JVCE 9 (1) (2024) : 26-32

Journal of Vocational Career Education

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

Learning Achievements in Maintenance of ABS (Antilock Braking System) Brake System Through PBL

Zidane Mushthofaina Al Akhyar ✉, Dwi Widjanarko, Yeri Sutopo

Universitas Negeri Semarang, Indonesia

Article Info

Article History :
Received
January 2024
Accepted
March 2024
Published
July 2024

Keywords:
interactive multimedia, problem-based learning, ABS (Antilock Braking System)

Abstract

The conventional approach of current learning media and the limited utilization of Android technology among students as a learning medium highlight the need for improvements and updates in how information is delivered from teachers to students. Transitioning from traditional methods to more modern approaches, particularly by leveraging existing technology, is essential. This study aims to develop Android-based interactive multimedia using the Problem-Based Learning (PBL) model to enhance learning achievements in the maintenance of ABS (Antilock Braking System) brake systems. It evaluates the feasibility and the improvement in learning outcomes among students in the Light Vehicle Engineering Department at SMK Muhammadiyah 2 Semarang in cognitive, affective, and psychomotor domains. The research employs the ADDIE development model, which includes Analysis, Design, Development, Implementation, and Evaluation. The experimental design used is a Pretest-Posttest Control Group Design. The subjects consist of 60 eleventh-grade students from the Light Vehicle Engineering Department, divided into control and experimental groups. The results of the feasibility assessment by media and material experts are 83.20% ("Feasible") and 88.78% ("Highly Feasible"), respectively. Improvements in learning outcomes are reflected in the N-Gain test results, with the experimental group achieving an average score of 0.4619, categorized as "Moderate," while the control group achieved an average score of 0.2588, categorized as "Low." Based on the N-Gain calculations, it can be concluded that the use of Android-based multimedia through the Problem-Based Learning model in ABS brake system maintenance materials is "Effective".

✉ Correspondence:
Jl. Lamongan Tengah No.2, Bendan Ngisor, Kec. Gajahmungkur,
Kota Semarang, Jawa Tengah 50233, Indonesia
E-mail: zidanmusthofaa2@students.unnes.ac.id

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

INTRODUCTION

The continuous development and updates in the implementation of the education system reflect the progress of education in Indonesia today. According to the Republic of Indonesia Law Number 20 of 2003 on the National Education System, the goal of educational development is to enhance capabilities, build character, and cultivate a dignified civilization to enrich the nation's intellectual life. Effective and high-quality learning can improve the learning process and lead to better outcomes (Andrian & Maksum, 2020). Utilizing Android technology can facilitate the development of an interactive learning medium in the form of an application containing materials, videos, and animations, designed based on the Problem-Based Learning (PBL) model.

Vocational education focuses on specific training designed for application in the workforce (Pavlova, 2009, in Suyitno, 2020). It emphasizes the detailed and specialized competencies required in professional settings. While general education provides broad-based knowledge, vocational education targets specific skills and training. The principles of vocational education, as introduced by Charles Allen Prosser, commonly referred to as the 16 Principles of Prosser, align with this focus.

According to Joyce and Weil, a learning model is a structured plan or pattern used to design curricula, learning materials, and classroom activities (Syamsidah & Suryani, 2018). A learning model is a conceptual framework that systematically organizes learning experiences to achieve specific learning objectives and serves as a guide for instructional designers and educators in planning teaching and learning activities (Umam & Sulaikho, 2021). PBL is an instructional approach that uses real-world problems as a context for learners to develop critical thinking skills and acquire problem-solving abilities (Sofyan et al., 2017).

The criteria for evaluating the quality of interactive learning media (MPI) include three aspects: content, instructional design, and visual presentation (Surjono, 2017). The content must meet the quality standards of the subject matter, ensuring that learners can independently understand the material. The instructional aspect should be evaluated by learning or instructional experts. The visual presentation refers to the user interface, which connects the learning content with users, facilitating engagement and effective learning.

Braking systems are essential in all vehicles, enabling drivers to stop safely and efficiently. Problems arise during sudden braking, particularly on slippery roads or in rainy conditions, which can cause the wheels to lock and reduce vehicle control. According to Sudaryono (2013), the Antilock Braking System (ABS) is an enhancement to conventional hydraulic braking systems, integrating electronic components such as ABS modules, sensors, and actuators into a cohesive system. The ABS aims to prevent wheel locking or skidding during sudden braking and to minimize stopping distances.

