JVCE 10 (1) (2025) : 64-71

Journal of Vocational Career Education

https://journal.unnes.ac.id/nju/index.php/jvce

The Effectiveness of Simulator Learning Media in Learning Motorcycle Charging Systems at Vocational High Schools

Rohayati Rohayati[1]✉, Nur Qudus[2], Dwi Widjanarko[2]

[1]SMK Negeri Situraja Sumedang Jawa Barat, Indonesia
[2]Universitas Negeri Semarang, Indonesia

Article Info

Article History :
Received
February 2025
Accepted
May 2025
Published
July 2025

Keywords:
Learning Media Effectiveness; Charging System; Simulator; Project-Based Learning; Student Competency

Abstract

The learning process of the motorcycle charging system at SMK Negeri Situraja still faces challenges, notably the low competency mastery of students who have not yet met the Minimum Competency Criteria. This issue arises from the limited time available for practical activities and the lack of varied and contextual teaching methods. This study aims to assess the effectiveness of the learning media, specifically a charging system simulator developed using the Project-Based Learning (PjBL) approach. The research method employed is Research and Development (R&D) with the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The research results demonstrate that the developed simulator media is effective in improving students competency, particularly in understanding the operating principles and components of the charging system. This effectiveness is indicated by a significant improvement in learning outcomes after the simulator-based instruction. Additionally, students became more active, gained a deeper understanding of the material, and were able to apply the knowledge in independent and safe practices. The advantage of this media, compared to previous studies, is the security system that protects students during use. This feature ensures safety and creates a secure learning environment. Therefore, the PjBL-based simulator media is a suitable innovation for learning in vocational schools to support the achievement of optimal learning outcomes.

✉ Correspondence:
Jl. Tanjung Manunggal V, RT 03 / RW 04, Sukatali, Situraja, Jl. Raya Sumedang - Cibeureum No.16, Sukatali, Kec. Situraja, Kabupaten Sumedang, Jawa Barat 45371, Indonesia
E-mail: ayarohayati@students.unnes.ac.id

p-ISSN 2339-0344
e-ISSN 2503-2305

INTRODUCTION

School is an educational institution where students learn various subjects. Vocational High School (SMK) is a formal education institution aimed at preparing students to enter the workforce in specific fields. One of the competencies that has rapidly developed alongside the advancement of the automotive industry is Motorcycle Engineering. In the implementation of the Merdeka Curriculum, students are expected to master learning achievements in vehicle electrical systems, including the charging system (Lince, 2022).

At SMK Negeri Situraja, the learning process of the charging system faces obstacles due to limited practice media, long implementation time, and less innovative teaching methods. This results in low learning effectiveness and engagement among students. To address these issues, an alternative learning media such as a charging system simulator is needed, which is designed to represent the components and functions interactively (Basri et al., 2021).

Simulator-based learning media, as developed in the study by Supraptono et al. (2025), has proven effective in enhancing understanding of electrical concepts as it can present process visualizations interactively and allow for self-practice repetition. This aligns with the learning needs for motorcycle charging systems in vocational schools, which demand both conceptual understanding and practical skills simultaneously. Effective use of learning media can improve conceptual understanding and participation among students in the learning process, especially if the media is designed in accordance with the characteristics of students and the content taught (Lubis et al., 2023). The use of appropriate learning media in vocational education supports the development of student competencies in line with industry demands and enhances their readiness to enter the workforce. Zulaikhah et al. (2024) state that interactive learning media have proven to improve student engagement, conceptual understanding, academic achievement, and learning motivation across various subjects. This is achieved through the use of media such as interactive videos, multimedia, storyboards, and pop-up cards, which can stimulate the interest and attention of students (Aulia et al., 2024). The simulator is considered highly feasible and effective as a supporting media in conducting practical lessons in electrical system training and maintenance courses (Alfana et al., 2024).

