



Development of E-Module Based on Discovery Learning to Improve Students' Learning Outcomes in PKKR Subject for Grade XI TKRO at State Vocational High School 1 Merbau

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Abstract: This research aims to develop, measure the validity, assess the practicality, and evaluate the effectiveness of an e-module based on discovery learning to enhance the learning outcomes of 11th-grade students in Electrical Vehicle Maintenance subject. This study falls under the category of Research and Development, involving the development of an e-module for the topic of light vehicle electrical maintenance that is valid, practical, and effective using the discovery learning approach. The development of this e-module based on discovery learning follows the 4-D model, which includes defining, designing, developing, and disseminating stages. The validation results of the developed e-module based on discovery learning fall under the category of valid. The practicality assessment of the discovery learning-based module is classified as very good, and the effectiveness of the e-module based on discovery learning as a learning media indicates that this learning media is considered effective.

Keywords: discovery learning; effectiveness e-module e-module; e-module validity

Introduction

In order to achieve educational goals, education implementation should be carried out with innovative learning methods in line with the advancements of the era (Ratnasari & Haryanto, 2019). Educational innovations emerge in various fields and forms, such as innovations in organized and managed education systems, as well as innovations in teaching techniques or delivery systems, such as the use of technology-based learning models (Oke & Fernandes, 2020). These innovations aim to produce quality learning activities, enabling the teaching and learning process to enhance students' abilities to think independently, creatively, and innovatively.

The Education for All (EFA) Global Monitoring Report 2011, titled Hidden Crisis, Armed Conflict, and Education, published by UNESCO, stated that Indonesia's Education Development Index has declined

from rank 65 to rank 69 out of 127 countries (Mboi et al., 2022). This indicates the need for a push to enhance students' skills and soft skills to make them excellent and high-quality students in their respective fields. In preparing competitive and high-quality students, the Indonesian government, through the Ministry of Education, Culture, Research, and Technology, has formulated policies to advance the educational curriculum from the 2013 Curriculum (K13) to the Prototype Curriculum or the Curriculum of Independent Learning.

This development essentially marks the initial step in the effort to transform education for the realization of excellent and high-quality students. Curriculum changes naturally follow the advancements of the era. Nowadays, there is a need for a learning process that focuses on students' critical thinking skills, creativity, self-confidence, freedom for students, freedom for teachers, and processes like these are summarized in the

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prototype curriculum (Vincent-Lancrin, 2023). The teaching-learning process is fundamentally aimed at enhancing students' competence, activities, and creativity in various meaningful learning activities and experiences (Pho et al., 2021). The teaching-learning process can be successful if supported by learning resources that can foster students' independence and interaction. One such learning resource is the use of systematically designed digital-based teaching modules that can be used effectively and efficiently (Abdulrahman et al., 2020).

(Gamage et al., 2022), Explains that educational modules are systematically organized educational tools written in standard language to be easily understood by users. Teaching modules are crucial parts of the learning process. They can promote independent and planned learning in students and facilitate teachers in measuring and monitoring students' progress. (Culajara et al., 2022), Explained in their study that digital-based teaching modules can enhance students' learning experiences and result in better performance. E-modules, apart from their positive impact on students, also assist teachers in organizing and monitoring students' learning processes. (Mershad & Said, 2022), stated that the use of e-modules helps teachers manage lessons and monitor each student's activities. The use of e-modules can be more practical compared to printed teaching modules.

Digital-based resources can enhance academic progress, provide various learning resources, increase flexibility, and improve students' learning effectiveness. This perspective is supported by (Liu & Yu, 2023), who stated in their study that e-modules are systematically packaged digital materials containing features not found in printed modules, making learning more innovative and effective. Light Vehicle Electrical Maintenance (PKKR) is one of the subjects that vocational high school students majoring in light vehicle engineering must master. This subject includes materials about vehicle electrical systems such as body electrical systems, ignition systems, starter systems, and charging systems. This research focuses on the maintenance of the starter system in the automotive light vehicle engineering class XI. Based on the results of initial interviews and observations at the school where the research was conducted with the teacher teaching Light Vehicle Electrical Maintenance (PKKR) in class XI at SMK Negeri 1 Merbau, it was stated that there were low learning outcomes in the learning process and a lack of active student participation in teaching activities. This is due to the lack of innovative and engaging learning media for students and the use of inappropriate teaching methods.