The ABS system in vehicles consists of several interrelated components (Satria, 2023). Broadly, it includes six main components, each with specific functions: the Wheel Speed Sensor (WSS) and gear pulser, disc brakes, master cylinders, control modules (ABS modules), brake boosters, and modulator units (hydraulic units). The ABS is an electronically controlled braking system. When issues arise within the ABS, the ABS warning light activates, notifying the driver of a problem in the system.

RESEARCH METHOD

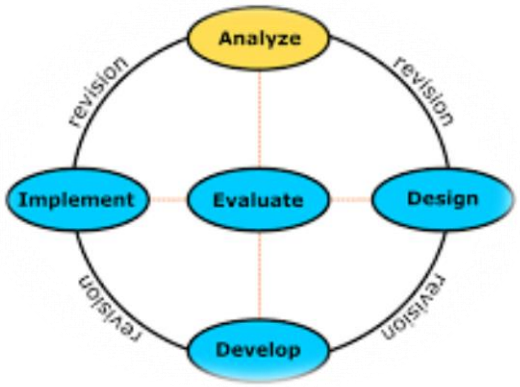

Figure 1. ADDIE Model Development

The research and development (R&D) approach was employed in this study, utilizing the ADDIE development model, which consists of five stages: Analyze, Design, Develop,

Implement, and Evaluate (Sugiyono, 2019). The study adopted an experimental design, specifically the Pretest-Posttest Control Group Design, comparing an experimental class with a control class.

The subjects were eleventh-grade students in the Light Vehicle Engineering Department at SMK Muhammadiyah 2 Semarang, divided into two groups: XI TKR1 (experimental class) and XI TKR2 (control class), with 30 students in each group. The experimental class used the developed multimedia, while the control class followed traditional learning methods.

The Problem-Based Learning (PBL) model was applied to engage learners in solving real-world problems through scientific methods. This model encourages learners to acquire knowledge related to the problem and develop problem-solving skills.

Table 1. Syntax of PBL

Syntax of the Problem-Based Learning (PBL) Model
Formulate problem descriptions (observing)
Develop possible causes (questioning)
Test the causes or perform the diagnostic process (gathering information)
Evaluate (reasoning and communicating)

RESULT AND DISCUSSION

The field implementation phase involved utilizing interactive multimedia on ABS brake systems as a learning medium for ABS brake system materials. During this phase, pretests, posttests, and student feedback questionnaires were administered.

Pretests and posttests were conducted for eleventh-grade learners in the Light Vehicle Engineering Department at SMK Muhammadiyah 2 Semarang. A total of 30 learners participated in the control class, and 30 learners participated in the experimental class. Below are the pretest and posttest results:

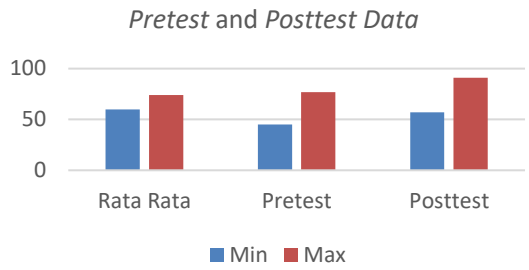

Figure 2. Diagram of Pretest and Posttest Scores

Based on the diagram above, the average pretest score was 59.72, with a minimum score of 45 and a maximum score of 77. The average posttest score was 74.08, with a minimum score of 57 and a maximum score of 91. After obtaining the pretest and posttest results from both the experimental and control classes, the evaluation phase was conducted.

Student feedback data on the developed interactive multimedia product were collected through questionnaires completed by 30 learners who used the interactive multimedia on ABS brake systems as a learning medium. The results of the analysis are presented in the following table:

Table 2. Student Feedback Percentage Analysis

Feedback	Percentage
Highly Appropriate	58.67%
Appropriate	28.09%
Moderately Appropriate	3.60%
Less Appropriate	0.08%
Not Appropriate	0%

Based on the analysis of student feedback, a satisfaction percentage of 89.95% was obtained. This result falls under the category of "Highly Appropriate" for use as a learning medium.

The pretest and posttest scores for both the experimental and control classes were tested for normality using the Kolmogorov-Smirnov (K-S) test with SPSS. The significance values obtained were 0.83, 0.075, 0.176, and 0.091. Since all values exceeded 0.05, the residuals were confirmed to follow a normal distribution.

After confirming normality, homogeneity testing was conducted. Homogeneity was determined using SPSS, with data deemed homogeneous if the significance value exceeded

0.05 (Ghozali, 2018). The significance value for homogeneity, based on the mean, was 0.942, which is greater than 0.05. This confirms that the data were homogeneous, satisfying the requirements for parametric statistical analysis.