The implementation of the Project-Based Learning (PjBL) model supports the enhancement of critical thinking, collaboration, and problem-solving skills in vocational learning contexts (Rehani et al., 2023). The project-based learning model encourages active participation among students in solving real-world problems through project design, which positively impacts their cognitive abilities and critical thinking skills (Surya & Sutopo, 2024). The combination of the simulator media and the PjBL model is expected to improve learning effectiveness and produce graduates who are adaptive and competent, meeting the needs of the workforce.

The charging system is an important component of the motorcycle's electrical system, serving to supply electrical energy to meet the vehicle's operational needs. This system consists of several key components, including the battery, fuse, main switch, voltage regulator, and alternator (Syaief et al., 2017). The conventional charging system is an essential subject in automotive electrical learning as it helps maintain the vehicle's stable electrical supply. Understanding this material is crucial for students to analyze and resolve issues related to electrical systems accurately (Mardiana & Hadromi, 2023). The important functions of the motorcycle charging system include generating electrical current to meet the motorcycle's electrical needs while the engine is running, charging the battery to keep it full and ready for use, and starting the engine when it is off (Subeki et al., 2024). Learning is a process to acquire knowledge, skills, and experience through formal and non-formal education programs (Yahya et al., 2023). The purpose of learning emphasizes personal development, understanding, and the application of concepts (mastery goals), not just achievements compared to others (Olivier et al., 2023). This study aims to analyze the effectiveness of using the motorcycle charging system simulator as a learning media in the learning processes of vocational high school students. The study is

expected to provide concrete recommendations for schools, teachers, and students in efforts to improve the skills of students.

The main benefit of using simulator media in motorcycle charging system learning is providing students with a more concrete and practical learning experience. Through interactive simulations, students can understand the workflow of the charging system visually and practically without having to interact directly with real vehicles, which are often limited in number. Additionally, simulators allow students to repeat the learning process without the risk of damaging equipment or safety hazards. This enhances the confidence of students in understanding the concepts and encourages them to experiment and explore further the working principles of vehicle electricity.

The positive impact of applying the Project-Based Learning (PjBL)-based simulator also includes the development of 21st-century skills such as problem-solving, communication, and collaboration. Through this approach, students not only gain technical knowledge but also become accustomed to working in teams to complete real-world projects relevant to the industry. Learning becomes more meaningful because students are actively involved in the process, feel a sense of ownership, and are able to connect theory with practice. This results in improved learning motivation, better learning outcomes, and graduates who are more competent and adaptable to the demands of the modern workforce.

METHODOLOGY

This study uses the Research and Development (R&D) method with the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation (Alodwan et al., 2018). The ADDIE model was chosen because it has a simple and systematic structure, making it easier to understand and apply in the development of learning media. Each stage in this model ensures that the developed product meets the needs of students and can provide optimal results. The stages of the ADDIE model can be seen in Figure 1.

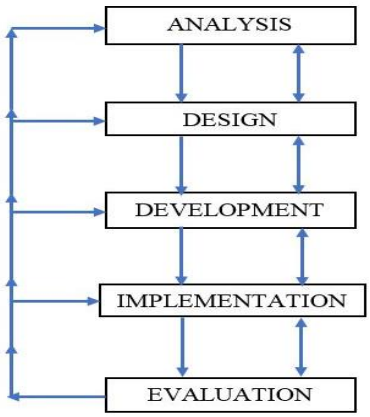

Figure 1. ADDIE Model Diagram

The data collection technique used in this study involves the administration of questionnaires and performance tests for both pretest and posttest. The research was conducted in class XI TSM at SMK Negeri Situraja, with a total of 70 students divided into two classes. In the implementation phase, the research participants consisted of 35 students in the experimental group and 35 students in the control group. The effectiveness test was conducted using data from the evaluation of students, employing the N-Gain test and Independent t Test for N-Gain. This effectiveness test was carried out by analyzing data from the pretest and posttest results. The objective was to compare the initial and final test results to determine if there was a significant difference between the two. The prerequisite tests used in this study included the normality test and the homogeneity test.

