valid. The verification of normality allows for the use of parametric tests, which are typically more powerful than their non-parametric counterparts, providing more precise insights into the data.

Furthermore, the results of the multivariate homogeneity assumption test, as presented in Table 8, indicate a significance value of 0.165. This value, being greater than 0.05 (sig. > 0.05), leads to the conclusion that the variance-covariance matrix between the experimental Class A (with a Visual Dominant Learning Style) and experimental Class B (with an Audio Dominant Learning Style) is homogeneous. Homogeneity of variance is another important assumption in multivariate analysis, ensuring that the comparison between the two classes is valid. The homogeneity indicates that the variability in scores for each group is similar, allowing for a fair comparison of the effectiveness of the different learning styles employed in each class.:

Table 9 *Multivariate homogeneity test results before treatment*

BoX-M	F	df.1	df.2	sig.
1.436	1.562	2	26.0	0.165

3.4 Similarity Test of Experimental Class A (Class with Visual Dominant Learning Style) and Experimental Class B (Class with Audio Dominant Learning Style)

With the assumptions of normality and homogeneity of the initial data being met, the MANOVA (Multivariate Analysis of Variance) test can be appropriately performed. Meeting these assumptions ensures the validity and reliability of the MANOVA test, allowing for accurate comparison of the groups. The statistical data from the MANOVA test are presented in Table 9. This test is used to determine if there are any statistically significant differences between the means of multiple dependent variables across the groups being studied. In this case, it compares the learning achievements of students from two experimental classes with different dominant learning styles—visual and audio—prior to any instructional intervention.

The results of the MANOVA test, as shown in Table 10, indicate a significance value greater than 0.05 (sig. > 0.05). This result means that there is no statistically significant difference in the mean pretest scores between the

J. of Technical Education and Training Vol. 17 No. 3 (2025) p. 189-203

experimental Class A (with a Visual Dominant Learning Style) and experimental Class B (with an Audio Dominant Learning Style). Consequently, it can be concluded that, before the instructional methods were applied, both groups had similar levels of learning achievement. This finding is crucial as it establishes a baseline equivalence between the groups, ensuring that any observed differences in posttest results can be attributed to the instructional interventions rather than pre-existing disparities in student achievement.

Table 10 *Results of the similarity of means between two experimental classes*

Levene's Test	F	df1	Df2	Sig.
Class A	0.265	1,00	48	0.725
Class B	0.172	1,00	48	0.568

3.5 Test Assumptions After Treatment (Giving E Module)

The assumptions of normality and homogeneity were rigorously tested using the SPSS program, a statistical software widely used for such analyses. These tests are essential for validating the conditions under which certain statistical tests can be applied. The results of the normality assumption test after the treatment in both experimental classes are detailed in Table 8. This table presents the significance values for each variable, demonstrating whether the data follows a normal distribution. A significance value greater than 0.05 (sig. > 0.05) for each variable indicates that the null hypothesis (H_0), which posits that the data is normally distributed, is accepted. This confirmation of normality is crucial as it supports the validity of subsequent parametric tests, which rely on this assumption.

In addition to testing for normality, the multivariate homogeneity assumption was also evaluated, with the results presented in Table 11. Similar to the normality test, the homogeneity test checks whether the variance-covariance matrices of the different groups are equivalent. The data in Table 11 shows that each variable from both experimental classes has a significance value greater than 0.05 (sig. > 0.05). This indicates that H_0 is accepted, leading to the conclusion that the data is homogeneous. Establishing homogeneity is critical for multivariate analyses, such as MANOVA, as it ensures that the groups being compared are sufficiently similar in their variability. These results collectively affirm that the data meets the necessary assumptions, allowing for robust and reliable comparisons between the experimental groups post-treatment.