The learning media used at SMK Negeri 1 Merbau includes the New Step 1 Training Manual TOYOTA

book, other automotive knowledge books in the library, and modules obtained by teachers during training. For practical activities, teachers use jobsheets, and some jobsheets at SMK Negeri 1 Merbau are in the form of student worksheets. The teaching method used involves teachers explaining the material according to the content of the learning media, and most students feel drowsy during the teaching activities. Furthermore, the teaching models used by teachers are still conventional, which fails to capture students' attention. The Minimum Passing Criteria (KKM) set in class XI TKR SMK Negeri 1 Merbau is 70, with 37.5% of 40 students (15 students) scoring above KKM, while the remaining 62.5% (25 students) are still below KKM. This can be seen in Table 1, which shows students' learning outcomes in the subject of Light Vehicle Electrical Maintenance (PKKR). This data indicates that the development of automotive vocational competencies is still relatively low and concerning.

The development of e-modules based on discovery learning is an innovation aimed at improving students' learning outcomes. The content of the developed e-module will be tailored to the stages of the discovery learning teaching method with the goal of providing a different impression in the learning process using e-modules based on discovery learning (Maghfiroh et al., 2023a). The variety of teaching methods used in the learning process requires educators to use appropriate methods for each teaching activity to ensure effective and efficient learning. One factor influencing the suitability of teaching methods used is the students' characteristics. As educators, understanding students' characteristics is essential to determine suitable teaching methods. Discovery learning is one of the teaching methods often used in the school learning process.

The discovery learning method encourages students to be active in the learning process. Students are expected to develop or discover new things or new knowledge from what educators have provided. In this method, educators provide materials as stimuli to students, and students themselves will explore further to find new knowledge beyond what educators have presented. The e-module based on discovery learning is an electronic book or digital book containing materials to be presented to readers, especially students, with the concept of the discovery learning teaching method (Maghfiroh et al., 2023b). The developed e-module will encompass the stages of learning using the discovery learning method. The e-module based on discovery learning not only contains text but also includes videos and animations, which are expected to enhance students' learning enthusiasm.

Method

This type of research falls under the category of Research and Development (R&D), aimed at developing an e-module for the subject of light vehicle electrical maintenance that is valid, practical, and effective using a discovery learning approach. According to (Sakız et al., 2021), research and development is a longitudinal study conducted over multiple years with the purpose of analyzing needs, producing, and testing the effectiveness of the product. The 4-D model by (Alam et al., 2022) is used, which consists of four stages: definition, design, development, and dissemination.

Referring to the research approach, this R&D implementation uses a combination of qualitative and quantitative approaches. The qualitative approach is descriptive in nature and is used in preliminary studies or data collection activities to gather initial information. An evaluative type of qualitative approach is employed to evaluate the product during the development process, both the process and the results, with subsequent product refinements. The quantitative approach in this research is experimental, used to test the effectiveness of the developed e-module. The experimental method is employed to determine the effect of one treatment on another in a controlled environment. This research focuses on the development of an e-module for teaching light vehicle electrical maintenance using a discovery learning approach. The development model used is the 4-D model which comprises four stages: definition, design, development, and dissemination.

In the first stage, the definition phase, needs analysis is conducted. This includes both initial and final analyses, involving interviews with Light Vehicle Electrical Maintenance subject teachers to understand the current learning situation. Student analysis is performed to understand student characteristics and their knowledge levels. Additionally, concept analysis is conducted to identify key concepts in learning, which will form the basis of the e-module content. The second stage is the design phase, where the concepts identified in the definition stage are hierarchically organized to create e-module content with a logical sequence.

The third stage is e-module development, which involves structuring the content in accordance with the discovery learning approach. This includes processes such as stimulation, problem formulation, data collection, data processing, verification, and generalization. Finally, the dissemination stage is carried out to ensure that the e-module is available and can be used by teachers and students.