With both normality and homogeneity requirements met, a paired t-test was performed. The results of the paired t-test are presented below:

Table 3. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test Experiment	60,33	30	7,954	1,452
	Post Test Experiment	78,50	30	6,611	1,207

The results show that the average pretest score for the experimental group was 60.33, while the average posttest score increased significantly to 78.50.

Tabel 4. *Paired Samples Correlations*

		N	Correlation	Sig.
Pair 1	Pre Test Experiment & Post Test Experiment	30	,767	,000

From the table above, the correlation between the pretest and posttest scores was found to be 0.767, with a significance value of 0.000. This indicates a strong and significant correlation between the two sets of scores.

The next calculation involved the N-Gain test, which evaluates the effectiveness of the intervention. The results of the N-Gain test using SPSS are as follows:

Table 5. N-Gain Test Results Classification

	Average Pretest Score	**Average Posttest Score**	**Maximum Score**	**Average N-Gain Score**
Experimental	60,33	78,50	100	0,4619
Control	59,10	69,67	100	0,2588

Tabel 6. Descriptive Statistics N Gain Ekperimen

	N	Minimum	Maximum	Mean	Std. Deviation
NGain	30	,28	,76	,4619	,11579
Valid N (listwise)	30				

Tabel 7. Descriptive Statistics N Gain Kontrol

	N	Minimum	Maximum	Mean	Std. Deviation
NGain	30	,19	,34	,2588	,04572
Valid N (listwise)	30				

The N-Gain test results showed an average N-Gain of 0.4619 for the experimental class, categorized as “Moderate”, and an average N-Gain of 0.2588 for the control class, categorized as “Low”. These findings indicate that the use of interactive multimedia in the experimental class led to better learning improvements compared to the traditional methods used in the control class.

Student feedback on the developed product was collected through questionnaires completed by 30 learners who used the Android-based interactive multimedia for ABS brake system maintenance. The feedback from the experimental class at XI TKR1 SMK Muhammadiyah 2 Semarang showed a satisfaction percentage of 89.95%, which is categorized as “Highly Appropriate” for use as a learning medium.

These results demonstrate that the developed multimedia effectively supports learning and enhances students' understanding of ABS brake system maintenance.

Discussion

Table 8. Results After Using the Application

No.	**Analysis**	**Results After Using SIREMBO**
1.	Needs Analysis	The material was delivered through the SIREMBO learning application, which includes ABS brake system materials along with drum and disc brake materials. The application also contains animations, videos, audio, and images that enhance interest and motivation to learn.

2	Problem Analysis	Utilizing Android devices among learners at SMK Muhammadiyah 2 Semarang as a learning medium and applying Problem-Based Learning (PBL) makes it easier for learners to understand and solve problems related to ABS brake system maintenance. This improves learning achievements.

The evaluation after using Android-based interactive multimedia with the Problem-Based Learning model on the ABS (Antilock Braking System) brake system maintenance material for learners in the Light Vehicle Engineering program showed significant outcomes. Based on learning achievements in the Chassis and Power Train Management System element, learners were able to understand, explain, identify, analyze, and perform practices related to the inspection and maintenance of ABS brake systems.

The learning evaluation results indicate that the use of Android-based interactive multimedia with the Problem-Based Learning model on ABS brake system maintenance material for learners in the Light Vehicle Engineering program is effective. It is considered effective due to the difference in the average posttest score (78.50) and the average pretest score (60.33) in the experimental class, with a t-test significance level of 0.000. The improvement in learning achievement was categorized as moderate, with an N-Gain score of 0.4619.

This is supported by Sardi (2023), who stated that the use of Android mobile learning enhances learning effectiveness. Mobile learning systems utilizing smartphones make learning more enjoyable and interactive. According to Tistiyanto (2022), the effectiveness of interactive learning media is evident from improvements in cognitive and psychomotor outcomes among learners. Understanding involves grasping the meaning or significance of an object or situation faced. Cognitive structure refers to perception or response to the surrounding environment, influencing ideas, emotions, actions, and social interactions. According to Liu et al. (2022), research findings based on data and discussion conclude that the development of interactive learning media based on the Problem-Based Learning model to enhance higher-order thinking skills is valid, engaging, efficient, and effective, as evaluated by experts, teachers, and learners. The importance of learning motivation for learners includes: (1) Awareness of their position in the initial, process, and final stages of learning, (2) Insights into their learning efforts compared to peers, (3) Guidance for learning activities, (4) Increased enthusiasm for learning, (5) Awareness of their learning journey and its connection to their future work. These five aspects highlight the importance of motivation being recognized directly by the learners. When motivation is acknowledged, learning tasks will be completed effectively.

