JMEL 15 (1) (2026)
Journal of Mechanical Engineering Learning
https://journal.unnes.ac.id/journals/jmel
doi: https://doi.org/10.15294/jmel.v15.i1.30822

Development of a Website-Based E-Module to Improve Student Learning Outcomes on Starter System Material at SMK Teuku Umar

Ridha Al Rizqi[1]*, Bunyamin[2], Wahyudi[3], Dwi Widjanarko[4]
[1,2,3,4]Automotive Engineering Education, Faculty of Engineering, Universitas Negeri Semarang
Building E5, Faculty of Engineering, UNNES Taman Siswa Street, Sekaran, Gunungpati, Semarang 50229, Indonesia
*Corresponding author. Email: ridhaal737@students.unnes.ac.id

How to cite (APA Style 7th) : Rizqi, R. A., Bunyamin, Wahyudi, & Widjanarko, D. (2026). Development of a Website-Based E-Module to Improve Student Learning Outcomes on Starter System Material at SMK Teuku Umar. *JMEL : Journal of Mechanical Engineering Learning*, *15*(1), 9–17. https://doi.org/10.15294/jmel.v15.i1.30822

ARTICLE INFO

Article History:
Received: June 10, 2026
Revised: July 9, 2026
Accepted: July 11, 2026

Keywords:
E-module; Starter system; Learning outcomes

Abstract

This study aimed to develop and examine the feasibility and effectiveness of a website-based starter system e-module for Grade XI students in the Light Vehicle Engineering Department at SMK Teuku Umar. This study employed a research and development approach using the ADDIE model, which consists of Analyze, Design, Development, Implementation, and Evaluation stages. The effectiveness of the product was tested using a one-group pretest–posttest design involving 29 Grade XI TKR 1 students. The instruments used in this study included expert validation sheets, learning outcome tests, and a student response questionnaire. The feasibility test involved two media experts and two subject matter experts. The results showed that the developed e-module was categorized as very feasible, with validation scores of 92.36% from media experts and 91.66% from subject matter experts. The learning outcome test showed that students' mean score increased from 47 in the pretest to 76 in the posttest. The paired-sample t-test indicated a significant improvement in students' learning outcomes, with tcount = 18.36, which was higher than ttable = 2.048. The N-Gain score was 0.5582, or 55.82%, indicating a moderate level of effectiveness. Student responses reached 85%, categorized as very positive. Therefore, the website-based starter system e-module is feasible and moderately effective for supporting starter system learning. However, this study was limited to one class and did not involve a control group; therefore, broader trials with comparison groups are recommended.

1. INTRODUCTION

Education plays a strategic role in developing competent human resources who are able to adapt to social, technological, and industrial changes. As stated in Law No. 20 of 2003 Article 1 Paragraph 1, education is a conscious and planned effort to create a learning environment and learning process that enables students to actively develop their potential. In this context, Vocational High Schools (SMK) are expected to prepare students with specific competencies required by the world of work through the integration of theoretical knowledge and practical skills. According to

Fikriyah and Furoida (2021), vocational education emphasizes the mastery of specific skills and requires learning strategies that are relevant to students' fields of expertise. Therefore, learning in vocational education, including automotive engineering, should be supported by instructional media that can help students understand technical concepts, visualize work processes, and develop practical competence.

One of the important competencies in the Light Vehicle Engineering Department is understanding the automotive starter system. This material requires students to understand the function of components, electrical circuits, working principles, inspection procedures, and troubleshooting steps. However, starter system learning is often difficult because it combines electrical concepts and mechanical operation that cannot always be understood through verbal explanation or printed materials alone. In 21st-century learning, the use of digital technology is increasingly important to create more effective and meaningful learning experiences. Solihudin (2018) emphasizes that digital technology integration can support the development of effective learning processes. Nevertheless, several studies still report common problems in SMK learning, such as dependence on textbooks, limited use of digital learning tools, and less engaging instructional delivery. Damitri (2020) and Januardi et al. (2021) found that such conditions can negatively affect students' motivation and learning outcomes.