Table 11 *Normality test results after administration of E Module*

Experiment Class	Variable	Significance
A (class with visual dominant learning style)	Posttest	0.135
B (class with audio dominant learning style)	Posttest	0.265

Table 12 *Homogeneity test of variance after treatment*

Variable	Levene Statistic	df.1	df.2	sig.
Class A	0.097	1	48	0.236
Class B	0.245	1	48	0.156

In the table above, the significance values for the homogeneity test are presented for both experimental classes. For Class A, which is characterized by a Dominant Visual Learning Style, the significance value obtained is 0.236. Similarly, for Class B, characterized by a Dominant Audio Learning Style, the significance value is 0.156. These significance values are both greater than 0.05 (sig. > 0.05), indicating that the differences in variance-covariance matrices between the two classes are not statistically significant. This means that the null hypothesis (H_0), which posits that the variance-covariance matrices of the two classes are equal, is accepted.

The conclusion that the variance-covariance matrix between the experimental Class A and Class B is homogeneous is crucial for the validity of subsequent multivariate analyses. Homogeneity of variance-covariance matrices implies that the variability in scores across the different variables is comparable between the two classes. This is a key assumption in multivariate analysis techniques like MANOVA, as it ensures that the comparisons made between the groups are fair and not influenced by unequal variances. Therefore, with this assumption met, researchers can confidently proceed with further statistical tests, knowing that the underlying data structure supports the integrity of their comparative analysis. This homogeneity supports the reliability of any observed differences in learning outcomes, attributing them more likely to the differing instructional methods rather than inherent variability in the groups' initial conditions.

3.6 Test The Effectiveness Between Experimental Class A (Class with Dominant Visual Learning Style) and Class B (Class with Dominant Audio Learning Style) with the Application of E Module

The effectiveness test between experimental class A (Class with Dominant Visual Learning Style) and Class B (Class with Dominant Audio Learning Style) with the Application of E Module was conducted using one sample t-test. The results of the one sample t-test in both classes are presented in table 13.

Table 13 *Effectiveness test results between experimental class A (Class with dominant visual learning style) and class B (Class with dominant audio learning style) with the application of E Module*

Variable	Experiment Class	Df	t count	t table
Performance	A (Visual Learning Style Dominant)	24	10.125	2.567
Study (Post-test)	B (Audio Learning style Dominant)	24	6.742	2.567

Based on the data presented in the table above, it can be seen that in experimental class A (class with Visual Dominant Learning Style) with the application of module E, the learning achievement value of OSH shows a significant increase, as indicated by the calculated t value of 10.125. This calculated t value is higher than the table value of 2.567, which indicates that the results obtained are statistically significant. This indicates that the use of E-module is effective in improving student learning outcomes in classes with visual dominant learning styles.

This significant increase in learning achievement suggests that the E-module specifically designed to meet the needs of visual learning styles can facilitate a better understanding of the OSH material. This module most likely includes visual elements such as pictures, diagrams and graphs that help visual students process and recall information more effectively. The effectiveness of this E-module proves that an approach tailored to learning styles can improve student engagement and their learning outcomes.

Furthermore, the success of E-module in experimental class A provides empirical evidence that learning materials optimized according to individual learning preferences can have a significant positive impact. This is in line with learning theory which suggests that students learn better when teaching methods match their learning styles. In this context, E modules provide the necessary tools for students with visual learning styles to more easily understand complex concepts in OSH.

In conclusion, the application of E-module tailored to students' dominant learning styles in experimental class A has proven effective in improving OSH learning achievement. These results highlight the importance of a personalized approach in education and show that considering students' learning styles can result in better learning outcomes. Therefore, educators are expected to adopt diverse and customized learning methods to accommodate various learning styles in order to achieve optimal educational outcomes.

3.7 Discussion of the Relationship between Research Results and Research Hypotheses Application of E-module

The use of E-module adapted to students' learning styles has a significant effect on improving knowledge of OSH among Mechanical Engineering students. This is evidenced by a significant improvement in learning outcomes in experimental class A, which is dominated by students with visual learning styles. The calculated t-value of 10.125, which far exceeds the table t-value of 2.567, indicates that this improvement is statistically significant, thereby supporting the alternative hypothesis (H_1) stating that the combined use of E-module and learning styles has a significant impact on improving OSH knowledge.

