Jurnal E-Komtek
Vol. 10, No. 1. (2026) pp. 246-256
https://jurnal.politeknik-kebumen.ac.id/index.php/E-KOMTEK
p-ISSN : 2580-3719 e-ISSN : 2622-3066

Development of Problem-Based Learning (PBL)-Based Instructional Media for Manual Automotive Clutch Systems

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https://doi.org/10.37339/e-komtek.v10i1.3286

Published by Politeknik Piksi Ganesha Indonesia

Artikel Info
Submitted:
25-06-2026
Revised:
29-06-2026
Accepted:
30-06-2026
Online first :
30-06-2026

Abstract
This study aims to develop a Problem Based Learning (PBL)-based learning media for the manual clutch system in the Automotive Technology Vocational Education Study Program, Universitas PGRI Yogyakarta. The research used the Research and Development (R&D) method with the 4D model. The teaching aid was developed through design, assembly, and finishing stages using hollow iron. Validation results showed 84% feasibility by media experts, 94% by material experts, and 86.2% by users (very feasible). This media is expected to enhance students' active understanding through PBL approach before direct practice.

Keywords: *Learning Media; Problem Based Learning; Manual Clutch System; Vocational Automotive Education; 4D Model*

Abstrak
Penelitian ini bertujuan mengembangkan media pembelajaran berbasis Problem Based Learning (PBL) untuk materi sistem kopling manual di Program Studi Pendidikan Vokasional Teknologi Otomotif Universitas PGRI Yogyakarta. Penelitian menggunakan metode Research and Development (R&D) model 4D. Media berupa alat peraga dibuat melalui tahap desain, perakitan, dan finishing menggunakan besi hollow. Hasil validasi menunjukkan kelayakan ahli media 84%, ahli materi 94%, dan uji coba pengguna 86,2% (sangat layak). Media ini diharapkan meningkatkan pemahaman mahasiswa secara aktif melalui pendekatan PBL.

Kata-kata kunci: *Media Pembelajaran; Problem Based Learning; Sistem Kopling Manual; Pendidikan Vokasional Otomotif; Model 4D*

1. Introduction

Technological advancements, particularly in the field of education, have developed rapidly in recent years. These developments play a significant role in improving the quality of Human Resources (HR). Based on research [1] education in Indonesia can progress more effectively when educators are given greater autonomy in managing the learning process. However, many human resources in Indonesia still have limited competence in the application of technology, especially within educational settings [2]. Therefore, higher education institutions continue to play a crucial role in developing competent, creative, and highly competitive human resources, particularly teachers in Indonesia [3].

The quality of educational human resources in Indonesia remains relatively low compared to other countries. This condition is reflected in the Programme for International Student Assessment (PISA) 2018 results, which ranked Indonesia 74th out of 79 participating countries [4]. Although the percentage of teachers meeting academic qualification standards has continued to increase, reaching 97.33% in the 2023/2024 academic year (BPS, 2024) [5], another major challenge lies in the unequal distribution of educational facilities and infrastructure across regions. Schools in urban areas generally have more adequate facilities, while many schools in rural areas still face significant shortages, resulting in disparities in educational quality [6]; [7]; [8]; [9].

The Automotive Vocational Technology Education (PVTO) Study Program at Universitas PGRI Yogyakarta was established in response to the rapid development of automotive technology. However, the learning process within this program still encounters several challenges, particularly the limited availability of instructional media that support students' understanding. In the Vehicle Power Transmission System Theory course offered in the even semester, students are required to master competencies related to the manual clutch system, including its operating principles, fault diagnosis procedures, and clutch classifications based on actuation mechanisms [10]; [11]; [12].

Current learning practices remain predominantly conventional and lecturer-centered, causing students to be relatively passive and limiting their understanding to theoretical concepts. In contrast, vocational education requires students to develop analytical and contextual problem-solving skills [13]. Based on interviews conducted with lecturers and students of the PVTO Study

Program, no specific instructional media integrating the Problem-Based Learning (PBL) approach are currently available for teaching manual clutch system materials. Learning through direct disassembly of vehicle units is considered less efficient at the introductory stage because it is time-consuming and does not adequately provide a comprehensive understanding of the relationships among components and the operational mechanisms of the system [14].

