Al-Ishlah: Jurnal Pendidikan
Vol.17, 4 (Desember, 2025), pp. 6740-6753
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v17i4.7657

Evaluating Differentiated Instruction Under the Merdeka Curriculum: A Quasi-Experimental Study in a Vocational High School Electrical Engineering Program

Asmeri Hadi[1], Nizwardi Jalinus[2], Mukhlidi Muskhir[3], Muhammad Giatman[4]

[1] Universitas Negeri Padang, Padang, Indonesia; asmerihadi134@gmail.com
[2] Universitas Negeri Padang, Padang, Indonesia; nizwardi@ft.unp.ac.id
[3] Universitas Negeri Padang, Padang, Indonesia; muskhir@ft.unp.ac.id
[4] Universitas Negeri Padang, Padang, Indonesia; giatmann@ft.unp.ac.id

ARTICLE INFO

Keywords:

differentiated learning;
vocational education;
vocational schools;
learning outcomes;
electricity engineering

Article history:

Received 2025-05-02
Revised 2025-12-09
Accepted 2025-12-27

ABSTRACT

Vocational education in Indonesia, especially in Vocational High Schools (SMK), often struggles to equip students with skills that align with industry demands. This study investigates the effectiveness and perceived usability of differentiated instruction under the Merdeka Curriculum in enhancing learning outcomes in the Electrical Engineering program at SMKN 2 Payakumbuh. A quantitative approach with a quasi-experimental design was used, involving two groups: an experimental group receiving differentiated instruction and a control group receiving traditional teaching. Data collection included pre-tests, post-tests, and student questionnaires. The instructional design for the experimental group was tailored to students' learning styles, readiness, and interests. Students in the experimental group demonstrated significantly higher post-test scores compared to the control group. The N-gain score for the experimental group reached 0.67 (moderate improvement), outperforming the control group (0.57). Additionally, students rated the practicality of the differentiated instruction highly, with a perceived usability score of 83.23%. The findings suggest that differentiated instruction effectively enhances academic performance and student engagement in vocational education. The positive student response indicates that such tailored approaches are both acceptable and practical in real classroom settings. Differentiated instruction under the Merdeka Curriculum shows promise as an effective model for vocational education. Broader implementation across other SMK programs is recommended to validate its scalability and impact.

Corresponding Author:
Asmeri Hadi
Universitas Negeri Padang, Padang, Indonesia; asmerihadi134@gmail.com

1. INTRODUCTION

Education is a very important factor in shaping the quality of human resources who can contribute to the country's advancement and compete globally (Alharbi, 2023; Mukti et al., 2023). The main objective of education is to produce a generation that is faithful, pious, intelligent, virtuous, and talented, who not only have intellectual abilities but also practical skills that can be used to face future challenges (Hamami & Nuryana, 2022; Jakandar et al., 2025; Rohaeni et al., 2021). Education in Indonesia, particularly at the upper secondary level, is vital in preparing students for the workforce and social life. This is aligned with national educational goals, as outlined in Law No. 20 of 2003, which emphasize the development of competent, responsible, and democratic individuals.

Vocational High Schools (VHS) are essential in equipping students with the technical competencies demanded by the industrial sector. The principal aim of vocational education in SMK is to equip students with competencies that meet the demands of the commercial and industrial sectors, enabling them to compete effectively in the global market. Nonetheless, despite these aims, numerous SMK graduates do not pursue careers aligned with their qualifications, with a considerable percentage opting for unrelated industries or remaining jobless. A key challenge is the persistent gap between vocational school curricula and the actual needs of the industry (Fahim et al., 2021; Pervez et al., 2024). This mismatch highlights the urgency to re-evaluate the curriculum and teaching strategies to enhance graduates' employability.

Based on observations conducted at SMKN 2 Payakumbuh, the results of the Final School Exams (UAS) showed that many students had not achieved the Minimum Competency Criteria (KKM), indicating a gap in competency achievement in the field of Electrical Lighting Installation (IPL). This indicates that the teaching methods used are ineffective and lack variety, thereby affecting students' interest and motivation. Additionally, a tracer study revealed that over 60% of graduates were unable to secure employment, continue their education, or start their businesses, indicating a mismatch between the education provided and the demands of the job market. The lack of practical skills in line with industry standards and limited internship opportunities are the main causes, necessitating a more in-depth evaluation of the curriculum and teaching methods in schools to ensure graduates are prepared to meet the demands of the job market and the business world.

In line with the development of education policies, the Merdeka Curriculum was introduced to give teachers greater freedom in designing more flexible and relevant learning experiences for students (Hunaepi & Suharta, 2024; Irsyad et al., 2024; Pratikno et al., 2022). This curriculum is designed to address evolving educational challenges, including post-pandemic learning recovery. The Merdeka Curriculum also provides space for teachers to adopt more student-centered learning approaches, such as differentiated instruction (Karim et al., 2025; Sianturi, 2025). Through differentiated learning, teachers can accommodate students' different needs and interests, allowing them to learn at their own pace and in their style. This can improve learning effectiveness, especially in vocational programs with diverse competencies, such as the Electrical Engineering program at SMKN 2 Payakumbuh.