A preliminary study conducted at SMK Teuku Umar, particularly in Class XI of the Light Vehicle Engineering Department, showed that the learning resources used in starter system learning were still limited. The teaching and learning process relied heavily on the New Step 1 Toyota textbook, which was considered insufficient to meet the current learning objectives for the starter system topic. Based on classroom observation and discussions with teachers, students had difficulty understanding the material, showed low motivation, and considered the learning process less interesting because interactive learning media were not yet available. The questionnaire results also showed that 73.3% of students considered electrical engine systems difficult, while the starter system topic had the lowest level of mastery, with 66.7% of students scoring below the minimum passing grade. These findings indicate that the existing learning resources have not fully supported the minimum process standards stipulated in Permendikbudristek No. 16 of 2022, especially in relation to learning design, media utilization, and student-centered learning activities.

The development of digital learning media has been widely proposed as an alternative solution to improve learning quality in vocational education (Cokro & Iskandar, 2025; Iskandar, 2023). Previous studies have shown that e-modules, website-based learning media, and other digital learning resources can improve students' understanding, motivation, learning independence, and learning outcomes (Malik et al., 2024; Musyono et al., 2024; Yulianto et al., 2025). Zaka & Supraptono (2020), Putra & Wibowo (2021), Mahmudin et al. (2022), and Pirdaus et al. (2022) reported that digital modules and web-based learning media have positive effects on student learning because they provide flexible access, structured content, and more attractive material presentation. These studies are relevant to the present research because they confirm the potential of digital learning media in supporting vocational learning (Iskandar et al., 2023; Maulana et al., 2025). However, the previous studies were conducted in different contexts, used different platforms or learning topics, and did not specifically focus on a website-based e-module for starter system material in the Light Vehicle Engineering Department at SMK Teuku Umar.

In addition, previous digital media studies have not sufficiently addressed the specific problem found in this study, namely the limited availability of interactive and independently accessible learning resources for starter system learning. Some previous studies focused on general e-modules, while others developed website-based media using certain platforms such as Google Sites, Blogger, or other web-

based tools. However, these studies did not specifically integrate starter system material, structured independent learning activities, visual presentation, and feasibility testing based on the actual needs of Grade XI TKR students at SMK Teuku Umar. Ferreira et al. (2024) and Muhammad et al. (2025) explain that manually developed websites using HTML, CSS, and JavaScript provide greater flexibility in design and content customization. In this study, this perspective is used to support the development of a website-based e-module that can be adapted to students' learning needs, the characteristics of starter system material, and the instructional objectives of vocational automotive learning.

Based on the previous explanation, the research gap of this study lies in the absence of a website-based starter system e-module that is specifically developed according to the learning problems, student characteristics, and instructional needs of Class XI TKR students at SMK Teuku Umar. Although previous studies have demonstrated that digital modules and web-based learning media can improve learning outcomes, they have not clearly addressed the development and testing of a website-based e-module for the automotive starter system topic in this specific school context. Therefore, this study offers a contextual contribution by developing a website-based e-module that combines structured material, visual support, independent learning access, and evaluation activities to support students' understanding of starter system concepts.

This study aims to develop and examine the feasibility and effectiveness of a website-based starter system e-module for Grade XI students in the Light Vehicle Engineering Department. The development process used the ADDIE model, which consists of Analyze, Design, Development, Implementation, and Evaluation stages. The research questions addressed in this study are as follows: How feasible is the website-based starter system e-module based on expert validation? How do students respond to the developed e-module? How effective is the e-module in improving students' learning outcomes on starter system material? The results of this study are expected to provide an alternative digital learning medium for automotive vocational education and support the implementation of more accessible, engaging, and student-centered learning.

2. RESEARCH METHOD

This study employed a Research and Development (R&D) approach to develop and examine the feasibility and effectiveness of a website-based e-module on the automotive starter system. The product was developed using the ADDIE model, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation (Addzikri & Iskandar, 2026) . The study also applied a pre-experimental design using a one-group pretest–posttest model to examine the improvement in students' learning outcomes after using the e-module (Khoiruddin & Iskandar, 2024; Setiyawan et al., 2025). The design is represented as O_1 X O_2, where O_1 refers to the pretest, X refers to learning using the website-based starter system e-module, and O_2 refers to the posttest (Septiyanto et al., 2024).

The study was conducted at SMK Teuku Umar, located at Jalan Karangrejo Tengah IX No. 99A, Semarang, Central Java, from February to July 2025. The population consisted of 88 students from the Light Vehicle Engineering Department. The sample involved 29 students from class XI TKR 1. Because the participants were taken from one intact class, the sampling technique was categorized as cluster sampling or purposive sampling. One existing classroom group was selected as the implementation group based on the relevance of the subject matter, learning schedule, and accessibility for product testing.