Based on these issues, it is necessary to develop instructional media based on the Problem-Based Learning (PBL) approach for manual automobile clutch system materials [15]. This media is intended to function not only as a visual learning aid but also as a tool for presenting contextual problems, enabling students to actively identify problems, analyze system components, and determine appropriate solutions [16]. The proposed instructional media is expected to facilitate lecturers in delivering course content and assist students in gaining a deeper understanding of the material before engaging in hands-on practical activities.

2. Method

This study adopted the Research and Development (R&D) method using the 4D model developed by Sivasailam Thiagarajan. The model consists of four stages: Define, Design, Develop, and Disseminate. The 4D model was selected due to its systematic and clearly structured procedures, which facilitate the development of Problem-Based Learning (PBL)-based instructional media. A quantitative descriptive approach was employed in the product testing phase. Data were collected using rating-scale questionnaires and analyzed in the form of percentages to determine the feasibility level of the developed instructional media [17], [18].

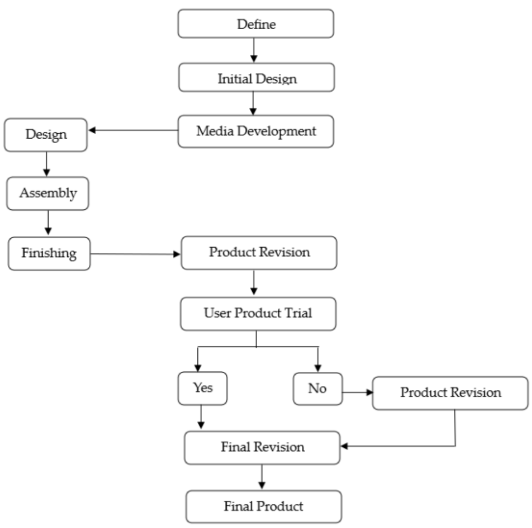

Figure 1. Research Flowchart

3. Results and Discussion

3.1 Media Development and Design

The media development process was carried out through three stages:

a. Design

Design stage included:

Figure 2. Design Stage

This stage involved the selection of materials and the measurement of the engine stand dimensions. The design process served as the initial step in developing the instructional media to ensure that all components met the required specifications.

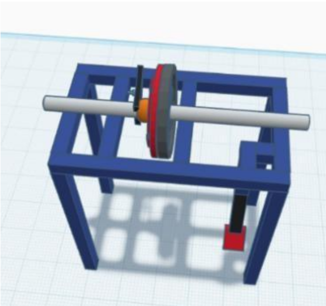

Figure 3. Design of Media

Desain The frame was designed using hollow steel with a thickness of 1.8 mm. The upper section of the frame was constructed with a length of 60.5 cm to accommodate the flywheel component and the pipe shaft assembly. The width of the upper frame section was 40 cm.

b. Assembly

Figure 4. Measurement and Cutting of Steel Materials

Steel materials are measured and cut to obtain components that match the design specifications, thereby facilitating the assembly process and resulting in a precise structure.

Figure 5. Welding Process of the Steel Frame

The assembly process was carried out by cutting and welding the materials according to the predetermined design specifications. Welding was performed using a 140-Ampere electric welding machine.

c. Finishing

Figure 6. Painting Process of the Media Frame

The finishing process was carried out by painting the assembled frame according to the predetermined design. Light blue metal paint was applied to improve the appearance of the instructional media and to protect the metal surface from corrosion.

Figure 7. Final Appearance of the Instructional Media after Finishing

The final appearance of the learning media upon completion reflects the state of the media after undergoing the design, assembly, and finishing processes.

3.2 Media and Content Validation by Expert (ExperT Judgemental)

The media expert validation results indicated an overall feasibility level of 84%, suggesting that the developed instructional media is categorized as feasible for use in the learning process. The results of the media validation assessment are presented in Table 1.

Table 1. Media Expert Validation Review

Assessment Items	Media Expert Validation	
	Media Display	Characteristics of PBL-Based Media
1	4	4
2	5	3
3	5	4
4	4	4
5	5	4
Total	23	19

Feasibility Percentage= $\frac{42}{50} \times 100 = 84$ %

The content expert validation yielded an overall eligibility percentage of 94%, indicating that the instructional content was highly eligible for use. The results of the content expert validation are presented in **Table 2**.