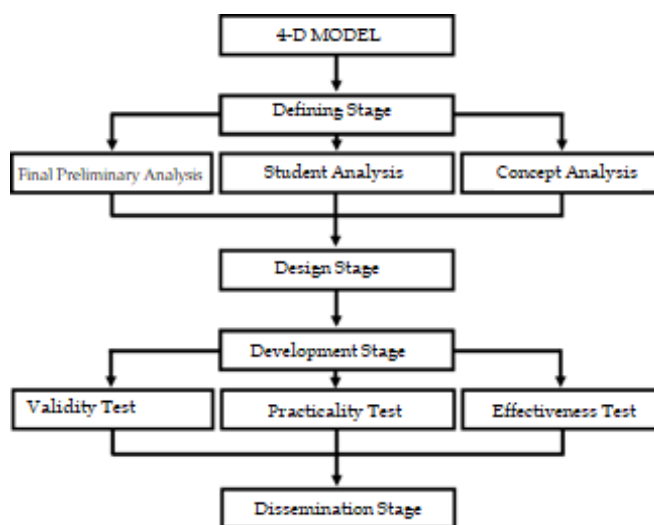


Figure 1. 4-D Model Development Procedure

Following the 4-D model and a discovery learning approach, this research aims to develop a valid, practical, and effective e-module for teaching the maintenance of light vehicle electrical systems. The Design phase in the development of the e-module for light vehicle electrical maintenance learning involves a series of key steps. It is essential to design a high-quality e-module that is easy for students to understand. This includes the use of communicative language and providing numerous questions that students can answer individually. The design of the e-module involves four steps following the 4-D model: Define, Design, Develop, and Disseminate. This includes the creation of test standards, media selection, format selection, and the initial design of the e-module. Test standards are used to measure student comprehension and understand their learning needs.

Next, the Development phase involves validity testing, practicality testing, and effectiveness testing. Validity testing involves experts evaluating the e-module to ensure it aligns with the learning objectives. Practicality testing assesses how easy the e-module is for teachers and students to use in practice. Effectiveness testing aims to measure the impact of the e-module on student learning outcomes, typically by comparing pre-tests and post-tests. The design and development phases of the e-module are at the core of creating high-quality teaching materials. This ensures that the e-module is not only content-valid but also practical and effective in enhancing student comprehension. By following these steps, developers can ensure that the resulting e-module significantly contributes to the learning of light vehicle electrical maintenance.

The Development phase of e-module creation includes validity testing, practicality testing, and effectiveness testing. First, validity testing involves

assessment by experts in relevant fields to ensure that the e-module meets educational standards and presents accurate content. This is done through rational thinking and systematic evaluation. Second, practicality testing focuses on the usability of the e-module by teachers and students. In this case, teachers and students are asked to complete questionnaires that assess how easy and efficient the e-module is in the learning process (Coman et al., 2020).

Third, effectiveness testing aims to measure the impact of the e-module on student learning outcomes. This is done by comparing test results before and after the use of the e-module. Test results help determine whether the e-module genuinely improves student comprehension. The product testing phase involves the development of a test design, expert validity testing, practicality testing involving teachers and students, and effectiveness testing by comparing test results before and after e-module use.

All of these steps are crucial to ensure that the developed e-module meets learning needs and standards, is easy to use in real contexts, and is effective in enhancing student comprehension. In this case, the subjects for testing are 11th-grade students in the Light Automotive Vehicle Technology program at Merbau State Vocational High School. Instruments used include needs analysis, validation instruments, practicality instruments, and performance test instruments. This evaluation is essential to ensure the quality and effectiveness of the e-module in supporting student learning in light vehicle electrical maintenance content.

Result and Discussion

The development of an e-module based on Discovery Learning for the subject of Light Vehicle Electrical Maintenance (PKKR) can be divided into several stages, starting from the definition stage to the design stage. The definition stage involves the analysis of the school's conditions, interviews with PKKR teachers, and an analysis of the curriculum and textbooks used (Tomas et al., 2021). The interviews with teachers revealed that PKKR learning typically uses conventional methods such as lectures and discussions. The use of textbooks and Student Worksheets (LKS) is still inadequate in motivating students, and students are less active in the learning process. The analysis of the subject's curriculum showed that it covers basic competencies related to starter system maintenance, while the analysis of textbooks indicated a lack of concept exploration and visual appeal in the teaching materials used.