This study aligns with Abougarair et al. (2022), who found that interactive learning media based on the Problem-Based Learning model is valid, effective, and efficient in enhancing creative thinking skills in learners. For teachers, maintaining and enhancing learning motivation involves: (1) Encouraging active participation by avoiding monotony and boredom in learning, (2) Setting realistic expectations and modifying unrealistic ones, (3) Providing incentives, such as praise or good grades, to motivate further learning efforts, (4) Guiding disengaged individuals to actively participate in the learning process. Similarly, El Fatah (2021) stated that Problem-Based Learning involves active participation and interaction among learners, creating a rich learning environment that enhances cognitive, affective, and psychomotor skills. Motivation is crucial in determining the success or failure of learning activities. Without motivation, successful learning is challenging, as individuals without motivation are unlikely to engage in learning activities. This indicates that the task does not meet their needs or interests.

The learner feedback on the final product, collected from 30 learners in the experimental class using Android-based interactive multimedia to enhance ABS brake system maintenance learning in XI TKR 1 SMK Muhammadiyah 2 Semarang, resulted in a satisfaction percentage of 89.95, categorized as highly appropriate for use as a learning medium. The feedback included aspects indicating that the use of this multimedia improved interest and motivation to learn.

Behavioral changes were observed in mastery of new response patterns to the environment, such as skills, knowledge, attitudes, abilities, understanding, emotions, appreciation, physical development, morals, and social relationships.

This study is consistent with Habib (2020), who concluded that the developed learning tools were feasible and effective, showing improved cognitive outcomes. Interest in learning increased, with the experimental class achieving an average interest score of 67.50, compared to 65.65 in the control class. Learning interest improved as learners were more engaged with Android-based interactive multimedia. Though the difference in motivation between learners using interactive multimedia and those in conventional learning was not statistically significant, there was a noticeable improvement in pretest and posttest scores in both experimental and control classes.

Similarly, He et al. (2020) found that using the Problem-Based Learning model on ABS brake system material resulted in differences in pretest and posttest outcomes after applying the problem-based learning approach. This indicates that the Problem-Based Learning model positively affects cognitive, affective, and psychomotor learning outcomes.

CONCLUSION

Based on the analysis of the research results, the following conclusions can be drawn:

1. The use of Android-based interactive multimedia through the Problem-Based Learning model to enhance learning achievement in ABS brake system maintenance is deemed highly feasible.
2. The evaluation results indicate that the use of Android-based interactive multimedia with the Problem-Based Learning model on ABS brake system maintenance material for learners in the Light Vehicle Engineering program is effective.
3. Learner feedback regarding the final product, implemented in a class of 30 learners using Android-based interactive multimedia to improve learning achievement in ABS brake system maintenance in XI TKR 1 at SMK Muhammadiyah 2 Semarang, was categorized as highly appropriate for use as a learning medium.

REFERENCES

Abougarair, A. J., Shashoa, N. A. A., & Aburakhis, M. K. (2022). Performance of anti-lock braking systems based on adaptive and intelligent control methodologies. Indonesian Journal of Electrical Engineering and Informatics (IJEEI), 10(3), 626-643. DOI: 10.52549/ijeei.v10i3.3794

Andrian, J., & Maksum, H. (2020). *Development of Android-Based Learning Media in The Subjects of Planning and Installation Video Audio System.* EDUTEC: Journal of Education And Technology, 3(2), 192-203.

Amri, M. F. (2020). Pengembangan Media Pembelajaran Interaktif Berbasis *Problem Based Learning (PBL)* Menggunakan *Macromedia Flash 8* Pada Mata Pelajaran Teknologi Dasar Otomotif Siswa Kelas X Teknik Kendaraan Ringan Otomotif SMK Negeri 5 Medan. (Doctoral dissertation, UNIMED). doi: *https://digilib.unimed.ac.id/id/eprint/39864*

Constantin, Y., Darusalam, U., & Nathasia, N. D. (2020). Aplikasi Personal Assistant Berbasis Voice Command Pada Sistem Operasi *Android* Dengan NLP. *JOINTECS (Journal Inf. Technol. Comput. Sci., vol. 5, no. 2, p. 121, 2020, doi: 10.31328/jointecs. v5i2. 1246*.

El-Fatah, A., Sharkawy, A. N., Ghazaly, N. M., & Moaaz, A. (2021). *A comparative study of different control methods for anti-lock braking system* (ABS). SVU-International Journal of Engineering Sciences and Applications, 2(1), 27-34. DOI: 10.21608/svusrc.2021.65855.1007

Ghozali I. (2018). Aplikasi Analisis Multivariate dengan Program IBM SPSS 25. Semarang: Badan Penerbit Universitas Diponegoro.