RESEARCH RESULTS & DISCUSSION

Research Results

1. Media Development

The results of the media development research for the motorcycle charging system simulator include an evaluation of the media's feasibility, which is a key indicator in assessing the quality of the developed product. The feasibility of the media was determined through a validation process involving two expert components: a media expert and a subject matter expert. The validation by the media expert aimed to assess the technical quality of the simulator in its entirety, including aspects of visual design, user interface, interactivity, operational ease, and

the media's suitability for the characteristics of students. This assessment is important to ensure that the simulator is not only technically feasible but also supports the achievement of learning objectives optimally. The subject matter expert's validation focused on the alignment of the simulator's content with the curriculum, technical accuracy, and the integration of the material with the competencies required in Motorcycle Engineering. The evaluation also included instructional design, the sequence of presentation, and the relationship between objectives, activities, and learning assessments. The validation results showed that the simulator media is suitable for use as an effective and efficient vocational learning tool.

The feasibility assessment of the motorcycle charging system simulator media was conducted by two validators: a media expert and a subject matter expert. The validation results indicated that both experts provided a Content Validity Ratio (CVR) and Content Validity Index (CVI) score of 1.00. This score falls into the "Very Suitable" category, indicating that the simulator media is highly appropriate for use as a learning aid. The average CVR and CVI score obtained was also 1.00. According to the criteria established by Lawshe (1975), an instrument or media is deemed feasible if the CVR is greater than 0.62. Therefore, with the CVR and CVI scores reaching the maximum value, this simulator media is considered "very valid" and meets the necessary requirements to be implemented in the Motorcycle Engineering learning process.

2. Cognitive Competence

In the context of this research, the implementation was carried out using the motorcycle charging system simulator, designed to support learning in the Motorcycle Engineering subject, specifically in the area of motorcycle electrical systems. The application of this media was conducted at SMK Negeri Situraja in Sumedang District, involving students from the XI Motorcycle Engineering program. The classes involved in the implementation process included two groups: Class XI TSM 1 as the experimental group, which received treatment through the use of the motorcycle charging system simulator in the teaching and learning activities, and Class XI TSM 2 as the control group, where the learning process took place conventionally without the use of the simulator. The total number of students in the experimental and control groups was 35, and they were the primary respondents in the media effectiveness testing. The purpose of this stage was to determine the extent to which the developed media could enhance student understanding and support the achievement of learning objectives optimally in a real-world classroom setting. The posttest results for the experimental class are shown in Table 1.

Table 1. Posttest Results for the Experimental Class – Performance Test

No	Description	Performance Test Results
1	Highest score	98
2	Lowest score	90
3	Minimum Competency Criteria	70
4	Total students	35
5	Number of competent students	35
6	Number of non-competent students	0
7	Percentage of competent students	100 %

3. Psychomotor Competence

Table 1 above shows the performance test results for 35 students with a Minimum Competency Criteria (MCC) of 70. All students scored ≥ 90, which is well above the MCC threshold, resulting in a 100% pass rate (35/35 students were competent). Based on these results, it can be concluded that the motorcycle charging system simulator learning media developed is effective.

Based on the results of the pretest and posttest, a normality test was conducted, which concluded that the pretest and posttest data for the experimental class had a normal distribution. This was indicated by the significance (Sig.) values in the Kolmogorov-Smirnov and Shapiro-Wilk tests, all of which were greater than 0.05. Meanwhile, in the control class, both the pretest and posttest data showed significance values less than 0.05, meaning the data did not follow a normal distribution. Therefore, the data for the

experimental class met the normality assumption. In addition to the normality test, the pretest and posttest data were also subjected to a homogeneity test using Levene's Test, which showed that all significance values (Sig.) for various approaches were greater than 0.05. The highest recorded significance value was 0.942, and the lowest was 0.802. This indicates that there was no significant variance difference between the groups being tested. Hence, it can be concluded that the data had homogeneous variance, thus meeting the homogeneity assumption.