Based on this definition, the researcher designed an e-module based on Discovery Learning for the topic of

starter system maintenance. This e-module is designed with the aim of making learning more engaging, increasing student participation, and supporting concept comprehension. This problem-based e-module follows the standard e-module writing format, including content standards, user instructions, and Discovery Learning-based learning stages (Hardeli et al., 2022). The design stage includes an attractive e-module cover design, an introduction, user instructions, concept maps, Core Competencies and Basic Competencies, Discovery Learning-based learning stages, exercises, summaries, glossaries, and a bibliography. The next stage is the validation and reliability testing of the instrument. The instruments used in this research have been tested for their validity and reliability in previous studies, making them valid and reliable for use in this research (Taherdoost, 2016).

This Discovery Learning-based e-module is designed to improve the quality of PKKR subject learning, especially in the area of starter system maintenance. It is expected to make learning more engaging and participative, enabling students to better understand the concepts. This e-module has gone through various well-designed stages, and the validity and reliability of the instruments have been tested. It is expected to make a positive contribution to improving PKKR learning at SMK Negeri 1 Merbau. The validation stage involves three validators: a subject matter expert, a media expert, and a language expert. The analysis results show that this e-module has a very high level of validity. Of the 26 statements evaluated, 16 have "very high" validity, while the others have "high" validity. The content in the e-module is in line with the competencies and learning objectives.

The practicality stage involves limited testing with students and teachers from the XI Light Automotive Vehicle Engineering class. The survey results show that both teachers and students responded positively to the practicality of this e-module. The student response percentage reached 94.65%, and teachers provided an even higher percentage. In the effectiveness stage, the Ngain Score and Mann-Whitney tests were conducted to compare the learning outcomes between the experimental class using the Discovery Learning e-module and the control class using conventional methods. The results show that the Discovery Learning-based e-module is effective in improving learning outcomes, with a higher Ngain Score in the experimental class.

After going through the validation, practicality, and effectiveness stages, this e-module underwent revisions based on feedback from the validators. Revisions include improving the appearance, images, and language usage to ensure the perfection of the e-

module. Overall, the Discovery Learning-based e-module for light vehicle electrical maintenance has undergone careful development and passed through validation, practicality testing, and effectiveness testing. It is found to be highly valid, practical, and effective in improving student learning outcomes at SMK Negeri 1 Merbau. Revisions were made to ensure a better qualities e-module.

Discussion

Definition Stage

Vehicle Electrical Maintenance (VEM) is one of the subjects that students in vocational high schools, specifically in the field of light vehicle engineering, must master. This subject cover topics related to the electrical systems in vehicles, such as body electrical systems, ignition systems, starter systems, and charging systems. This research focuses on the maintenance of the starter system in the automotive light vehicle engineering class of grade XI. To ensure effective learning, it is crucial to create teaching materials that align with students' understanding and keep pace with the times. Based on observations and interviews, existing teaching materials were only available in the school library. This limitation meant that students had no additional resources beyond what was in the library. To address this issue, an instructional material in the form of an e-module based on discovery learning was developed. The module adheres to the 2013 curriculum or the curriculum used in SMK Negeri 1 Merbau.

The e-module was developed using Exe-Learning software, allowing it to be saved in various file formats such as Scorm, website, and edited using applications like Book Cover and PostLab. The Discovery Learning syntax, consisting of six stages, was employed in creating the e-module. Additionally, the module includes videos that provide clear insights, motivating students as the content relates to everyday life (Al Mamun & Lawrie, 2023). The aim of the Discovery Learning-based E-Module Using Exe-Learning in class XI Light Vehicle Engineering at SMK Negeri 1 Merbau is to assist teachers in delivering the curriculum and enable students to learn independently or collaboratively, enhancing their knowledge and improving learning outcomes.

