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Exploration of Students' Experiences in Using a Starter Wiring Simulator in Automotive Electricity Learning

Firman Nur Falah[1], Muhammad Atala Abka[2], Wahid Munawar[3]

[123]Automotive Engineering Education Study Program, Indonesian University of Education

Corresponding Author: firmannurfalah46@upi.edu, atalarojak30@upi.edu, wahidmunawar@upi.edu

Abstract

This study aims to investigate students' experiences in utilizing a starter wiring simulator during the automotive electrical learning process at SMKN 1 Leuwidamar. This study adopted a descriptive qualitative approach with a sample of 11th-grade students majoring in Motorcycle Engineering and Business. Data were collected through participant observation, semi-structured interviews, documentation, and practical assessments. The study findings indicate that the use of a starter wiring simulator contributed to improving students' understanding and practical skills. The percentage of students who successfully assembled the starter circuit increased from 40% to 70%, while the average time to complete the circuit decreased from 27.4 minutes to 18.6 minutes. In addition, students found it easier to understand component functions and perform troubleshooting, and were more active and interested during the learning process. The level of student satisfaction with the use of the simulator was also in the good category. Therefore, the starter wiring simulator can be an effective learning tool to improve the quality of automotive electrical education in vocational high schools.

Keywords: Starter Wiring Simulator, Automotive Electricity, Learning Media, Student Experience, Practical Learning, Automotive Vocational School

INTRODUCTION

The development of vocational education, particularly in the automotive engineering sector, requires learning methods that are not only theoretical but also encompass the mastery of practical skills relevant to industry needs. Vocational education should be designed with context and application so that students can understand and apply the competencies they learn

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(Hidayat and Abdillah, 2019). However, in learning about automotive electrical engineering, which is characterized by difficult and abstract material, many students experience challenges in understanding the concepts and how the system as a whole works.

Theory suggests that utilizing learning media can be one way to address this issue. Learning media serves as a tool that can help convey information and increase students' attention and understanding of the material (Arsyad, 2017). In this regard, simulators have proven effective because they can depict real-life situations safely and in a controlled manner. Using simulators allows students to practice without risk, while providing a more interactive and meaningful learning experience (Smaldino et al., 2014). Research also confirms that the appropriate use of learning media can have a significant impact on student learning outcomes (Fuatzin et al., 2025).

The reality on the ground shows that learning still largely relies on traditional methods that discourage active student engagement. The limited use of technology-based learning media results in low learning effectiveness and a lack of student understanding of the material (Taufiq et al., 2023). Furthermore, the limited variety of media also hinders improving the quality of the teaching and learning process (Yulianto et al., 2025).

This situation creates a gap between expected learning and actual implementation. On the one hand, learning should be interactive and practice-based, but on the other hand, its implementation is not optimal. This discrepancy results in a lack of student learning experience, even though this experience is a crucial element encompassing cognitive, affective, and psychomotor interactions that can influence student motivation and understanding (Uno, 2016). Existing data shows that student learning activity increased from 62.58% to 83.29% after using simulator media (Fikri et al., 2024), underscoring the importance of utilizing appropriate learning media.

Efforts have been made to address this issue, such as implementing innovative learning models and utilizing simulators. Research shows that these approaches can improve learning outcomes and student engagement (Suyitno et al., 2024). However, most research focuses on learning outcomes, while students' experiences as individual learners have not been studied in depth.

This study focuses on exploring students' experiences using a starter wiring simulator in automotive electrical learning. A qualitative approach was chosen because it allows for deeper exploration of students' experiences, perspectives, and interactions through interviews and observations (Creswell, 2016). Therefore, this study is expected to provide a comprehensive understanding of the use of simulators as a learning medium and their contribution to improving

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the quality of education in automotive engineering and developing more efficient, innovative, and student-centered learning in the automotive engineering field..

METHOD

This study utilized a descriptive qualitative approach to explore students' experiences using a starter wiring simulator in automotive electrical learning. A qualitative approach was chosen because it can help understand social phenomena from the participants' perspectives, including behaviors, experiences, and interactions that occur during the learning process (Creswell and Creswell, 2021). This method provides a comprehensive explanation of students' perspectives, challenges, benefits, and reactions to using the simulator as a learning tool.

The research was conducted at SMKN 1 Leuwidamar, a state-owned automotive engineering school that has implemented learning related to motor vehicle electrical engineering. Subjects included eleventh-grade Motorcycle Engineering and Business students taking automotive electrical lessons, teachers, and laboratory technicians as additional informants. Participants were selected using a purposive sampling technique, selecting respondents deemed to have direct experience using starter wiring simulators (Sugiyono, 2022).

Data collection was conducted through participant observation, semi-structured interviews, and documentation. Observations were used to assess student engagement during the simulator practice, student interactions, and any technical challenges that arose. In-depth interviews were conducted to explore student learning experiences, perceptions of the simulator, and its impact on material understanding. Documentation in the form of photos of activities, practical work results, and evaluation results served as supporting data (Moleong, 2021).

RESULTS AND DISCUSSION

The results of learning activities using the starter wiring simulator were obtained through a combination of participatory observation, semi-structured interviews, practical assessment sheets, and documentation during three practical meetings (2 × 45 minutes each). The research subjects were 10 students of grade XI Motorcycle Engineering and Business. To maintain data consistency, measurements were carried out using the same observation sheet at each meeting and validated and the results of student work.