In the context of the research title "The Effectiveness of E-module and Learning Styles in the Self-Regulated Learning Model to Improve Occupational Safety and Health Knowledge," these findings provide empirical evidence that the self-regulated learning model combined with E-module designed according to students' learning styles, particularly visual learning styles, can improve learning effectiveness. The integration of visual elements such as images, diagrams, and graphs in E-module has been proven to assist students with visual learning styles in understanding and retaining information more effectively.

Thus, the results of this study support hypothesis H_1 and reject the null hypothesis (H_0), which states that there is no significant effect. These findings are also consistent with learning theory, which states that teaching methods that align with individual learning styles within a self-directed learning framework can enhance student engagement and learning outcomes. This underscores the importance of a personalized approach in education, particularly in the development of digital instructional materials in the fields of engineering and occupational safety.

The integration of E-module with learning styles in a self-regulated learning model is a state-of-the-art approach to improving educational outcomes (Mahardika et al., 2021; Sanova et al., 2022). E-module, or electronic modules, are digital tools designed to deliver educational content dynamically and interactively through multimedia elements such as text, images, videos, animations and simulations (Mufidah et al., 2023; Nasir et al., 2022). These modules can be customized to meet various learning styles, which are individual preferences and strategies that influence how students acquire and process information.

The self-regulation learning model emphasizes students' active participation in their own learning process, including setting goals, monitoring progress, and adjusting strategies based on their understanding and needs (Bylieva et al., 2021; Idkhan et al., 2024; Yoto, Marsono, et al., 2024). When E-module are tailored to students' learning styles in this model, several benefits emerge, students tend to engage more deeply with the material when it is presented in a format that suits their preferential learning mode (Billett, 2011; Romadin & Fauziah, 2023). For example, visual students can utilize diagrams and graphical representations that help explain complex concepts, improving their understanding and retention.

Auditory students can utilize E-module that include audio components such as narration or explanation, allowing them to reinforce understanding through hearing (Al-hawamleh et al., 2022; Ramadhan et al., 2020). This adaptation supports their learning style by providing information in a format that suits their auditory processing strengths (Hidayat et al., 2023; Putri et al., 2023). Similarly, kinaesthetic students can interact with simulations or virtual labs integrated in the E-module, allowing them to apply theoretical knowledge in practical scenarios (Mahardika et al., 2021). This approach encourages active learning and helps kinaesthetic students develop practical skills while reinforcing the understanding of theoretical concepts.

In addition, the flexibility and accessibility of E-module facilitate self-regulation among students (Al-hawamleh et al., 2022; Bylieva et al., 2021). They can set the pace of learning according to individual needs and preferences, access resources and engage in activities that support their learning styles. By empowering students to take control of their own learning process, E-module tailored to learning styles support autonomy and motivation, key factors in establishing effective self-regulatory learning behaviours.

Apart from that, the development of E-module in TVET is an important innovation for improving the quality of learning, especially in the face of the digital era and the demands of Industry 4.0. E-module provide flexibility, accessibility, and interactivity through the use of multimedia elements, making learning more interesting and contextual for vocational students (Manggala & Nyana, 2024). Other research also indicates that E-module can improve understanding of complex concepts, such as brazing and riveting methods using the VAK learning approach, although they still face challenges related to digital infrastructure and educators' technological literacy (Hashim et al., 2024). Additionally, adaptively designed E-module have proven effective in developing 21st-century competencies, improving learning outcomes, and preparing students to face future challenges (Chairad et al., 2025; Dini et al., 2024). Thus, the implementation of E-module in TVET not only supports the transfer of technical knowledge but also fosters creativity, critical thinking skills, and awareness of lifelong learning.

Based on the results, research findings, and discussion, it can be concluded that the integration of E-module with learning styles within the framework of the self-regulated learning model significantly improves the knowledge of Mechanical Engineering students regarding OSH. This improvement is statistically proven through the calculated t-value, which far exceeds the table t-value, and practically through improved learning outcomes in the experimental class, particularly among students with visual learning styles. This indicates that when digital instructional materials are designed in accordance with students' learning characteristics, the learning process becomes more effective, focused, and positively impacts the understanding of technical and applied subjects such as OSH. Furthermore, the development of E-module in TVET is a strategic innovation that not only enhances the effectiveness of technical learning but also fosters 21st-century competencies and awareness of lifelong learning in the digital age and Industry 4.0.