Table 2. Content Expert Validation Result

Assessment Items	Content Expert Validation	
	Media Display	Characteristics of PBL-Based Content
1	5	5
2	4	4
3	5	5
4	5	5
5	5	4
Total	24	23

Feasibility Percentage= $\frac{47}{50} \times 100 = 94$ %

3.3 Product Trial

The product trial was conducted using a user response questionnaire to evaluate the feasibility of the instructional media by measuring its ease of use and applicability in the learning process. Based on the responses of nine participants, the instructional media obtained a feasibility percentage of 86.2%, indicating that it was highly feasible for use. The user response results are presented in Table 3.

Table 3. User Pesponse Results

Respondents	Ease of Use						Implementation of PBL-Based Media					
	1	2	3	4	5	Total	1	2	3	4	5	Total
1	3	4	5	3	4	19	5	4	3	3	4	19
2	4	5	4	5	4	22	5	4	5	4	5	23
3	4	5	5	3	4	21	3	4	3	4	4	18
4	5	5	5	5	5	25	5	5	5	5	5	25
5	5	5	3	4	5	22	3	3	4	4	5	19
6	5	3	4	4	5	21	3	4	2	5	3	17
7	5	5	4	5	5	24	5	4	5	5	5	24
8	5	5	4	5	4	23	4	3	5	5	5	22
9	4	5	5	3	5	22	4	5	3	5	5	22
Total	40	42	39	37	41	199	37	36	35	40	41	189

Feasibility Percentage = $\frac{388}{450} \times 100 = 86{,}2\%$

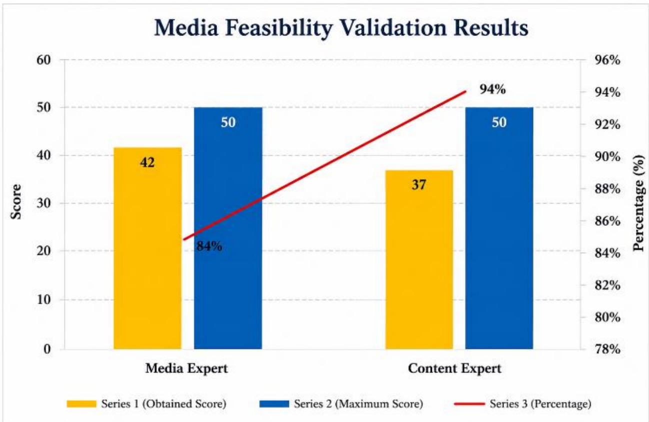

Figure 8. Diagram of the Results of the Qualification Test

The media expert validation results indicated an overall feasibility level of 84%, suggesting that the developed instructional media is categorized as feasible for use in the learning process. The content expert validation yielded an overall eligibility percentage of 94%, indicating that the instructional content was highly eligible for use.

3.4 Final Product

After undergoing validation by media experts and content experts, the product was declared ready for use with several minor revisions, including the addition of user instructions, learning outcomes, and component labels on the instructional media [18]. The content expert also recommended the addition of a driving motor to enhance the functionality of the media. The results of the eligibility test, conducted through a user response questionnaire, yielded an eligibility percentage of 86.2%, which falls into the "very eligible" category. Therefore, the instructional media was considered highly suitable for use in the learning process. The final product was then presented from several perspectives, including side, front, and top views [19];[20].

Figure 9. Side View of The Final Product

The side view of the final product shows the final state of the learning material from the side, revealing the arrangement of its components and its construction after the entire development process has been completed.

Figure 10. Front View of The Final Product

Front view of the final product shows the final state of the learning material from the front, displaying the arrangement of its main components and the structure of the material after the entire development process has been completed.

Figure 11. Top View of The Final Product

The top view of the final product shows the final state of the learning medium from above, illustrating the arrangement and position of the manual clutch system components after the entire development process has been completed.

4. Conclusion

The development of the instructional media was carried out through three stages: design, assembly, and finishing. During the design stage, hollow steel with a thickness of 1.8 mm was selected as the primary material. The upper frame was designed with dimensions of 60.5 cm × 40 cm to accommodate the flywheel component and pipe shaft assembly.

The assembly stage involved cutting and welding the materials using a 140-Ampere electric welding machine, followed by putty application and grinding processes to produce a neat and durable construction. Upon completion, the media underwent expert validation and obtained a media validation score of 84% and a content validation score of 94%. Furthermore, the tool usage test indicated an eligibility level of 86.2%. This result was obtained through questionnaires administered to respondents, assessing aspects related to ease of use and the implementation of the instructional media in the learning process.

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