In the initial stage, students' basic abilities in understanding the starter system were measured without the aid of a simulator. The results showed that 4 students (40%) were able to construct a simple circuit according to the diagram, while 6 students (60%) still experienced

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errors in the wiring path, especially in the relay and ground line connections. The average time to complete the circuit in the initial stage was 27.4 minutes with a variation between 22 and 35 minutes.



Figure 1. Learning without the aid of a simulator

After implementing the starter wiring simulator, re-measurements were conducted on the same indicators. The results showed that 7 students (70%) were able to correctly assemble the circuit according to the diagram, while 3 students (30%) still made minor errors such as incorrect relay terminal installation. The average time to complete the circuit decreased to 18.6 minutes, with a time range of 14 to 25 minutes.



Figure 2. Learning using the help of a simulator

Table 3. Test results

Indicator	Before (Without Simulator)	After (With Simulator)
Successful students (people)	4	7
Students have not succeeded (people)	6	3
Percentage of success	40%	70%
Average time (minutes)	27.4	18.6
Time span (minutes)	22–35	14–25

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In the component recognition stage, students were asked to identify the seven main components of the starter system. Results showed that eight students (80%) were able to correctly name and explain the functions of at least five components, while two students (20%) still had difficulty distinguishing between relay and fuse functions.



Figure 4. Students mention and explain the components shown by the teacher.

The starter wiring simulator used as Appropriate Technology (TTG) has specifications in the form of a 12-volt DC voltage source measured using a digital multimeter with an average value of 12.3 volts at no-load conditions and 11.9 volts when the load is active. The main components consist of a conventional type starter motor (working current ±35–60 A when active), a 4-pin relay (type 12V/30A), a 10A fuse, and a safety diode. The simulator panel uses an open cable path of ±1.5 meters for each circuit, thus allowing direct observation of the current flow.



Figure 5. Wiring Simulator

The device's performance was tested 10 times under different scenarios, including normal and fault conditions. In 9 tests (90%), the system successfully activated the starter motor. In 1 test (10%), the system failed because the cable was intentionally disconnected to simulate a fault. The starter motor's response time was measured using a digital stopwatch, averaging 1.2 seconds from the moment the switch was pressed until the motor was activated.

Students' ability to follow the procedures for using the equipment was also observed. Eight students (80%) were able to complete all steps without assistance after the first

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demonstration, while two students (20%) still needed guidance in the initial stages, particularly when connecting the voltage source. This data was obtained from the teacher's observation checklist during the practice.

In the troubleshooting aspect, students were given three different types of errors: a disconnected cable, a reversed relay, and a removed fuse. The results showed that 7 students (70%) were able to identify at least two of the three errors in ≤10 minutes, while 3 students (30%) required more time or instructor assistance. The average time it took students to find one error was 6.8 minutes.



Figure 6. Troubleshooting the starter wiring system

Student satisfaction was measured using a 1–4 Likert scale questionnaire administered after all activities were completed. The results showed that the average score for ease of use of the tool was 3.32 (SD = 0.48), understanding of the material was 3.41 (SD = 0.51), and learning interest was 3.28 (SD = 0.46). A total of 9 students (90%) chose the category “agree” or “strongly agree” that the simulator helped understand the starter system, while 1 student (10%) chose “quite agree”.

The results of community service activities must be clear and concise. The results must be described in detail.*scientific*which consists of: Training/counseling results, TTG specifications, manuals for the machine, partners trained to use the machine resulting from the training/tool activities, TTG Machine Performance Test, and the level of partner satisfaction after the activity. In the results of the service, it is best to compare the results of the service activities carried out with activities/publications from previous service activities.

Discussions should significantly expand on the results of the activity, not repeat previous community service activities. Extensive citations and discussions of published literature should be avoided.

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CONCLUSION

Based on the results of research on the use of starter wiring simulators in automotive electrical learning at SMKN 1 Leuwidamar, it can be concluded that the use of simulator media can improve students' understanding, practical skills, and learning experiences more effectively than learning without simulators. This can be seen from the increase in the number of students who successfully assembled the starter circuit according to the diagram, namely from 40% to 70%, as well as a decrease in the average time to complete the circuit from 27.4 minutes to 18.6 minutes. In addition, students also showed an increase in their ability to recognize starter system components, carry out tool usage procedures, and troubleshoot electrical circuits.

Observation and interview results show that the starter wiring simulator provides a more interactive, engaging, and easy-to-understand learning experience because students can directly observe the current flow and function of each component in real time. The use of the simulator is also able to increase student active involvement during the learning process so that the practical atmosphere becomes more effective and conducive. The level of student satisfaction with the use of the simulator is in the good category, indicated by the majority of students agreeing that the simulator helps understand the starter system material. This activity addresses the partner's problem regarding students' low understanding of automotive electrical material which was previously dominated by conventional learning methods. The starter wiring simulator can be applied as a practical learning medium that supports competency-based learning in vocational schools, especially on starter systems and motor vehicle electrical materials.

The recommendations from this activity include the need to develop a more comprehensive and varied simulator for use in other automotive electrical materials, such as ignition systems, charging systems, and lighting systems. Teachers are also advised to integrate the use of simulator media continuously into the practical learning process so that students' cognitive, affective, and psychomotor abilities can develop optimally. Furthermore, further research can be conducted with a larger number of subjects and examine the effect of simulators on student learning outcomes and motivation in more depth.

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