Previous studies have examined the implementation of differentiated learning in various vocational education contexts and demonstrated its positive impact on improving student motivation and learning outcomes. For example, research conducted by Rajak & Dey (2025) showed that differentiated learning can increase student engagement in the classroom by providing space for students to learn according to their styles and needs. Additionally, research by Labordo (2024) also found that this approach can reduce competency achievement gaps among students with different backgrounds. On the other hand, research by Vaganova et al. (2020) revealed that the implementation of differentiated learning in vocational schools can improve the quality of education focused on practical skills, thereby better preparing students to enter the workforce or engage in entrepreneurship. This aligns with the efforts made in this study to explore the effectiveness of differentiated learning in improving the quality of education at SMKN 2 Payakumbuh, particularly in preparing students to meet the evolving needs of the industry.

This study addresses that gap by specifically investigating the implementation of differentiated instruction in the Electrical Engineering program at SMKN 2 Payakumbuh. It aims to evaluate how this method affects student learning outcomes and readiness for industry or entrepreneurship. By narrowing the scope to a specific program and curriculum policy, the research offers a unique contribution to the literature on vocational education reform in Indonesia.

The central research questions are:

1. To what extent does differentiated instruction improve student learning outcomes in Electrical Engineering at SMKN 2 Payakumbuh?
2. How do students perceive the usability of differentiated instruction in their learning experience?

A quantitative quasi-experimental design was chosen to provide measurable evidence of effectiveness while maintaining practical feasibility within an actual classroom setting. This design allows comparison between a group receiving differentiated instruction and a control group receiving conventional instruction, offering insights into both learning gains and implementation feasibility.

2. METHODS

2.1. Research Methods

This study employs a quantitative technique specifically designed to assess the influence of instructional tactics on student performance in vocational education. The quantitative approach facilitates an objective comparison of student learning results prior to and during the adoption of differentiated instruction, utilizing numerical data to evaluate the intervention's efficacy (Sugiyono, 2015). This research aims to analyze the application of differentiated learning in the Electrical Installation subject in Electrical Engineering at SMKN 2 Payakumbuh, as well as to test whether the application of this approach can improve the effectiveness of student learning outcomes.

The independent variable in this research is the instructional approach, namely differentiated instruction, whereas the dependent variable is the students' learning outcomes, assessed through pretest and posttest scores. The study utilizes a quasi-experimental design featuring a non-equivalent control group. The experimental group underwent treatment through differentiated teaching, incorporating tiered assignments, flexible grouping, learning contracts, and multimedia designed to align with students' readiness levels, interests, and learning profiles. Simultaneously, the control group received instruction through traditional teaching methods devoid of distinction.

The research employed is descriptive research, which seeks to systematically, factually, and accurately characterize a certain occurrence. This text outlines the implementation process and perceived usability of differentiated instruction within the Merdeka Curriculum. This component emphasizes the collection of objective data on the implementation of differentiated instruction by educators and its impact on student engagement and academic achievement in the occupational topic of Electrical Installation. The study incorporates observational and questionnaire-based data to augment the test results, offering a thorough perspective on the practicality and efficacy of differentiated education in actual classroom environments.

2.2. Research Subject

This study was conducted at SMKN 2 Payakumbuh in the Electrical Engineering Program with a concentration in Electrical Installation Engineering (TITL). The research subjects comprised two established classes: XI TITL 1, designated as the experimental group (n = 31), and XI TITL 2, functioning as the control group (n = 30). The choice of these two classes was determined by the school's administrative categorization. Although complete random assignment was impractical due to institutional limitations, both groups were analogous regarding class size, gender distribution, and previous academic achievement.

In terms of demographics, the experimental group (XI TITL 1) consisted of 25 male and 6 female students, while the control group (XI TITL 2) included 24 male and 6 female students. Prior academic performance based on average final report card scores from the previous semester showed no significant difference between the two classes, with averages of 73.6 (experimental group) and 72.9 (control group), ensuring relative baseline equivalence.

This study focuses on the application of differentiated instruction to enhance the effectiveness of students' learning outcomes in the subject of Electrical Lighting Installation. The experimental group was provided with a tailored set of differentiated learning modules, crafted to align with students' readiness levels, learning styles, and interests. These modules included activities such as tiered assignments, varied instructional media, and flexible grouping strategies. The control group followed the standard instructional method without the integration of differentiated strategies.

The research makes use of a quasi-experimental design and applies a methodology that involves a non-equivalent control group and utilizes a pretest-posttest. This design involves comparing the learning outcomes of both groups before and after the treatment, using pretests and posttests. Although randomization was not possible, this design is appropriate for educational settings where intact classroom groups must be used. It allows researchers to infer causal relationships between the differentiated learning intervention and student outcomes, while acknowledging potential limitations due to external variables. This design also provides a realistic picture of how instructional interventions function in actual classroom environments, making the findings highly relevant for practical application in vocational education.

2.3. *Instruments*

This study utilized several research instruments to collect the required data. Each instrument served a specific function in supporting the analysis of the effectiveness of differentiated learning's effectiveness in the Electrical Lighting Installation subject.