The ADDIE development procedure was implemented through five systematic stages. In the Analyze stage, the researchers identified the competencies to be achieved, student characteristics, learning problems, and relevant starter system content. Data were obtained through classroom observation, student learning evaluation, teacher discussion, student

discussion, and questionnaire distribution. The results of this stage showed that students needed more accessible, structured, and visually supported learning media for the starter system topic.

In the Design stage, the researchers prepared the structure of the e-module, including the navigation flow, learning objectives, material sequence, visual components, practice activities, and evaluation section. A storyboard was developed to ensure that the content was organized systematically and could support students' independent learning. In the Development stage, the e-module prototype was created based on the design specifications and validated by media and subject matter experts. Revisions were made according to the validators' suggestions before implementation.

In the Implementation stage, the revised e-module was used in learning activities with 29 students of class XI TKR 1. The implementation began with a pretest to measure students' initial knowledge, followed by learning using the e-module, and ended with a posttest and student response questionnaire. In the Evaluation stage, the researchers analyzed expert validation results, students' learning outcomes, N-Gain scores, and student responses to determine the feasibility and effectiveness of the developed e-module.

The data in this study consisted of quantitative data obtained from expert validation scores, learning outcome test scores, and student response questionnaire scores (Soesana et al., 2023). The instruments used in this study included expert validation sheets, learning outcome tests, and a student response questionnaire. The expert validation sheets were used to assess the feasibility of the e-module before implementation. The validation involved two media experts and two subject matter experts. The media validation aspects included visual design, navigation, readability, layout consistency, accessibility, and technical quality. The subject matter validation aspects included content accuracy, relevance to learning objectives, material sequence, clarity of explanation, suitability of evaluation items, and support for independent learning. The validation sheets used a 4-point Likert scale.

The learning outcome test was used to measure students' mastery of starter system material before and after using the e-module. The initial test instrument consisted of 40 multiple-choice items arranged based on competence indicators. Before being used in the pretest and posttest, the items were tested for validity, reliability, difficulty level, and item discrimination (Iskandar & Nashiroh, 2026). Item validity was analyzed using point-biserial correlation. An item was considered valid when the calculated r-value was higher than the r-table value at the selected significance level. The validity analysis showed that 36 out of 40 items were valid, while four items were removed or revised. Reliability was analyzed using the KR-21 formula because the items were dichotomously scored, with 1 for correct answers and 0 for incorrect answers. The reliability coefficient was 0.946, indicating very high reliability. The difficulty index was calculated to identify whether the items were categorized as difficult, moderate, or easy (Magdalena et al., 2021). The item difficulty index was calculated using I = B / J, where I is the difficulty index, B is the number of students answering correctly, and J is the total number of students (Iskandar et al., 2026).

Table 1. Level of difficulty of test items

Interval	Interpretation
0.00-0.30	Difficult
0.31-0.70	Moderate
0.71-1.00	Easy

Data analysis consisted of descriptive and inferential statistics. The normality test was conducted using the Liliefors test. The data were considered normally distributed when L_0 was lower than Ltable. The homogeneity test was performed using the F-test by comparing the variances of pretest and posttest scores. The data were considered homogeneous when Fcount was lower than Ftable.

The paired-sample t-test was used to determine the significance of the difference

between pretest and posttest scores. The formula used was $t = \bar{D} / (SD / \sqrt{n})$, where t is the paired-sample t-test value, $\bar{D}$ is the mean of the difference scores, SD is the standard deviation of the difference scores, and n is the number of paired observations. The decision was made by comparing the significance value with $\alpha = 0.05$. If $p < 0.05$, there was a statistically significant difference between pretest and posttest scores.

The N-Gain was used to measure the level of improvement in students' learning outcomes after using the e-module. The N-Gain score was calculated using the following formula: N-Gain = (posttest score − pretest score) / (ideal score − pretest score). The N-Gain value was interpreted using the following criteria: $0.70 \leq g \leq 1.00$ = high, $0.30 \leq g < 0.70$ = medium, $0.00 < g < 0.30$ = low, $g = 0.00$ = no increase, and $-1.00 \leq g < 0.00$ = decrease. The N-Gain percentage was also used to interpret effectiveness, with >76% categorized as effective, 55%–75% as quite effective, 40%–54% as less effective, and <40% as ineffective (Hidayat et al., 2024; Raharjo et al., 2025).