Habib, S., Afnan, Z., Chowdhury, S. A., & Chowdhury, S. A. (2020). *Design and development of IoT based comprehensive system for emergency assistance* (Doctoral

dissertation, Brac University). http://hdl.handle.net/10361/14364

He, L., Ye, W., He, Z., Song, K., & Shi, Q. (2020). A combining sliding mode control approach for electric motor anti-lock braking system of battery electric vehicle. Control Engineering Practice, 102, 104520. https://doi.org/10.1016/j.conengprac.2020.104520

Jiang, J., Zhang, T., & Chen, D. (2021). *Analysis, design, and implementation of a differential power processing DMPPT with multiple buck–boost choppers for photovoltaic module. IEEE Transactions on Power Electronics, 36(9), 10214-10223.*

Lashkov, I., & Kashevnik, A. (2020). Smartphone-based intelligent driver assistant: context model and dangerous state recognition scheme. In Intelligent Systems and Applications: Proceedings of the 2019 Intelligent Systems Conference (IntelliSys) Volume 2 (pp. 152-165). Springer International Publishing.

Liu, Y., Pei, X., and Guo, X., (2022). "Redundancy Control of Anti-lock Braking System Based on Electro-hydraulic Braking System," SAE Int. J. Veh. Dyn., Stab., and NVH 7(1):53-67, 2023, https://doi.org/10.4271/10-07-01-0004.

Nauri, I. M., Ihwanudin, M., Ismail, H., Mindarta, E. K., Harly, M., Putra, A. S., & Awanggapati, B. (2020, December). *Efforts to improve chassis system learning through learning media anti-lock brake system (abs) integrated hardware-in-the-loop (hil). In Journal of Physics: Conference Series* (Vol. 1700, No. 1, p. 012098). IOP Publishing.

Pavlova, M. (2009). *Technology and Vocational Education for Sustainable Developmen, Empowering Individuals for The Future. Bonn; Springer*

Sardi, S., Anis, S., & Wijaya, B. R. (2023). The Development of Android-Based Scar Media Differentiated Learning Model Anti Lock Brake System Material Light Vehicle Engineering Competence Class XII Vocational School. Journal of Vocational and Career Education, 8(2), 1-11.

Satria, A., Widjanarko, D., & Anis, S. (2023). *Developing Adobe Flash Media with Android-Based to Improve Students' Learning Outcome in Anti-Lock Brake System. Journal of Vocational and Career Education, 8(1).*

Sofyan, H., Wagiran., Komariah, K., Triwiyono. E. (2017). Buku *Problem Based Learning* Dalam Kurikulum 2013. Yogyakarta: UNY Press 2017.

Sudaryono. (2013). *Chasist Management System (CMS)*. Jakarta: Kementerian Pendidikan & Kebudayaan.

Sugiyono. (2019). *Metode Penelitian Kuantitatif Kualitatif dan R&D.* Cetakan Pertama. Bandung. Alfabeta, CV.

Suharsimi, A. (2013). Prosedur Penelitian Suatu Pendekatan Praktik. Cetakan ke-15. Jakarta. PT Rineka Cipta.

Surjono, H.D. (2017). Multimedia Pembelajaran Interaktif. Yogyakarta: UNY Press.

Suyitno. (2020). Pendidikan Vokasi dan Kejuruan strategi dan revitalisasi. Yogyakarta: K-Media.

Suzuki. 2002. *ABS dan Sistem Power Window.* PT. Indomobil Suzuki Internasional

Syamsidah, & Suryani, H. (2018). Buku Model *Problem Based Learning*. Yogyakarta: DEEPUBLISH.

Tistiyanto, M. F. (2022). Pengembangan Media Pembelajaran Interaktif Berbasis *Andorid* menggunakan *ISpring Suite 9* pada Mata Kuliah Pemeliharaan Sasis dan Pemindah Tenaga di Kelas XI TKR SMK NEGERI 1 PERCUT SEI TUAN (Doctoral dissertation, Universitas Negeri Medan).

Y. Yang, Q. Tang, L. Bolin and C. Fu. (2022). "Dynamic Coordinated Control for Regenerative Braking System and Anti-Lock Braking System for Electrified Vehicles Under Emergency Braking Conditions," in IEEE Access, vol. 8, pp. 172664-172677, 2020, doi: 10.1109/ACCESS.2020.3024918.