2.3.1 Questionnaire

The first tool was a student feedback questionnaire that asked students about their thoughts and feelings about the differentiated learning module and how easy it was to use. The questionnaire had 20 closed-ended questions that were assessed on a Likert scale from 1 to 5. These questions asked about things like how clear the content was, how easy it was to use, how relevant it was to students' requirements, and how engaged they were.

This instrument was given to the experimental group after they had finished learning. The purpose was to assess how practical and usable the differentiated learning modules were from the students' perspectives. Expert validation was conducted by two Electrical Engineering education lecturers and one instructional design specialist, using a four-point rubric assessing clarity, relevance, technical accuracy, and feasibility of implementation. The average expert rating score was 89.2%, indicating high validity.

2.3.2 Learning Style Mapping

The second instrument was a learning style diagnostic questionnaire used to map students' learning preferences at the beginning of the learning process. This instrument comprised 30 multiple-choice items derived from the VARK model (Visual, Auditory, Reading/Writing, Kinesthetic) created by Fleming & Mills (1992) and was subsequently modified to the Indonesian setting by Sukmawati (2023).

The questionnaire was distributed only to the experimental group and was used to assign students to differentiated tasks and materials. Grouping strategies were applied according to the dominant learning styles identified (e.g., visual learners were assigned visual media tasks, while kinesthetic learners engaged in hands-on activities). This ensured the instructional approach aligned with the characteristics of the learners.

2.3.3 Pretest and Posttest

This study employed a testing instrument comprising pretests and posttests featuring 90 objective items linked with the skills of the Electrical Lighting Installation curriculum to assess learning outcomes. The test blueprint included the following competency domains:

Table 1. Practicality Criteria

Competency Area	No. of Items
Work Safety and PUIL (General Requirements for Electrical Installation)	15
Simple home lighting installation	15
Multi-storey house lighting installation	15
Hotel Lighting Installation	15
Lighting Installation with a smart switch	15
Public street lighting installation	15

Each item was mapped to specific indicators in the Merdeka Curriculum for the Electrical Engineering program. Before it was given, the test was checked by specialists in the field of vocational education and tried out with a group of students from a different but similar class. The validity of the test items was measured using point-biserial correlation coefficients, and the reliability was assessed with Cronbach's Alpha using IBM SPSS Statistics 25. The following table summarizes the results:

Table 2. Validity Range and Cronbach's Alpha

Instrument	Validity Range (rpbis)	Cronbach's Alpha
Learning Outcome Test (Pre/Post)	0.312–0.765 (valid)	0.956 (very high)
Questionnaire (Usability)	0.298–0.691 (valid)	0.743 (high)

2.4. Data Analysis Technique

2.4.1 Descriptive Statistics

Descriptive Statistics is a method for analyzing data that gives a full picture of the data gathered in this study. The purpose of data description is to make the data easier to understand by identifying the mean, median, and mode of the research results. This technique was performed using IBM SPSS Statistics 25 and Microsoft Excel. In this study, data description provides information about the distribution and central tendency of the data, which facilitates further analysis.

2.4.2 Preliminary Test

Before doing more data analysis, a test was done to make sure that the data that had been acquired fulfilled the standards for analysis. Normality and homogeneity tests were part of this test. We used the Kolmogorov-Smirnov test to see if the data was normally distributed. A significance value (Sig.) greater than 0.05 showed that the data were regularly distributed. Levene's Test for Equality of Variances was used to see if the control and experimental groups had the same amount of variance. A significance score greater than 0.05 indicated that the data variances were homogeneous.

2.4.3 Data Analysis

We used a number of tools to examine the validity and effectiveness of differentiated learning modules. The modules were validated using the Expert Validation approach, meaning that instructors who have participated in the Teacher Training Program (PGP) from the Ministry of Education, Culture, Research, and Technology reviewed them. Additionally, to measure the practicality of the modules, a questionnaire using a Likert scale was distributed to students after the learning activities were conducted. The Likert scale has a score range from 1 to 5, referencing the practicality criteria presented in Table 3.

Table 3. Practicality Criteria

Achievements Results (%)	Qualifications	Category
81,26 < Score ≤ 100	Excellent	Very Practical
62,51 < Score ≤ 81,25	Good	Practical
43,76 < Score ≤ 62,50	Enough	Practical Enough
25 ≤ Score ≤ 43,75	Less	Less Practical

From Table 1, the practicality criteria of this module were calculated based on the percentage obtained, with the module considered practical if its practicality value was more than 62.51%. The N-Gain Score, which compares the scores from the pretest and posttest, was also used to test how well the module worked. The effectiveness level requirements are shown in Table 4.

Table 2. Criteria for Effectiveness Levels

N – Gain	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g < 0,3	Low

Table 2 indicates that an n-gain value greater than 0.7 reflects a high level of improvement in students' learning outcomes. When the n-gain falls between 0.3 and 0.7, the improvement is categorized as moderate. Conversely, an n-gain value below 0.3 suggests minimal or negligible improvement in learning outcomes.

If t_{hit} is significantly different from t_{tab}, then H_0 is rejected. If t_{hit} is less than t_{tab}, then H_0 is allowed. IBM SPSS Statistics 25 software was used to do this T-test. A significance value (Sig. 2-tailed) below 0.05 indicates a statistically significant difference between the experimental and control groups, whereas a value above 0.05 indicates that the difference is not statistically significant.