Design Stage

The design stage follows the definition stage. During this phase, a prototype of the discovery learning-based e-module is created, aligning with the Core Competencies (CC) and Basic Competencies (BC) outlined in the syllabus developed at SMK Negeri 1 Merbau, specifically focusing on the topic of applying maintenance methods to the starter system. The e-module is designed according to the Discovery Learning

syntax using Exe-Learning software. In the initial phase, the e-module is designed using applications like Book Cover and PostLab to make the instructional material more engaging for both teachers and students. The e-module includes various components such as: module identity, comprising educational unit, sub-theme, and subject; introduction; user instructions; concept map; CC, BC, learning indicators, and learning objectives; student learning activities.

The e-module incorporates student activity sheets following the Discovery Learning steps, including the start or stimulation phase, where a relevant video is shown to stimulate students' interest (Hardeli et al., 2022). The Problem Statement phase involves educators presenting hypotheses about the presented phenomenon, and students contribute their hypotheses regarding the formulated problem. In the Data Collection phase, students are divided into groups to discuss the topic using specified procedures. Data Processing involves students analyzing and processing the data collected from their discussions. In the Verification phase, students discuss their observations, address provided questions, and compare their observations with theories from other source materials.

The Generalization phase involves each group presenting their discussion outcomes and drawing conclusions (Pedaste et al., 2015). Subsequently, the module includes practice questions, summaries, glossaries, and additional reading materials. Once completed, the e-module is converted into an electronic format using Exe-Learning software (Hadiyanti et al., 2021). This application is used to transform the module into an electronic format and allows the addition of videos within the e-module. After editing, the e-module is saved as an executable file and can be run on laptops after installing the necessary application.

Development Stage (Develop)

Validation and Revision of Discovery Learning-Based E-Module

The question posed in the problem statement, What is the validity of the development of a discovery learning-based e-module for the topic of applying maintenance to the starter system for Class XI Light Automotive Vehicles? has been answered based on the validation results of the discovery learning-based e-module using the Exe-Learning software by the validator. The validation results indicate that the discovery learning-based e-module using the Exe-Learning software designed by the researcher is valid and can be used in the learning process. The percentage obtained from the validation results of the discovery learning-based e-module using Exe-Learning is 77%, falling within the range of 77% to 80%. Overall, the discovery learning-based e-module is considered valid,

as validated by the content aspect with a validation result of 75% with valid criteria, while the format and language aspects received validation results of 80% and 77% with valid criteria. This is the result of the validator's analysis of the discovery learning-based e-module using the Exe-Learning software designed by the researcher, with revisions made based on the feedback provided by the validator.

The discovery learning-based e-module using the Exe-Learning software for the topic of applying maintenance to the starter system is considered valid based on the assessment of the validator for the following reasons (Utami et al., 2022): The content of the discovery learning-based e-module using the Exe-Learning software, as designed, is in line with the curriculum and syllabus in use. The problems presented in the e-module are consistent with the material, and the learning objectives and content match the discovery learning steps contained in the module. This encourages students to engage in investigative activities and discover concepts independently, thus supporting students' understanding of the learning material. The presentation of the discovery learning-based e-module using the Exe-Learning software, as designed, includes an identity, cover, introduction, usage instructions, and the desired competencies. It also contains activity sheets organized according to the steps of the discovery learning process. The material elaboration includes teaching content and practice questions, complete with feedback. The e-module's design is visually appealing in terms of color, font type, font size, and it attracts students to engage in learning.

The language used is in accordance with proper language rules, and the format and font choices are user-friendly, making it easy for students to understand the content interactively and communicatively (Azar & Tan, 2023). The physical dimensions and cover design of the e-module are visually appealing, and the text within the e-module is clear and easily legible (Wahyuni & Arnyana, 2022). The expected goal of the discovery learning-based e-module has been achieved, as it has produced a valid e-module designed using Exe-Learning software to enhance students' learning outcomes. This research aligns with the findings of (Prasad & Bakhshi, 2022), who also reported that the overall development of e-modules was considered good, with a response rate of 62.47%, falling into the "good" category when converted into a table.