3. RESULTS AND DISCUSSION

Results

This study produced a website-based e-module for starter system material developed using the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation. The e-module was designed to improve students' cognitive learning outcomes by providing structured instructional materials, visual support, interactive content, and accessible web navigation for vocational high school students in the Light Vehicle Engineering Department.

In the analysis stage, the researchers identified the learning problems, student needs, and relevant competencies related to starter system material. The analysis showed that the existing learning resources, particularly the New Step 1 Toyota book, were not sufficient to support students' understanding of starter system components, working principles, and operation. The needs analysis indicated that students required a more interactive, visually engaging, and independently accessible learning medium to help them understand the material more effectively.

In the design stage, the researchers developed the structure and navigation flow of the e-module. The storyboard was prepared to organize the content systematically and ensure that each page was connected to the intended learning objectives. The e-module consisted of several main menus, including home, foreword, developer profile, learning outcomes, learning materials and activities, evaluation, and user guide. These components were designed to provide clear navigation, readable content, and visual support for students.

In the development stage, the e-module was created using HTML, CSS, and JavaScript. The final product was hosted online and tested for compatibility with both laptop and smartphone screens. Navigation buttons were embedded to make the e-module easier to access, while the content was arranged into separate sub-pages to support independent and flexible learning. Before implementation, the product was validated by media experts and material experts to determine its feasibility.

Table 2. Expert feasibility test results

Validator	Expert 1	Expert 2	Total score	Max score	Feasibility percentage	Category
Media experts	62	71	133	144	92.36%	Very feasible
Material experts	64	68	132	144	91.66%	Very feasible

The feasibility test involved two media experts and two material experts. The media experts gave scores of 62 and 71 out of a maximum total score of 144, resulting in a feasibility percentage of 92.36%. Meanwhile, the material experts gave scores of 64 and 68 out of a maximum total score of 144, resulting in a feasibility percentage of 91.66%. Based on these results, the website-based starter system e-module was categorized as very feasible in terms of both media quality and material quality. This finding indicates that the developed e-module met the required standards for visual design, navigation, readability, accessibility, content

accuracy, relevance to learning objectives, and support for independent learning.

In the implementation stage, the test instrument was first validated using 29 students from class XI TKR 3. The initial instrument consisted of 40 multiple-choice items. The validity analysis showed that 36 items were valid because their r-values were higher than the r-table value of 0.367, while four items were removed because they did not meet the validity criteria. The reliability test using the KR-21 formula produced a coefficient of 0.946, indicating that the instrument had very high reliability. The difficulty level analysis showed that two items were categorized as easy, 29 items were categorized as moderate, and five items were categorized as difficult. These results indicate that the learning outcome test was appropriate for measuring students' understanding of starter system material.

After the instrument testing stage, the e-module was implemented in class XI TKR 1, involving 29 students. Students used the e-module during the learning process and then completed a response questionnaire to evaluate their perception of the developed product.

Table 3. Student response of the e-module

Student response component	Score
Total student response score	1282
Maximum possible score	1508
Percentage	85%
Category	Very positive

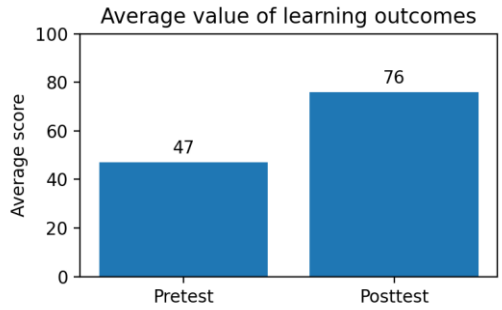

Figure 1. Average student learning outcomes

The student response questionnaire consisted of 13 items using a 4-point Likert scale and was completed by 29 students. Therefore, the maximum possible score was calculated as 29 students × 13 items × 4 points = 1508. The total score obtained from student responses was 1282, resulting in a percentage of 85%. Based on the interpretation criteria, this result was categorized as very positive. This finding shows that students perceived the e-module as accessible, visually attractive, easy to use, and helpful for understanding starter system material. The positive response also indicates that the website-based format supported students' independent learning and increased their interest in learning automotive electrical system material.