3. FINDINGS AND DISCUSSION

3.1. Findings

3.1.1 Descriptive Statistics

The researcher gathered three categories of data in this investigation. The data comprised Learning Style Distribution, pre-test and post-test learning outcomes, and responses from questionnaires regarding the practicality of the learning process.

3.1.1.1 Learning Style Distribution

The initial analysis focused on identifying learning style preferences among students in the experimental group. This observation was conducted to design a differentiated instructional process tailored to the needs of these learners. A key stage in this preparation was the development of learning media that aligned with students' dominant learning styles, including visual, auditory, and kinesthetic modalities. Figure 1 illustrates the distribution of learning style tendencies within the experimental class.

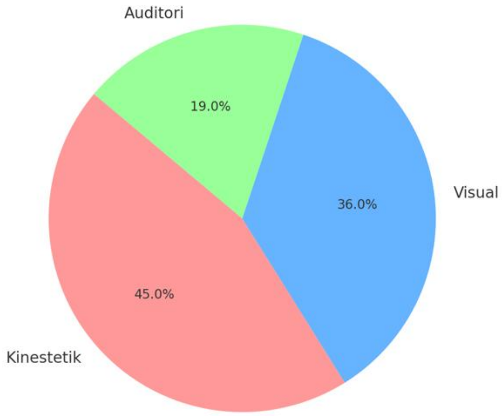

Figure 1. Percentage of Learning Tendencies in the Experimental Class

The observational findings indicate that students in the experimental group exhibited diverse learning preferences. A large proportion of learners (45%) demonstrated a preference for hands-on activities, followed by visual-based learning (36%) and auditory-based learning (19%). These findings were used to design instructional variations that accommodated individual learning needs. Overall, the results suggest that the majority of students in the experimental class tend to learn more effectively through active, experiential learning.

3.1.1.2 Pretest–Posttest Performance

Before and after the learning process, there were a total of six pre-tests and post-tests that were given to the students. One of the objectives was to determine the degree to which differentiated learning was successful in the experimental classroom. It was decided to administer pre-tests and post-tests in order to evaluate the effectiveness of differentiated learning in the experimental classroom. At the beginning of the learning process, pre-tests were administered, and at the end of the learning process, post-tests were administered. The pretest was administered to the experimental class, which utilized differentiated learning methodology, at the beginning of the learning process. The average score was higher than the score that was obtained by the control group. Figure 2 examines the differences between the experimental class and the control class in terms of the average scores obtained from the pre-test and the post-test.

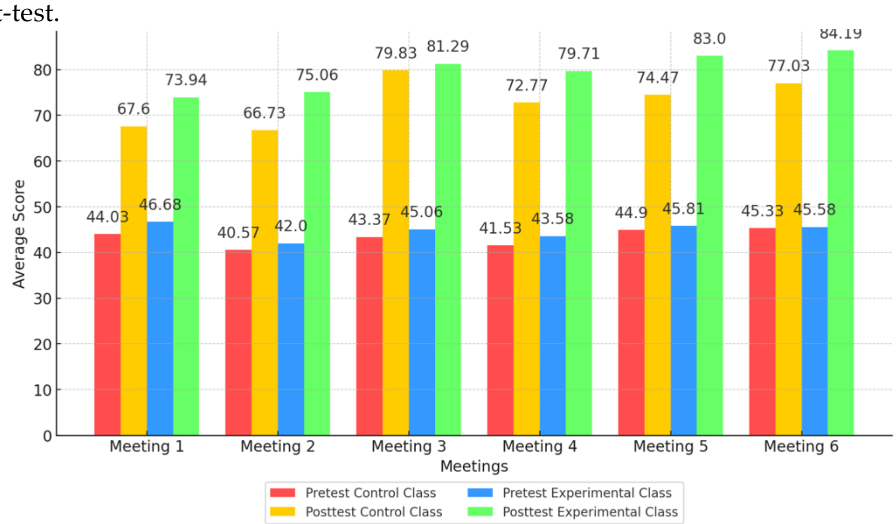

Figure 2. Comparison of Average Pretest and Posttest Scores for Control and Experimental Classes

The bar chart that can be found in Figure 2 illustrates how the average results of the pre-test and post-test for the control and experimental courses varied over the course of six learning sessions. The scores on the pretest within the control group, which was taught using conventional methods, were not very high, with an average score ranging from 40 to 46 and a maximum score of 46. Following the completion of conventional instruction, the average posttest score increased significantly, moving from 66 to 77. There was some growth in the control group, but it was not nearly as much as the growth shown in the experimental group.

On the other hand, the average score on the pretest was between 42 and 46 in the experimental class that utilized differentiated instruction. Comparatively, the average score in the control class was lower than the average score in the experimental class. The experimental class's posttest scores significantly improved after differentiated instruction was implemented, with an average score ranging from 73 to 84. This was a significant improvement. It is clear from this that differentiated learning is superior to traditional teaching methods in terms of assisting pupils in learning.