Table 2. N-Gain Score Calculation Results

No	**Experimental Class**	**No**	**Control Class**
	N-Gain Score (%)		***N-Gain Score (%)***
Average	70.86	Average	30.44
Minimum	50	Minimum	-7
Maximum	89	Maximum	53

The average N-Gain for the experimental class is 70.86%, significantly higher than the control class, which is at 30.44%. The minimum score for the experimental group is 50%, while the control group's score dropped to -7%. The highest increase for the experimental group was 89%, while the control group reached only 53%. These data emphasize that the learning method in the experimental class is much more effective in improving learning outcomes.

Table 3. Posttest t-Test Results for Control and Experimental Clas**ses**

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% onfidence Interval of the Difference	
									Lower	Upper
N_Gain Persen	Equal variances assumed	1.945	.168	13.928	68	.000	40.420	2.902	34.629	46.211
	Equal variances not assumed			13.928	64.478	.000	40.420	2.902	34.624	46.217

The results of the Independent Samples t-test show that the Levene's Test significance value is 0.168 (> 0.05), so the variances of both groups are considered homogeneous. The significance value (2-tailed) of 0.000 (< 0.05) indicates a significant difference between the N-Gain scores of the experimental and control classes. The mean difference of 40.420, with a 95% confidence interval ranging from 34.629 to 46.211, suggests that the treatment in the experimental class significantly improved learning outcomes compared to the control class.

Discussion

The feasibility of the motorcycle charging system simulator media was validated by 5 media experts and 5 subject matter experts. The analysis results using the Content Validity Ratio (CVR), Content Validity Index (CVI), and Percentage of Agreement showed that all items were deemed "feasible." This indicates that the instrument is valid in terms of content and effectively reflects the practicality of the learning media. This aligns with the opinion of Dahal et al. (2023), who state that the feasibility of a learning product can be assessed through ease of use, time efficiency, and the applicability of the product in real-world contexts. This feasibility reflects how practical the product is for implementation in real environments by the target users. Based on the data from the feasibility calculation of the motorcycle charging system simulator media, which resulted in "very feasible," it means that the developed simulator media is suitable for use

in the learning process. This is in line with the statement by Mayasari et al. (2024), who argue that effective learning media helps students better understand entrepreneurship concepts and improves their learning outcomes. Android-based interactive learning media were found to enhance student learning motivation and facilitate understanding of the charging system concepts through engaging visuals and simulations (Mardiana & Hadromi, 2023). The use of simulator media has proven effective in improving skills (Saransi et al., 2024). Other opinions suggest that using simulators in learning offers various benefits, such as allowing for the repetition of processes when mistakes occur, simplifying data collection, and enabling adjustments to observe the effects on specific variables. Moreover, simulators support real-time visualization and the development of collaborative skills (Yakkou et al., 2024).

The effectiveness of the simulator media can be determined through performance test evaluations before and after treatment. The learning media is considered effective if there is a significant improvement in the learning outcomes of students. The effectiveness of the media was analyzed using an Independent Sample t-Test on the posttest results. Before performing the analysis using the Independent Sample t-Test, the posttest data were subjected to normality and homogeneity tests.

The results of the normality and homogeneity tests showed that the pretest and posttest data for the experimental class followed a normal distribution and had homogeneous variance. The effectiveness test using the Independent Sample t-Test showed a significant difference between the learning outcomes of the experimental and control classes. The simulator media proved effective in improving the learning outcomes of students, with a high improvement category. These findings align with the opinion that simulator media positively impacts the improvement of skills in students. The Project-Based Learning (PjBL) approach-based motorcycle charging system simulator has advantages over media used in previous studies, as it is equipped with a safety system to protect students during practical sessions. This safety feature creates a safer learning environment, allowing students to focus more on understanding the concepts and skills of the charging system. Furthermore, the PjBL approach encourages active student involvement in completing projects, contributing to the enhancement of technical competencies and critical thinking. Therefore, this media is deemed suitable for implementation as an innovative learning tool in vocational schools.