Furthermore, this approach supports the principles of self-regulated learning, in which students are not only recipients of information but also managers of their own learning processes. E-module equipped with multimedia elements and tailored to learning styles provide greater flexibility, accessibility, and control in learning, thereby encouraging active engagement, intrinsic motivation, and better academic achievement. Therefore, these findings underscore the importance of developing digital instructional materials based on learning styles as part of a personalized education strategy in the digital age, particularly in vocational and technical education, to create more meaningful and adaptive learning experiences tailored to the needs of learners.

4. Conclusion

Based on the research results presented, it can be concluded that the application of E-module in experimental class A with the dominance of visual learning styles significantly improves learning achievement in Occupational Health and Safety subjects. This is evidenced by the significant t value (10.125), which exceeds the table value indicating statistically significant results. E-module customized with visual elements such as pictures and diagrams help clarify complex concepts, improving students' understanding of the material. This success confirms that approaches that tailor learning materials to individual learning styles can positively influence student learning outcomes, demonstrating the importance of personalized approaches in educational contexts to achieve optimal results. For future research in the development of E-module, it is more advisable to input the latest technology such as AI, AR, VR technology, so that the implementation of learning is relevant to industrial learning 4.0 and 5.0.

Acknowledgement

The authors would like to thank to those who involved in completing this research.

Conflict of Interest

The author declares no conflict of interest in this study's conduct, analysis, or publication.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nurlaela Nurlaela;* ***literature review:*** *Mohd Zulfakar Mohd Nawi;* ***instrument validation and methodology:*** *Achmad Romadin and Mohd Zulfakar Mohd Nawi;* ***data collection:*** *Nurlaela Nurlaela;* ***analysis and interpretation of results:*** *Nurlaela Nurlaela;* ***draft manuscript preparation:*** *Achmad Romadin and Mohd Zulfakar Mohd Nawi. All authors reviewed the results and approved the final version of the manuscript.*

References

Ahmad Razali, N., Leman, A. M., Rahman, K. A., & Afizi Shuaib, N. (2020). Development of Safety and Health Culture of Construction Project through Academic Institution and Industry Linkages on TVET Platform: A Proposed Study. *IOP Conference Series: Materials Science and Engineering*, *864*(1), 1–9. https://doi.org/10.1088/1757-899X/864/1/012137

Al-hawamleh, M. S., Alazemi, A. F., Al-jamal, D. A. H., Shdaifat, S. Al, & Gashti, Z. R. (2022). Online Learning and Self-Regulation Strategies : Learning Guides Matter. *Education Research International*, *2022*.

Alfaro, L., Apaza, E., Luna-Urquizo, J., & Rivera, C. (2019). Identification of learning styles and automatic assignment of projects in an adaptive e-learning environment using project based learning. *International Journal of Advanced Computer Science and Applications*, *10*(11), 697–704. https://doi.org/10.14569/IJACSA.2019.0101191

Almulla, M. A. (2023). Constructivism learning theory : A paradigm for students ' critical thinking , creativity , and problem solving to affect academic performance in higher education Constructivism learning theory : A paradigm for students ' critical thinking , creativity , . *Cogent Education*, *10*(1). https://doi.org/10.1080/2331186X.2023.2172929

Alt, D., & Naamati-schneider, L. (2021). Health management students ' self- regulation and digital concept mapping in online learning environments. *BMC Medical Education*, *21*(110), 1–16.

Ananta, R., Hardiyanta, P., Pawitno, E., & Nugroho, E. A. (2023). Edupreneurship through Teaching Factory in the Light Vehicle Engineering Skills Program at Muhammadiyah Kutowinangun Vocational School. *Journal of Vocational Education Studies*, *6*(2), 302–311.