The performance of the experimental class was significantly higher than that of the control class. Given the differences between the classrooms that served as the control and those that served as the experimental setting, it is possible to assert that differentiated learning has a more significant impact on improving the learning outcomes of students. When compared to the control group, which adopted more conventional methods of instruction, the experimental group that implemented differentiated learning experienced a greater improvement in post-test outcomes. There was an improvement in the post-test results of the control class; nevertheless, these values were not as good as the scores of the experimental class. Clearly, this demonstrates that a learning technique that is better tailored to the requirements of each individual learner is more effective. Therefore, it is possible to claim that differentiated learning is more effective in improving the quality of learning outcomes, particularly when it comes to instructing classes that include a variety of learning styles.

3.1.1.3 Module Practicality

Furthermore, based on data from the questionnaire on the practicality of learning implementation, the practicality of the differentiated learning module was tested using a questionnaire distributed to students in the experimental class. Figure 3 shows the data on the practicality of learning implementation in this study.

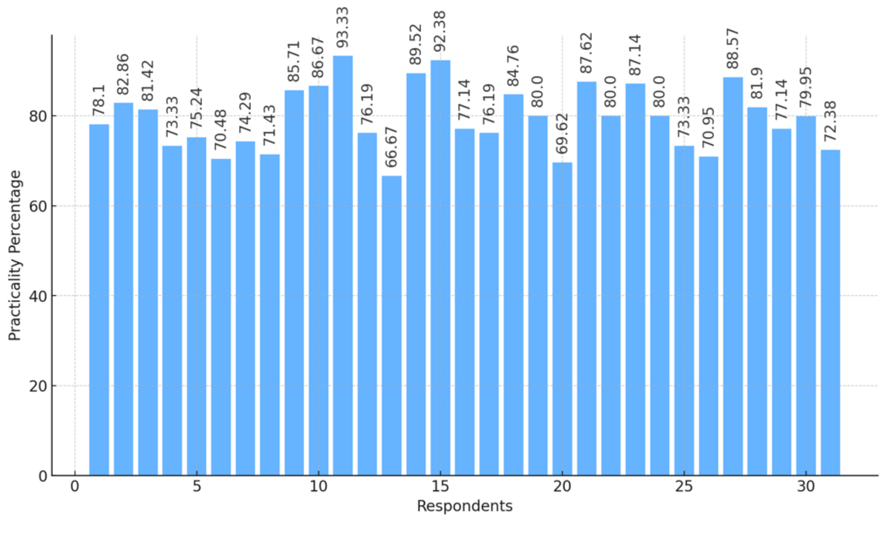

Figure 3. Graph of Practicality of Differentiated Learning Module According to Respondents

The questionnaire analysis results indicate that the learning module implemented is very practical for students. Data from 31 respondents show a mean value of 83.23, with a median value of 82 and a mode of 80. The range of values between a minimum of 70 and a maximum of 98 shows considerable variation, but overall, students feel that the module is very practical for use in learning. With a standard deviation of 7.163 and a variance of 51.314, these results indicate that the majority of students feel that the differentiated learning module is quite easy to implement and relevant to their needs.

Based on the analysis of the data, it can be inferred that differentiated learning implemented in the experimental class positively influenced student learning results. The experimental class had much higher post-test scores than the control class, which was a regular class. Differentiated learning lets students learn in a way that works best for them, which leads to better learning results. The learning modules that were used were also shown to be useful and successful, with high practicality values from student surveys. So, the application of differentiated learning should make the teaching at SMKN 2 Payakumbuh better, especially in the Electrical Engineering Program.

3.1.2 Preliminary Test

The prerequisite test for analysis aims to determine whether the collected data meets the prerequisites for analysis using specific tests. The analysis is carried out using data normality tests and homogeneity tests.

3.1.2.1 Normality Test

Following the completion of the precondition test, the typicality test is the initial piece of information that is examined. There is a statistical approach known as the normality test that examines the data to determine whether or not it follows a normal distribution. A level of 0.05 is used in the Kolmogorov-Smirnov test, which determines whether or not the data is normal. In the event that the significance value (Sig.) is more than 0.05, it is generally accepted that the data follows a regular distribution. Additionally, the results of the normality test for the pre-test and post-test values of both the control group and the experimental group are presented in Tables 3 and 4, respectively.

Table 3. The Results of Normality Tests for The Control Class Pre-test and Post-test Scores

Pretest	Kolmogorov-Smirnova			Postest	Kolmogorov-Smirnova		
	Statistic	df	Sig.		Statistic	df	Sig.
Pretest1	.157	30	.056	Postest1	.148	30	.093
Pretest2	.141	30	.135	Postest2	.117	30	.200*
Pretest3	.138	30	.148	Postest3	.158	30	.053
Pretest4	.119	30	.200*	Postest4	.140	30	.137
Pretest5	.155	30	.064	Postest5	.145	30	.108
Pretest6	.148	30	.091	Postest6	.155	30	.064

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 3 illustrates the results of the pretest done six times. The significant values for each pretest were 0.056, 0.135, 0.148, 0.200, 0.064, and 0.91. The Kolmogorov-Smirnov sig. values above are more than 0.05 or Sig. > 0.05, which means that the data from the control class pretest, which was done six times, is normally distributed. The normality test data for the control class's posttest scores, on the other hand, show that all of their significance values (sig.) are more than 0.05 (Sig. > 0.05). This means that the posttest scores from the six meetings are spread out in a typical way. The Sig. values that were found are: 0.093, 0.200, 0.053, 0.137, 0.108, and 0.096.