This research provides significant benefits for the development of learning, particularly in vocational education like SMK. By developing a Project-Based Learning (PjBL) based motorcycle charging system simulator, this study offers a more innovative, interactive, and contextual learning solution. This media not only facilitates better understanding of concepts but also helps students develop practical skills in a safe and guided manner. Additionally, teachers benefit from alternative teaching strategies to overcome limitations in practice media and learning time. Thus, the results of this research directly contribute to the improvement of the quality of the learning process and outcomes in SMK.

The potential application of this simulator media is vast and not limited to just the charging system subject in the Motorcycle Engineering program. The same concept and approach can be applied to other electrical competencies, such as ignition systems, starter systems, or even electrical engineering and industrial automation fields. Moreover, with further development, this simulator could be integrated into Android-based or computer-based digital platforms, making it suitable for distance learning (online learning) or blended learning. This opens opportunities for schools with limited practical facilities to still offer high-quality learning through easily accessible media.

The novelty found in this study lies in the integration of physical simulator media with the PjBL learning approach, as well as the addition of safety features in the media. Few previous studies have specifically combined these three elements comprehensively. The safety feature in the simulator is a standout point, providing maximum protection during practical sessions, which are often a primary concern when using electrical equipment. Meanwhile, the application of PjBL promotes more active, collaborative

learning focused on solving real-world problems. This innovation makes the simulator media not only a learning aid but also a tool for developing the soft skills of students in line with current workforce demands.

CONCLUSION

Based on the research results, it can be concluded that the learning media in the form of a motorcycle charging system simulator, developed through the Project-Based Learning (PjBL) approach, has a high feasibility level and meets the effectiveness criteria as a tool to aid in automotive electrical learning. This media is designed in accordance with systematic instructional principles and considers pedagogical, technical, and occupational safety aspects, making it suitable for implementation in vocational learning at the Vocational High School level.

The use of the simulator media has proven to contribute positively to the mastery of student competencies in both cognitive and psychomotor domains. This media facilitates a deeper understanding of concepts and improves technical skills through interactive visualization and safe, structured practice. The integration of the PjBL approach allows students to actively engage in project-based learning, encouraging the development of analytical skills and problem-solving in practical applications.

The implementation of the simulator media also shows a positive effect on increasing student motivation, reflected in the rise in active participation, curiosity, and enthusiasm in completing learning activities. These indicators show that the developed media is not only effective in supporting the achievement of cognitive learning outcomes but also in fostering a positive disposition toward the overall learning process. The PjBL-based simulator media is suitable for use as a strategic innovation in the development of vocational practical learning, particularly in Motorcycle Engineering competencies at Vocational High Schools, to support the achievement of adaptive, contextual, and work-oriented learning outcomes.

REFERENCES

Alfana, Y. D., Yuliady, I., Zulfadli, Z., & Fernandes, E. (2024). Learning media development of lighting simulator in electrical maintenance training course for vocational education. Jurnal Pendidikan Teknologi Kejuruan, 7(4), 276-285.

Alodwan, T., & Almosa, M. (2018). The Effect of a Computer Program Based on Analysis, Design, Development, Implementation and Evaluation (ADDIE) in Improving Ninth Graders' Listening and Reading Comprehension Skills in English in Jordan. *English Language Teaching*, 11(4), 43.

Aulia, H., Hafeez, M., Mashwani, H. U., Careemdeen, J. D., Mirzapour, M., & Syaharuddin, S. (2024, March). The role of interactive learning media in enhancing student engagement and academic achievement. In *Proceeding of International Seminar On Student Research In Education, Science, and Technology* (Vol. 1, pp. 57-67).

Basri, I. Y., Faiza, D., Lapisa, R., Natsir, M., Maksum, H., & Giatman, G. (2021). Rancang Bangun Simulator Sistem Starter Sepeda Motor Dalam Mengatasi Keterbatasan Media Pembelajaran. *Jurnal Pendidikan Teknik Elektro*, *2*(1), 60-64.

Dahal, N., Pant, B. P., Luite, B. C., Khadka, J., Shrestha, I. M., Manandhar, N. K., & Rajbanshi, R. (2023). Development and Evaluation of E-Learning Courses: Validity, Practicality, and Effectiveness. *International Journal of Interactive Mobile Technologies*, *17*(12).