Aram, S. A. (2021). Managing occupational health among goldminers in Ghana: Modelling the likelihood of experiencing occupational related health problems. *PLoS ONE*, *16*(7 July), 1–16. https://doi.org/10.1371/journal.pone.0254449

Arifin, S., & Sukmawidjaya, M. (2020). Technology Transformation and Its Impact on Lecturer's Performance. *JPI (Jurnal Pendidikan Indonesia)*, *9*(1), 153. https://doi.org/10.23887/jpi-undiksha.v9i1.24372

Ashfahani, A., Haryono, H., & Kustiono, K. (2020). The Effectiveness of Project Based Learning and Discovery Learning with Modul to Improve Learning Outcome for AutoCAD Subject. *Innovative Journal of Curriculum and Educational Technology*, *9*(2), 72–77. https://doi.org/10.15294/ijcet.v9i2.39460

Billett, S. (2011). Vocational Education: Purposes, Traditions and Prospects [1 ed.]. In *Journal of Chemical Information and Modeling* (Vol. 53, Nomor 9). https://doi.org/10.1017/CBO9781107415324.004

Bylieva, D., Hong, J., Lobatyuk, V., & Nam, T. (2021). Self-Regulation in E-Learning Environment. *Education Scinces*, 1–24.

Chairad, M., Ambri Damanik, S., Hasibuan, B., & Putra Lubis, A. (2025). The Importance of Adaptive E-module in 21st Century Education. *ICIESC 2024*. https://doi.org/10.4108/eai.17-9-2024.2352962

Chiu, T. K. F., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2023). Teacher Support and Student Motivation to Learn with Artificial Intelligence (AI) based Chatbot. *Ai And Student Motivation Teacher*, 1–34.

Dewi, C. A., Awaliyah, N., Fitriana, N., Darmayani, S., Nasrullah, Setiawan, J., & Irwanto, I. (2022). Using Android-Based E-module to Improve Students' Digital Literacy on Chemical Bonding. *International Journal of Interactive Mobile Technologies*, *16*(22), 191–208. https://doi.org/10.3991/ijim.v16i22.34151

Dini, N. A. I., Ikhsan, M., Pamungkas, O., & Kuswanto, H. (2024). ICT-Based Teaching Materials on Science Learning to Improve 21st-Century Skills : A Systematic Review. *IJORER : International Journal of Recent Educational Research*, *5*(5), 1239–1251.https://doi.org/10.46245/ijorer.v5i5.679

Haruna, R., Kamin, Y. Bin, & Buntat, Y. Bin. (2019). Understanding Work-Based Learning in Technical and Vocational Education and Training in Nigeria Rabiu. *International Journal of Recent Technologi and Engineering*, *8*(1), 1726–1733.

Hashim, S., Ali, N. A. M., & Masran, S. H. (2024). E-module in TVET: Unveiling Brazing and Riveting Methods Through VAK Learning. *The Asian Conference on Education 2023: Official Conference Proceedings*, *January*, 1559–1576. https://doi.org/10.22492/issn.2186-5892.2024.130

Hashim, S., Azman, A. A., Che Lah, N. H., & Daud, M. F. (2025). Exploring the Relationship Between Personality Types and Learning Styles Among Special Education Students in TVET: A Case Study. *Journal of Technical Education and Training*, *17*(2), 38–52. https://doi.org/10.30880/jtet.2025.17.02.003

Hermansyah, S., & Pammu, A. (2023). *Socialization Making Media Learning Interactive E-module based Flippbook in Elementary School 4 Maiwa*. 1–7.

Hidayat, K., Hasan, S. H., & Wiyanarti, E. (2023). Social Learning E-module for Optimizing Critical Thinking Skills. *Journal of Education Technology*, *7*(1), 166–176.

Hussain, Z., Burhanuddin, M. A., & Khanapi, A. G. (2021). Measure of Awareness on Occupational Health and Safety Vulnerability in Technical and Vocational Education and Training Institutions. *Turkish Journal of Computer and Mathematics Education*, *12*(9), 1093–1103.

Idkhan, A. M., Irfan, A. M., Putra, I. I., & Romadin, A. (2024). The Effect of Problem-Based Learning Model on Learning Motivation and Its Impact on Students ' Learning Achievement. *Internasional Journal of Integrative Sciences (IJIS)*, *3*(6), 539–550.