Similarly, research conducted by (Khuzaimah et al., 2022), on the development of Exe-Learning-based e-modules for the topic of Harmonic Motion in Class X found that the educator's response was 3.08, indicating interesting, and the students' response from small group

testing resulted in 3.52, categorized as "very interesting." The discovery learning-based e-module using the Exe-Learning software developed is used to build students' knowledge and assist educators in delivering information. Students can learn independently or in groups. This aligns with the statement by (Grassini, 2023), that quality education is achieved when educators create engaging, creative, and innovative teaching materials that go beyond conventional teaching materials.

Following the validation of the discovery learning-based e-module using the Exe-Learning software, the researcher received feedback and input from the validator, including (Permatasari et al., 2022): Simplify the instructions for teachers in the module; Ensure that subtopics are consistent with the concept map; Add references to the e-module; Practicality of Discovery Learning-Based E-Module Using Exe-Learning Software The question in the problem statement, "How practical is the development of a discovery learning-based e-module using Exe-Learning Software for the topic of applying maintenance to the starter system for Class XI Light Automotive Vehicles?" has been answered based on the practicality results of the discovery learning-based e-module using Exe-Learning Software from both educators and students. According to (Awad Ahmed et al., 2021), practicality involves the ease of conducting tests, including preparation, utilization, execution, analysis, and implementation.

A product is considered highly practical if it is user-friendly. The practicality of a product is assessed after subjecting it to research subjects. After conducting limited trials at SMK Negeri 1 Merbau for Class XI TKRO, the practicality of the discovery learning-based e-module using Exe-Learning Software was assessed based on the completion of response questionnaires by educators and students. The results of the questionnaires completed by educators showed that the e-module designed using Exe-Learning Software is highly practical for use as a teaching aid, with a 95% approval rate. Meanwhile, the results of the questionnaires completed by students indicated that the e-module designed using Exe-Learning Software is highly practical for use in the learning process, enabling both independent and group learning, with an 84% approval rate. This aligns with the design of the discovery learning-based e-module using Exe-Learning Software, which features an attractive interface, ease of understanding and operation, and practicality, facilitating independent or group learning for students (Utaminingsih et al., 2022).

Table 1. Questionnaire Results of Students' Responses to the Practicality of Discovery Learning-Based E-Module

| Item Number | Student Score | Score Maximum | Persentase | Description |
|-------------|---------------|---------------|------------|----------------|
| 1 | 152 | 160 | 95 | Very Practical |
| 2 | 154 | 160 | 96.25 | Very Practical |
| 3 | 156 | 160 | 97.50 | Very Practical |
| 4 | 159 | 160 | 99.37 | Very Practical |
| 5 | 159 | 160 | 99.37 | Very Practical |
| 6 | 151 | 160 | 94.37 | Very Practical |
| 7 | 151 | 160 | 94.37 | Very Practical |
| 8 | 158 | 160 | 98.75 | Very Practical |
| 9 | 148 | 160 | 92.50 | Very Practical |
| 10 | 152 | 160 | 95 | Very Practical |
| 11 | 154 | 160 | 96.25 | Very Practical |
| 12 | 155 | 160 | 96.87 | Very Practical |
| 13 | 147 | 160 | 91.87 | Very Practical |
| 14 | 154 | 160 | 96.25 | Very Practical |
| 15 | 152 | 160 | 95 | Very Practical |
| 16 | 149 | 160 | 93.12 | Very Practical |
| 17 | 151 | 160 | 94.37 | Very Practical |
| 18 | 132 | 160 | 82.50 | Very Practical |
| 19 | 152 | 160 | 95 | Very Practical |
| 20 | 158 | 160 | 98.75 | Very Practical |
| 21 | 134 | 160 | 83.75 | Very Practical |
| 22 | 155 | 160 | 96.875 | Very Practical |
| 23 | 152 | 160 | 95 | Very Practical |
| 24 | 149 | 160 | 93.12 | Very Practical |
| 25 | 152 | 160 | 95 | Very Practical |
| Total | 3786 | 160 | 94.65 | Very Practical |

Based on the analysis of the questionnaire responses from students regarding the practicality of the e-module based on discovery learning using the Exe-Learning Software, it was found that. The e-module based on discovery learning using the Exe-Learning Software has an attractive appearance, can be used independently or in groups, and optimizes the understanding of concepts for students. In terms of content and the construction of the e-module based on discovery learning, it achieved a practicality score of 90% with a categorization of very practical, and in terms of language and presentation, it received a score of 91% with a categorization of very practical. The e-module based on discovery learning is developed in accordance

with the cognitive development of students, making it easy to understand.