The evaluation stage was conducted to determine the effectiveness of the developed e-module. The normality test using the Liliefors method showed that both pretest and posttest scores were normally distributed, with L_0 values of 0.138 and 0.155, respectively, which were lower than the critical value of Ltable = 0.161. The homogeneity test yielded Fcount = 1.101, which was lower than Ftable = 1.88, indicating that the data were homogeneous. The paired-sample t-test resulted in tcount = 18.36, which exceeded ttable = 2.048, indicating a statistically significant improvement in students' learning outcomes after using the e-module.

The effectiveness of the e-module was further evaluated using N-Gain analysis. The results showed that one student was in the low category ($g < 0.30$), 25 students were in the medium category ($0.30 \leq g < 0.70$), and three students achieved a high level of improvement ($g \geq 0.70$). The average N-Gain score was 0.5582, or 55.82%, indicating that the developed e-module had a moderate level of effectiveness in enhancing students' learning outcomes.

Discussion

The website-based e-module developed in this research proved to be both feasible and effective. The feasibility scores from media and material experts, which exceeded 91%, demonstrated that the design, content quality, and user interface were aligned with the needs of vocational learning. The validation results also indicate that the e-module had appropriate visual design, clear navigation, accessible

content, and relevant learning materials for starter system instruction.

The significant increase in posttest scores supports the claim that the e-module effectively enhanced cognitive learning. The t-test result of 18.36 confirms this statistically, while the moderate average N-Gain score of 0.5582 highlights its practical educational impact. These results are consistent with previous findings by Panjaitan et al. (2020) and Parwati et al. (2019), which emphasized the importance of interactive media in supporting learning outcomes. In this study, visuals, animations, and structured content were beneficial, especially for students who needed concrete representations of starter system components and working principles.

Student responses were also very positive, with an 85% response score. This result indicates that the e-module met students' expectations in terms of accessibility, visual appearance, readability, and ease of use. Compatibility with both mobile and desktop devices contributed to the usability of the product and enabled more flexible access to learning materials. However, several students still noted navigational challenges, suggesting that future revisions should improve menu clarity, page transitions, and user guidance.

Overall, the e-module serves as a responsive, interactive, and accessible learning tool that improves both the learning process and cognitive outcomes in vocational education. It also supports the implementation of independent and digital-based learning in line with current curriculum demands. Nevertheless, the effectiveness evidence should be interpreted carefully because the study used a one-group pretest–posttest design without a control group.

4. CONCLUSION

This research concludes that the development of a website-based e-module on starter system material for Grade XI students of the Light Vehicle Engineering Department at SMK Teuku Umar was valid, feasible, and effective in improving students' cognitive learning outcomes. The e-module, developed using the ADDIE model, showed significant improvement as evidenced by the paired-sample t-test (tcount = 18.36 > ttable = 2.048) and the average N-Gain score of 0.5582, or 55.82%, which falls into the moderate category. These findings demonstrate that the integration of interactive and accessible digital learning resources can enhance students' conceptual understanding and contribute to the development of educational technology in vocational learning contexts. Future research is recommended to enhance the e-module by integrating more interactive and adaptive features to meet diverse learning needs and preferences.

5. DECLARATION/STATMENT

5.1. Acknowlegment

The authors express their sincere gratitude to all parties who supported this research, including the supervisors, examiners, media and material validators, Universitas Negeri Semarang, and SMK Teuku Umar, especially the students of class XI TKR who participated as research subjects.

5.2. Author Contribution

Ridha Al Rizqi: Designed and conducted the research, developed the e-module, performed data analysis, and wrote the manuscript. Bunyamin: Supervised the research process, provided methodological guidance, and reviewed the developed media. Wahyudi: Provided guidance on research writing, methodology, and instrument development, including test and expert validation instruments. Dwi Widjanarko: Provided suggestions on manuscript writing and media development, including the appearance and content of the e-module.

5.3. Conflict of Interest

Authors declare that they have no conflicts of interest.

6. REFERENCES

Addzikri, J. A., & Iskandar, R. (2026).