Isa, R. F. M. (2020). Technical and Vocational Education and Training (Tvet): Tempat Asas Pembinaan Budaya Keselamatan Di Malaysia. *Journal of Vocational Education Studies*, *2*(2), 101. https://doi.org/10.12928/joves.v2i2.1205

Koolivand, H., Shooreshi, M. M., Safari-Faramani, R., Borji, M., Mansoory, M. S., Moradpoor, H., Bahrami, M., & Azizi, S. M. (2024). Comparison of the effectiveness of virtual reality-based education and conventional teaching methods in dental education: a systematic review. *BMC Medical Education*, *24*(1), 1–15. https://doi.org/10.1186/s12909-023-04954-2

Liu, S., Nkrumah, E. N. K., Akoto, L. S., Gyabeng, E., & Nkrumah, E. (2020). The State of Occupational Health and Safety Management Frameworks (OHSMF) and Occupational Injuries and Accidents in the Ghanaian Oil and Gas Industry: Assessing the Mediating Role of Safety Knowledge. *BioMed Research International*, *2020*. https://doi.org/10.1155/2020/6354895

Mahardika, A. I., Wiranda, N., Arifuddin, M., Kamal, M., Erlina, M., & Hayati, M. (2021). The Student Response to Interactive E-module to Support Science Literacy in Distance Learning Physics. *International Journal of Innovative Science and Research Technology*, *6*(11). www.ijisrt.com258

Manggala, M., & Nyana, suryan adi P. (2024). Inovatif pembelajaran menggunakan e-modul. *JETISH: Journal of Education Technology Information Social Sciences and Health*, *3*(1), 550–557.

Michaelis, M., Preiser, C., Voelter-Mahlknecht, S., Blomberg, N., & Rieger, M. A. (2022). Uptake of Voluntary Occupational Health Care—Assessments of German Occupational Health Physicians and Employees. *International Journal of Environmental Research and Public Health*, *19*(15), 1–23. https://doi.org/10.3390/ijerph19159602

Moreno, N. I., Callueng, R. Z., & Portez, A. P. (2025). Exploring Technical Vocational Teacher Education: Inputs to Curriculum Model Development. *Journal of Technical Education and Training*, *17*(2), 87–105. https://doi.org/10.30880/jtet.2025.17.02.006

Mufidah, A., Indana, S., & Arifin, I. S. Z. (2023). E-module Based on Blended Learning Type Flipped Classroom on Climate Change Materials to Train Students' Digital Literacy Ability. *International Journal of Current Educational Research*, *2*(1), 1–16. https://doi.org/10.53621/ijocer.v2i1.204

Mukhopadhyay, K. (2019). Competency Management Initiatives Through It Interventions For Sustainable Development. *Conference Paper*. https://www.researchgate.net/publication/335543345_Competency_Management_Initiatives_Through_It_Interventions_For_Sustainable_Development

Najib, D. S. (2020). *Master plan Safety, Occupational 2016-2020*.

Nasir, M., Sunarno, W., & Rahmawati, F. (2022). Flipped classroom using E-module to improve understanding of light concepts : needs analysis of E-module development to empower scientific explanation. *Journal of Physics: Conference Series*, *2021*(Icspe 2021), 1–10. https://doi.org/10.1088/1742-6596/2165/1/012040

Pharamela, S., & Singh-Pillay, A. (2025). Technical and Vocational Education and Training College Lecturers and 21st-Century Skills: Awareness and Implications for Teaching Practices. *Journal of Technical Education and Training*, *17*(2), 182–196. https://doi.org/10.30880/jtet.2025.17.02.013

Putri, L., Permana, I., & Holiyani, I. (2023). Upaya Meningkatkan Literasi Digital Peserta Didik Melalui Penggunaan E-Modul Berbasis Flipbook pada Materi Keanekaragaman Hayati The Efforts to Improve Students ' Digital Literacy using Flipbook-Based E-module on Biodiversity Topic. *Report Of Bilogical Education*, *4*(2), 85–98.