Table 4. The Results of Normality Tests for The Experimental Class Pre-test and Post-test Scores

Pretest	Kolmogorov-Smirnova			Postest	Kolmogorov-Smirnova		
	Statistic	df	Sig.		Statistic	df	Sig.
Pretest1	.137	31	.147	Postest1	.134	31	.166
Pretest2	.143	31	.106	Postest2	.155	31	.057
Pretest3	.144	31	.099	Postest3	.146	31	.089
Pretest4	.135	31	.159	Postest4	.151	31	.068
Pretest5	.130	31	.194	Postest5	.148	31	.083
Pretest6	.156	31	.053	Postest6	.146	31	.090

a. Lilliefors Significance Correction

Meanwhile, Table 4 shows the pretest-posttest results in the experimental class, which was also conducted six times. In the pretest normality test data, the Kolmogorov-Smirnov sig values were 0.147, 0.106, 0.099, 0.159, 0.194, and 0.053. The data above are all greater than 0.05 or Kolmogorov-Smirnov sig. > 0.05, which means that the pretest data collected six times in the experimental class are normally distributed. Meanwhile, the post-test normality test data obtained the Kolmogorov-Smirnov sig. values of 0.166, 0.057, 0.089, 0.068, 0.083, and 0.090. The sig. values obtained from the above analysis are all greater than 0.05 or sig. Kolmogorov-Smirnov > 0.05, so it can be said that all post-test values are normally distributed.

3.1.2.1 Homogeneity Test

A homogeneity test is the second essential test, and its purpose is to determine whether two or more sample data groups are from populations with the same variance. Therefore, carrying out this test will demonstrate that the data that is going to be investigated comes from the same group. Within the context of the homogeneity test, the Levene test was utilized. Here are the guidelines to follow when determining whether or not to employ the Levene test: If the Sig value is greater than 0.05, the data variance is regarded as homogeneous. On the other hand, if the Sig value is less than 0.05, the data variance is considered to be non-homogeneous. The results of the homogeneity test are presented in Table 5, which compares the values obtained before and after the test.

Table 5. Results of Pretest and Posttest Homogeneity Test

Pretest	Sig.	Postest	Sig.	Terms	Qualifications
Pretest1	0.388	Postest1	0.837	Sig > 0.05	Variations Homogen
Pretest2	0.349	Postest2	0.480	Sig > 0.05	Variations Homogen
Pretest3	0.703	Postest3	0.527	Sig > 0.05	Variations Homogen
Pretest4	0.165	Postest4	0.098	Sig > 0.05	Variations Homogen
Pretest5	0.230	Postest5	0.730	Sig > 0.05	Variations Homogen
Pretest6	0.860	Postest6	0.308	Sig > 0.05	Variations Homogen

The Sig. value is derived from Table 5. The mean of pretest 1 to pretest 6 is greater than 0.05, which means that all of the pretest data in this research have the same variance. The Sig. value, on the other hand, The Sig. values calculated from the mean posttest scores from the first to the sixth posttest are 0.837, 0.480, 0.527, 0.098, 0.730, and 0.308. This means that all of Levene's test results are more than 0.05, which means that the posttest data in this research are all the same.

3.1.3 Validity and Effectiveness

The results show that the differentiated learning module used in this study is valid based on two aspects: content and context validation. The content validation was conducted by a vocational teacher majoring in electricity with more than 20 years of experience who has participated in industrial training and internships, and ensured the synchronization of the module material with the learning objectives that must be mastered by students. Meanwhile, the context validation was conducted by a Master Teacher who assessed whether the module fulfills differentiated learning procedures and the needs of students' visual, auditory, and kinesthetic learning styles. Thus, this module is proven to be valid and suitable for use in learning in SMK. In addition, the effectiveness of this learning module can be seen from the percentage of students who completed differentiated learning compared to the percentage of students who completed conventional learning. Students are considered to have completed the module if they have a post-test score of ≥ 70. The learning outcomes from these learning methods can be seen in Figure 4, which compares the results of conventional learning and differentiated learning.

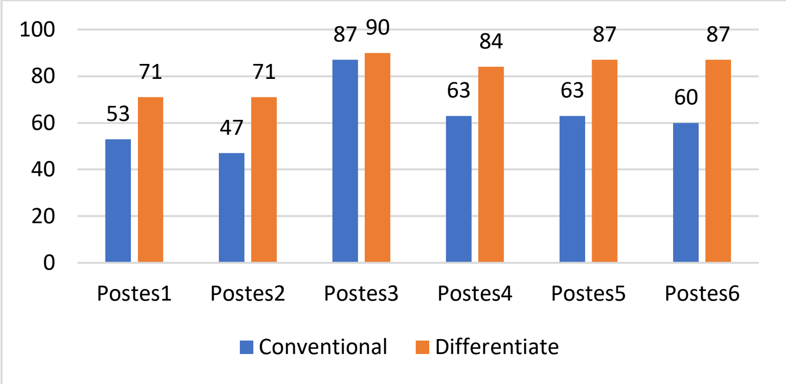

Figure 4. Comparison of Data on the Results of Conventional and Differentiated Learning

Figure 4 shows that the percentage of learning completion achieved through differentiated instruction was higher than that achieved through conventional instruction. The conventional data showed a success rate of 60% of the total number of students, while differentiated instruction achieved a success rate of 87% of the total number of students. This indicates that differentiated instruction was effective in improving student learning outcomes.