Pengembangan Media Pembelajaran Online Berbasis Google Sites Untuk Meningkatkan Hasil Belajar Sistem Rem. *ARMADA : Jurnal Penelitian Multidisiplin*, *4*(6), 2107–2116.

Cokro, S., & Iskandar, R. (2025). Pengembangan Media Pembelajaran Flipbook Pengelasan untuk Siswa SMK IPT Semarang. *Panthera : Jurnal Ilmiah Pendidikan Sains Dan Terapan*, *5*(3), 302–310.

Damitri, D. E. (2020). Keunggulan media PowerPoint berbasis audio visual sebagai media presentasi terhadap hasil belajar siswa SMK teknik bangunan. *Jurnal Kajian Pendidikan Teknik Bangunan, 6*(2), 1–7.

Ferreira, F., Borges, H. S., & Valente, M. T. (2024). Refactoring react-based web apps. *Journal of Systems and Software*, *215*(1), 1–12.

Fikriyah, V. N., & Furoida, K. (2021). Peningkatan keterampilan siswa sekolah menengah kejuruan melalui pelatihan software pemetaan. *Abdi Geomedisains*, *1*(2), 50–58.

Hidayat, H., Asri, S., Setiyawan, A., Huda, K., Roziqin, A., & Iskandar, R. (2024). The Implementation of Plasticine Wax Media to Increase the Right-Aligned Lathe Chisel Geometry Understanding for the Students of Automotive Engineering Education During Covid-19 Pandemics. *5th Vocational Education International Conference (VEIC 2023)*, 1231–1236.

Iskandar, R., & Nashiroh, P. K. (2026). Validity and Reliability of a Research Instrument on the Learning Outcome of Automotive Engineering. *International Journal of Educational Practice and Policy*, *4*(2), 278–294.

Iskandar, R., Nashiroh, P. K., & Khumaedi, M. (2026). Qualitative and Quantitative Item Analysis of Essay Test Instruments in a Learning Planning and Microteaching Course. *Journal of Mathematics Instruction, Social Research and Opinion*, *5*(2), 1979–1988.

Iskandar, R., Syafei, M. H. G., Bahatmaka, A., Hidayat, H., & Huda, K. (2023). Utilization of PowerPoint and YouTube as Digital-Based Learning Media: Literature Review. *Jurnal Ilmiah Wahana Pendidikan*, *9*(20), 936–942.

Januardi, Aptriyana, J., & Lestari, N. D. (2021). Analisis kesulitan siswa dalam pembelajaran daring di SMK se-Kecamatan Kayuagung. *Jurnal Pendidikan Ekonomi UM Metro, 9*(2), 86–94.

Khoiruddin, M. A., & Iskandar, R. (2024). Pengembangan Gamifikasi untuk Meningkatkan Motivasi Belajar dan Hasil Belajar Materi Sistem AC. *Jurnal Pendidikan Vokasi Otomotif*, *7*(1), 194–214.

Magdalena, I., Fauziah, S. N., Faziah, S. N., & Nupus, F. S. (2021). Analisis validitas, reliabilitas, tingkat kesulitan dan daya beda butir soal ujian akhir semester tema 7 kelas III SDN Karet 1 Sepatan. *BINTANG: Jurnal Pendidikan dan Sains, 3*(2), 198–214.

Mahmudin, Ratnawati, D., & Khaharsyah, A. (2022). Pengembangan e-modul sistem pendingin berbasis website Google Sites untuk siswa sekolah menengah kejuruan. *Jurnal Dinamika Vokasional Teknik Mesin, 7*(1), 29–34.

Malik, M. B., Iskandar, R., & Naryanto, R. F. (2024). Development of android-based mobile learning media to increase learning results in vocational high schools. *Journal of Research in Instructional*, *4*(2), 425–438.

Maulana, R., Iskandar, R., & Naryanto, R. F. (2025). Pengembangan E-Modul Interaktif Sistem Penerangan Berbasis Pembelajaran Berdiferensiasi. *Panthera : Jurnal Ilmiah Pendidikan Sains Dan Terapan*, *5*(3), 219–231.

Muhammad, I., Jupri, A., & Herman, T. (2025). Development of web-based learning media with a realistic mathematics education approach to increase student self-determination. *Infinity Journal, 14*(2), 303–322.