Ramadhan, S., Indriyani, V., Asri, Y., & Sukma, E. (2020). Design of Learning Modules Writing Narrative Text Based on Project Based Learning (PjBL) by Using Mobile Devices. *Journal of Physics: Conference Series*, *1471*(1), 1–10. https://doi.org/10.1088/1742-6596/1471/1/012029

Rînjea, C., Chivu, O. R., Darabont, D. C., Feier, A. I., Borda, C., Gheorghe, M., & Nitoi, D. F. (2022). Influence of the Thermal Environment on Occupational Health and Safety in Automotive Industry: A Case Study. *International Journal of Environmental Research and Public Health*, *19*(14). https://doi.org/10.3390/ijerph19148572

Romadin, A., & Fauziah, L. (2023). Implementasi Media Pembelajaran Kartu Make a Match Pada Mata Pelajaran Ppkn Kelas Iii Di Sds Al Fath Bsd Untuk Meningkatkan Hasil Belajar. *Adi Widya: Jurnal Pendidikan Dasar*, *8*(2), 145–153. https://doi.org/10.25078/aw.v8i2.3039

Romadin, A., Nuhadi, D., & Yoto, Y. (2022). Implementation of Work Based Learning on Welding Engineering Expertise Competency in The Manufacturing Industry. *Journal of Vocational …*, *5*(1), 16–31. http://journal2.uad.ac.id/index.php/joves/article/view/5674%0Ahttp://journal2.uad.ac.id/index.php/joves/article/download/5674/2783

Sanova, A., Bakar, A., Afrida, A., Kurniawan, D. A., & Aldila, F. T. (2022). Digital Literacy on the Use of E-module Towards Students' Self-Directed Learning on Learning Process and Outcomes Evaluation Cources. *JPI (Jurnal Pendidikan Indonesia)*, *11*(1), 154–164. https://doi.org/10.23887/jpi-undiksha.v11i1.36509

Saputra, N. A., Hamidah, I., Setiawan, A., Riza, L. S., Rachman, I., & Matsumoto, T. (2025). Technology Literacy of Vocational Students in CAD Learning Materials: A Study at Private and Public Mechanical Engineering Vocational Schools. *Journal of Technical Education and Training*, *17*(2), 1–21. https://doi.org/10.30880/jtet.2025.17.02.001

Sauli, F. (2021). The collaboration between Swiss initial vocational education and training partners: perceptions of apprentices, teachers, and in-company trainers. *Empirical Research in Vocational Education and Training*, *13*(1). https://doi.org/10.1186/s40461-021-00114-2

Simatupang, H., Purnama, D., & Simatupang, Z. (2020). The Development Of Best Practice Handbook Learning Strategy Based On Flip Book To Support Blended Learning Processes. *IOP Conf. Series: Journal of Physics*, *1462*, 1–5. https://doi.org/10.1088/1742-6596/1462/1/012014

Skovsgaard, J. (2018). The Future of Education and Skills: Education 2030. *OECD Education Working Papers*, 1–23. http://www.oecd.org/education/2030/E2030%0APosition%0APaper%0A(05.04.2018).pdf

Stephen, J. S. (2021). A high-impact practice for online students : the use of a first-semester seminar course to promote self-regulation , self-direction , online learning self-efficacy. *Smart Learning Environments*, *8*(6).

Tripopsakul, S. (2021). Preparing for Industry 4 . 0 – Will youths have enough essential skills ?: An Evidence from Thailand. *International Journal of Instruction*, *13*(3). https://doi.org/10.29333/iji.2020.1337a

Turan, M. B., & Koç, K. (2018). The impact of self-directed learning readiness on critical thinking and self-efficacy among the students of the school of physical education and sports. *International Journal of Higher Education*, *7*(6), 98–105. https://doi.org/10.5430/ijhe.v7n6p98

Yoto, Marsono, Suyetno, A., Ardista, P., & Mawangi, N. (2024). The role of industry to unlock the potential of the Merdeka curriculum for vocational school. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2335820

Yoto, Y., Suyetno, A., Ardista, P., Mawangi, N., & Romadin, A. (2024). The role of industry to unlock the potential of the Merdeka curriculum for vocational school. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2335820