Lawshe, C. H. (1975). A quantitative approach to content validity 1. *Personnel psychology*, 28(4), 563-575.

Lince, L. (2022, May). Implementasi kurikulum merdeka untuk meningkatkan motivasi belajar pada sekolah menengah kejuruan pusat keunggulan. *In Prosiding Seminar Nasional Fakultas Tarbiyah Dan Ilmu Keguruan IAIM Sinjai* (Vol. 1, pp. 38-49).

Lubis, L. H., Febriani, B., Yana, R. F., Azhar, A., & Darajat, M. (2023). The use of learning media and its effect on improving the quality of student learning

outcomes. *International Journal Of Education, Social Studies, And Management (IJESSM)*, *3*(2), 7-14.

Mardiana, A. D., & Hadromi, H. (2020). Pengembangan Media Pembelajaran Interaktif Berbasis Aplikasi Android Menggunakan Adobe Flash Pada Materi Sistem Pengisian Konvensional. *Jurnal Pendidikan Teknik Mesin*, *20*(2).

Mayasari, L. E., Qudus, N., Ihsani, A. N. N., & Wahyuningsih, S. E. (2024). Developing CapCut-Based Video Tutorials for Learning Outcomes in Creative Product and Entrepreneurship. *Journal of Vocational and Career Education*, *9*(1), 18-32.

Olivier, E., Morin, A. J., Leo, V., & Salmela-Aro, K. (2023). The interconnected development of depressive symptoms and school functioning from mid-adolescence to early adulthood: A piecewise growth mixture analysis. *Journal of Educational Psychology*, *115*(3), 427.

Rehani, A., & Mustofa, T. A. (2023). Implementasi Project Based Learning dalam Meningkatkan Pola Pikir Kritis Siswa di SMK Negeri 1 Surakarta. *Didaktika: Jurnal Kependidikan,* 12(4), 487-496.

Saransi, F., Wahid, A., & Kamal, K. (2024). Kepraktisan Pengembangan Perangkat Pembelajaran Simulator Bagian Mesin Untuk Meningkatkan Keterampilan Kadet Dalam Pengoperasian Mesin Kapal Niaga. *ILTEK: Jurnal Teknologi*, *19*(02), 67-79.

Subeki, K., Sugiarto, T., Maksum, H., & Saputra, H. D. (2024). Pengembangan Simulator Sistem Pengisian IC Regulator sebagai Media Pembelajaran Siswa SMK. *MSI Transaction on Education*, *5*(1), 1-12.

Supraptono, E., Wagino, W., Abidin, A. F. B., Yusro, M., & Koto, R. D. (2025). Enhancing student understanding in electrical engineering: An Android-based e-learning approach. *International Journal of Information and Education Technology*, 15(6), 1150–1160. https://www.ijiet.org/show-228-2971-1.html

Surya, R. G. P. S., & Sutopo, Y. (2024). Development of Canva-Based Interactive Media in a Project-Based Learning Model to Improve the Cognitive Abilities of Vocational High School Students. *Journal of Vocational and Career Education*, *9*(2).

Syaief, A. N., Ningsih, Y., & Rizqiannor, R. (2017). Perancangan Simulator Charging System Pada Sepeda Motor. *Elemen: Jurnal Teknik Mesin*, *4*(2), 70-75.

Yahya, I. H. M., & Mahande, I. R. D. (2023). *Belajar dan Pembelajaran Kejuruan*. Indonesia Emas Group.

Yakkou, H., Chillali, A., & El kadri Elyamani, N. E. (2024). The effect of using simulator ‘‘evolution of electrical systems’’in electricity lessons on students' motivation and academic performance. *Heliyon*, 10(15).

Zulaikhah, S., Sutopo, Y., Kusumawardani, R., Supraptono, E., Fuad, M. N., & Nurfitriyani, S. A. (2024). The Role of Career Guidance in Preparing Vocational School Students in the Building Construction Department for the Workforce. *Journal of Vocational and Career Education*, *9*(2), 140-146.