Meanwhile, the analysis of the questionnaire responses from teachers regarding the e-module based on discovery learning using the Exe-Learning Software indicates that it can simplify and assist teachers in delivering the material and is easy to understand. With the e-module based on discovery learning using the Exe-Learning Software, teaching becomes more meaningful, and the learning outcomes of students improve, making them more interested in further studying PKKR (the specific subject or content area).

Table 2. Results of the Questionnaire Responses from Teachers Regarding the Practicality of the E-Module Based on Discovery Learning

| Question Item | Score | Score Maks | Persentase | Description |
|---------------|-------|------------|------------|----------------|
| 1 | 4 | 4 | 100 | Very Practical |
| 2 | 4 | 4 | 100 | Very Practical |
| 3 | 4 | 4 | 100 | Very Practical |
| 4 | 4 | 4 | 100 | Very Practical |
| 5 | 3 | 4 | 75 | Very Practical |
| 6 | 4 | 4 | 100 | Very Practical |
| 7 | 4 | 4 | 100 | Very Practical |
| 8 | 3 | 4 | 75 | Very Practical |
| 9 | 4 | 4 | 100 | Very Practical |
| 10 | 4 | 4 | 100 | Very Practical |
| 11 | 4 | 4 | 100 | Very Practical |

| Question Item | Score | Score Maks | Persentase | Description |
|-----------------------|-------|------------|------------|----------------|
| 12 | 4 | 4 | 100 | Very Practical |
| 13 | 4 | 4 | 100 | Very Practical |
| 14 | 4 | 4 | 100 | Very Practical |
| 15 | 4 | 4 | 100 | Very Practical |
| 16 | 3 | 4 | 75 | Very Practical |
| Total Item Score 1-16 | | 64 | 95.31 | Very Practical |

Conclusion

In this development research, an e-module based on discovery learning has been developed for the subject of Light Vehicle Electrical Maintenance with the basic competency of Applying starter system maintenance procedures. The validation results of the developed e-module based on discovery learning fall into the "valid" category. This validity is determined after validation by content, media, and language experts. The practicality of the e-module based on discovery learning, after being tested for suitability by media and content experts, resulted in a final score of 87% for content experts, indicating that the e-module is highly suitable for use in the learning process. For media experts, the score was 91%, classifying the e-module as suitable for use in the learning process. Student feedback on the e-module based on discovery learning received a percentage score of 94%, indicating that it is excellent. Meanwhile, teacher feedback received a percentage score of 95%, categorizing the e-module as excellent. The effectiveness of the e-module based on discovery learning as a learning medium indicates that it is an effective learning tool, as evidenced by the improvement in student learning outcomes from pretests to posttests. The average student learning outcome for the pretest was 27.62, while for the posttest, it was 79.80. This indicates an increase in student learning outcomes, and the N-Gain test results show an average improvement score of 0.52, indicating moderate improvement in student learning outcomes.

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Author contribution

Conceptualization and Methodology; N. K.; Formal Analysis; H. M., and W.; Investigation; W. P., N. K, H. M., and W.; Original Draft Writing; W. P., W., H. M., and N. K., were responsible for writing and drafting the initial manuscript of the article; Review and Editing, W. P., W., N. K., and H. M., conducted editing to improve the structure and substance of the article; Visualization, W., and W. P were responsible for creating charts and tables; Final Approval, all authors approved the published version of the manuscript.

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Conflict of interest

Conflict of interest that could harm any party does not exist in this research. The study is conducted with full transparency, and all involved parties are committed to maintaining the integrity and objectivity of the research results.

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