Additionally, in order to determine the significance of differentiated learning, an investigation was carried out with the use of the N-gain score test. When compared to differentiated learning, the N-gain for traditional learning was 0.57, whereas it was 0.67 for differentiated learning. Even though there was a distinction between differentiated learning and conventional learning, both types of learning were still classified as moderate by the same group. Therefore, the differentiated learning approach that was utilized was successful; nonetheless, it was still regarded as moderate. A summary of the results of the N-gain test analysis is presented in Table 6.

Table 6. Results of Pretest and Posttest Homogeneity Test

Class	Average Pretest	Average Postest	N-Gain	% N-Gain
Control	45.33	77.03	0.57	57%
Eksperiment	45.58	84.19	0.67	67%

It is possible that the t-test results, used to determine the statistical significance of differences between the two groups, can also be used to validate the research findings and demonstrate the magnitude of these differences. The findings of this experiment will greatly contribute to a better understanding of the effects that varied learning has. The independent sample t-test was carried out with the assistance of IBM SPSS Statistics 25. In cases when the significance level (two-tailed) is less than 0.05, the comparison between the control and experimental groups is considered to be significant. After the analysis, if the value of the Sig. (2-tailed) If the statistic is greater than 0.05, then the difference between the control class and the experimental class is not considered to be significant. Based on the statistical analysis, the significance level for the two-tailed test is 0.00. The outcomes of the students in the experimental class were influenced by the treatment that was administered to them, which resulted in the experimental class's scores being higher than the scores of the students in the control class.

3.2. Discussion

This study aimed to evaluate the effectiveness of differentiated instruction under the Merdeka Curriculum in the Electrical Engineering program at SMKN 2 Payakumbuh. The results revealed that differentiated instruction positively influenced student learning outcomes. Students in the experimental group, who were taught using instructional strategies tailored to their learning styles and readiness levels, outperformed the control group, who received conventional instruction. This supports the assertion that instructional personalization enhances learner engagement and academic success (Tomlinson, 2014).

Although the experimental group showed significant improvement, the N-gain score of 0.67 indicates a moderate level of effectiveness, falling short of the "high" category (>0.7). This outcome invites critical reflection. One plausible explanation is the limited duration of the intervention—only six instructional sessions. Previous studies have shown that achieving high levels of learning gains through differentiated instruction often requires sustained implementation over a longer period (Hall, Strangman, & Meyer, 2011). Additionally, while the intervention accounted for learning styles (visual, auditory, kinesthetic), it may not have fully addressed other learner differences such as prior knowledge, socio-emotional readiness, or cognitive load, which also influence learning outcomes (Subban, 2006).

Moreover, external variables potentially influenced the results. First, the use of intact classes (non-randomized groups) introduces a risk of selection bias, despite the groups being similar in prior achievement. Environmental factors such as classroom conditions, teacher-student interaction quality, or access to digital resources during instruction may also have played a role but were not controlled in the study. These confounding variables could partially account for the difference in post-test performance and the moderate level of effectiveness observed (Fraenkel, Wallen, & Hyun, 2019).

Student perception of the differentiated modules, with a practicality score of 83.23%, supports their usability and acceptance. The positive response aligns with findings by Aulia et al. (2024), who highlighted increased student motivation and satisfaction through learner-centered approaches. Additionally, Ojong (2023) emphasized that differentiated instruction helps bridge competency gaps, especially in classrooms with diverse learner profiles. The vocational context amplifies the relevance of these findings, as the acquisition of practical and job-relevant skills is essential for employability (Setiawan et al., 2023).

From a theoretical standpoint, the study contributes to the discourse on adaptive learning by affirming that differentiated instruction supports more inclusive, responsive pedagogy, especially within vocational education. It aligns with the core principle of the Merdeka Curriculum, which emphasizes flexibility, learner autonomy, and contextualized instruction (Hunaepi & Suharta, 2024). However, the findings also caution that differentiated instruction alone may not guarantee high learning gains unless paired with systematic teacher training, curriculum support, and infrastructure readiness (Sianturi, 2025).

Given that this study was conducted in a single school with a limited sample, generalizability remains constrained. Future research should expand to include multiple schools, varied vocational programs, and possibly longitudinal designs to assess the sustained impact of differentiated instruction. Investigating the roles of mediating variables, such as digital tool integration, teacher expertise, and school culture, would also enrich the understanding of implementation outcomes.

4. CONCLUSION

The findings of this study indicate that the application of individualized instruction within the Electrical Engineering Program at SMKN 2 Payakumbuh can markedly enhance student learning results in contrast to traditional pedagogical approaches. The experimental class that used differentiated instruction showed higher posttest scores, with students learning according to their learning styles, whether kinesthetic, visual, or auditory. This indicates that learning tailored to individual student needs is more effective in improving competency achievement.