Musyono, A. D. N. I., Hadik, M., Roziqin, A., Rohman, S., Septiyanto, A., & Iskandar, R. (2024). Development of a Flipbook-Based Inventor Drawing Teaching Module to Improve Learning Outcomes in the Manufacturing Technical Drawing Subject. *6th Vocational Education International Conference (VEIC 2024)*, 119–126. Semarang:

Atlantis Press.

Panjaitan, W. A., Simarmata, E. J., Sipayung, R., & Silaban, P. J. (2020). Upaya meningkatkan hasil belajar siswa menggunakan model pembelajaran discovery learning di sekolah dasar. Jurnal Basicedu, 4(4), 1350–1357.

Parwati, N. N., Suryawan, I. P. P., & Aspari, R. A. (2019). *Belajar dan pembelajaran*. PT Rajagrafindo Persada.

Pirdaus, F., Samidjo, & Subagyo. (2022). Pengembangan pembelajaran berbasis website dengan media Blogger Learning Mechanical Engineering pada mata pelajaran sistem pendingin kelas XI di SMK Muhammadiyah Gamping Sleman tahun ajaran 2020/2021. *Jurnal Vokasi Dewantara, 3*(1), 36–46.

Putra, M. H. I., & Wibowo, T. W. (2021). Pengembangan modul pembelajaran trainer sistem starter untuk siswa teknik kendaraan ringan di SMK Rajasa Surabaya. *JTPM, 11*(1), 56–61.

Raharjo, N. G., Iskandar, R., & Naryanto, R. F. (2025). Pengembangan Media Pembelajaran Sistem Penerangan Sepeda Motor Berbasis Android untuk Meningkatkan Hasil Belajar Siswa Kelas XI di SMK Negeri 3 Kabupaten Tangerang. *Panthera: Jurnal Ilmiah Pendidikan Sains Dan Terapan*, *5*(3), 232–249.

Septiyanto, A., Said, I. U., Wijaya, M. B. R., Setiyawan, A., Khoiron, A. M., & Iskandar, R. (2024). Effectiveness of Implementing Android-Based Variable Valve Actuation (VVA) Media in Learning at Vocational High School. *5th Vocational Education International Conference (VEIC-5 2023)*, 369–373.

Setiyawan, A., Isnen, M. B., Abdurrahman, Naryanto, R. F., & Iskandar, R. (2025). Development of audio video-based catalytic converter trainer media to improve student understanding of vehicle emission control. *AIP Conference Proceedings*, *3354*(1), 020001.

Slamet, F. A. (2022). *Model penelitian pengembangan*. Institut Agama Islam Sunan Kalijogo Malang.

Soesana, A., Subakti, H., Karwanto, Fitri, A., Kuswandi, S., Sastri, L., Falani, I., Aswan, N., Hasibuan, F. A., & Lestari, H. (2023). *Metodologi penelitian kuantitatif.* Yayasan Kita Menulis.

Solihudin, T. (2018). Pengembangan e-modul berbasis web untuk meningkatkan pencapaian kompetensi pengetahuan fisika pada materi listrik statis dan dinamis. *Jurnal Wahana Pendidikan Fisika, 3*(2), 51–61.

Sukarelawa, M. I., Indratno, T. K., & Ayu, S. M. (2024). *N-Gain vs stacking: Analisis perubahan abilitas peserta didik dalam desain one group pretest-posttest*. Penerbit Suryacahya.

Usmadi. (2020). Pengujian persyaratan analisis: Uji homogenitas dan uji normalitas. *Inovasi Pendidikan, 7*(1), 50–62.

Xu, M., Fralick, D., Zheng, J. Z., Wang, B., Tu, X. M., & Feng, C. (2017). The differences and similarities between two-sample t-test and paired t-test. *Shanghai Archives of Psychiatry, 29*(3), 184–188.

Yulianto, M. D., Iskandar, R., & Naryanto, R. F. (2025). Evaluasi Pengaruh Media Pembelajaran Terhadap Hasil Belajar Otomotif Melalui Pendekatan Meta-Analisis. *Jurnal Pendidikan Dan Teknologi Indonesia*, *5*(1), 97–111.

Zaka, A. M., & Supraptono. (2020). Pengembangan e-modul common rail untuk meningkatkan hasil belajar pada kompetensi perawatan bahan bakar mesin diesel di SMK Negeri Jawa Tengah. *Automotive Science and Educational Journal, 9*(1), 1–6.