The practical implications of this study are that differentiated instruction can be applied in vocational schools to improve the quality of vocational education, particularly in preparing students for an increasingly competitive job market. With this method, students feel more motivated and engaged in the learning process, which in turn helps them acquire the practical skills needed in the industry. Therefore, the implementation of differentiated learning should be considered as a more relevant and effective teaching model in vocational education settings.

However, this study has limitations in terms of the limited sample size, which was restricted to one school and one vocational program. Further research could expand the sample to include more schools and other vocational programs, as well as examine other factors that may influence the effectiveness of differentiated learning. Thus, further research could provide a broader understanding of the application of this method in various educational contexts.

REFERENCES

Alharbi, A. M. (2023). Implementation of Education 5.0 in developed and developing countries: A comparative study. *Creative Education*, *14*(5), 914–942.

Aulia, Y., Dahlan, D., & Dahlan, H. M. (2024). Improving student learning outcomes through the implementation of differentiated learning in a problem-based learning model. *PEDAGOGIK: Jurnal Pendidikan*, *11*(1), 36–53.

Fahim, A., Addae, B. A., Ofosu-Adarkwa, J., Qingmei, T., & Bhatti, U. A. (2021). Industry 4.0 and higher education: an evaluation of barriers affecting master's in business administration enrolments using a grey incidence analysis. *IEEE Access*, *9*, 76991–77008.

Hamami, T., & Nuryana, Z. (2022). A holistic–integrative approach of the Muhammadiyah education system in Indonesia. *HTS Teologiese Studies/Theological Studies*, *78*(4).

Hunaepi, H., & Suharta, I. (2024). Transforming education in Indonesia: The impact and challenges of the Merdeka belajar curriculum. *Path of Science*, *10*(6), 5026–5039.

Irsyad, S. F., Syarif, H., & Zainil, Y. (2024). Flexible Approach In English Language Learning Curriculum Design: Optimizing Teaching In Merdeka Curriculum. *Eduvest-Journal of Universal Studies*, *4*(11), 9843–9852.

Jakandar, L. I. E., Pantiwati, Y., Sunaryo, H., & Fikriah, A. (2025). Integration of Religious Values in Character Education: Building the Morals of the Golden Generation. *Al-Hayat: Journal of Islamic Education*, *9*(1), 124–141.

Karim, L. N., Solikhah, I., Saputri, A. P., & Prayitno, M. A. (2025). Implementation of Differentiated Learning and Development of English Teaching Materials within the Context of the Merdeka Curriculum. *Indonesian Research Journal on Education*, *5*(1), 902–909.

Labordo Jr, D. C. (2024). Assessing the Influence of differentiated instruction on enhancing reading comprehension skills among learners: A quasi-experimental study. *The New English Teacher ISSN 2985-0959 (Online)*, *18*(2), 13–28.

Mukti, M. P. W., Cahyono, A., & Suwardi, S. (2023). Quality Education Plays A Central Role in Shaping A Superior and Competitive Generation. *International Conference on Science, Education, and Technology*, *9*, 447–451.

Ojong, A. S. (2023). Unraveling the Efficacy of Differentiated Instruction in Enhancing Second Language Acquisition: A Comprehensive Review and Future Directions. *International Journal of Linguistics, Literature & Translation*, *6*(6).

Pervez, N., Mahmood, W., Akram, M., & Waqas, M. (2024). Analyzing the Alignment between University Curriculum and Job Market Requirements in Pakistan: Challenges and Opportunities. *Indus Journal of Social Sciences*, *2*(2), 397–410.

Pratikno, Y., Hermawan, E., & Arifin, A. L. (2022). Human resource 'Kurikulum Merdeka'from design to implementation in the school: What worked and what not in Indonesian education. *Jurnal Iqra': Kajian Ilmu Pendidikan*, *7*(1), 326–343.

Rajak, K. K., & Dey, N. G. (2025). Differentiated Assessment Strategies: An Assessment Practice for Diverse Learners in the Inclusive Classroom. *Asian Journal of Education and Social Studies*, *51*(1), 17–24.

Rohaeni, A., Wasliman, I., Rostini, D., & Iriantara, Y. (2021). Management of Noble Moral Education for Madrasah Aliyah Students at Persatuan Islam Boarding School. *Journal of Industrial Engineering & Management Research*, *2*(4), 154–171.

Setiawan, A., Anwar, M. S., Wardana, M. R. F., & Yambasu, R. A. (2023). The Effect of Differentiated Learning on Improving Student Learning Outcomes. *Delta-Phi: Jurnal Pendidikan Matematika*, *1*(1), 46–50.

Sianturi, B. (2025). Teachers' Perceptions and Challenges in Implementing Differentiated Learning in Kurikulum Merdeka. *J-SHMIC: Journal of English for Academic*, *12*(1), 1–15.

Sugiyono, S. (2015). Metode Penelitian & Pengembangan Research and Development. *Bandung: Alfabeta*.

Vaganova, O. I., Odarich, I. N., Ol'ga, A. R., Volkova, J. S., & Bulaeva, M. N. (2020). Level differentiation technology in vocational education. *Amazonia Investiga*, *9*(28), 42–49.