



## Development of an Integrated Digital Logbook with Problem-Based Learning (PBL) Student Worksheets in Motorcycle Engineering Instruction to Enhance Vocational Character in Vocational High School Students

Miftahussurur Miftahussurur<sup>1✉</sup>, Yeri Sutopo<sup>2</sup>

<sup>1</sup>Vocational School Ma'arif NU 1 Cilongok, Banyumas, Jawa Tengah, Indonesia

<sup>2</sup>Graduate School, Universitas Negeri Semarang, Indonesia

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### Abstract

This study was motivated by the need to strengthen vocational character, particularly discipline, technical competence, and problem-solving skills, among vocational high school students. Conventional paper-based workshop documentation has limited this process due to its vulnerability to manipulation and its inability to support real-time monitoring. This study aimed to develop and evaluate the feasibility, effectiveness, and practicality of an integrated digital logbook platform incorporating Problem-Based Learning (PBL)-based student worksheets for Motorcycle Engineering instruction at SMK Ma'arif NU 1 Cilongok. A Research and Development (R&D) approach using the ADDIE model was employed, consisting of Analysis, Design, Development, Implementation, and Evaluation phases. Data were collected through expert validation instruments, teacher and student practicality questionnaires, and vocational character observation rubrics. Instrument validity was analyzed using Aiken's V, inter-rater reliability was examined using the Intraclass Correlation Coefficient (ICC), and platform effectiveness was evaluated using Normalized Gain (N-Gain) analysis and an independent-samples t-test. The results indicated that all research instruments met acceptable validity and reliability criteria, with Aiken's V values ranging from 0.750 to 1.000 and ICC values ranging from 0.541 to 0.822. The platform effectively improved students' vocational character, as demonstrated by a higher N-Gain score in the experimental group (0.6104; moderate category) compared with the control group (0.2760; low category), with a statistically significant difference ( $p < .001$ ). The platform also demonstrated high practicality, receiving positive responses from teachers (87.02%) and students (86.64%). In conclusion, the PBL-integrated digital logbook platform was feasible, effective, and practical for supporting vocational learning. The platform provides a digital solution for improving workshop documentation management while fostering students' self-regulation, discipline, and professional work habits aligned with industry expectations.

#### ✉ Correspondence:

Jalan Masjid Kauman, Cilongok, Kec. Cilongok, Kabupaten Banyumas,  
Jawa Tengah 53162, Indonesia  
E-mail: [miftahussurur77@students.unnes.ac.id](mailto:miftahussurur77@students.unnes.ac.id)

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## INTRODUCTION

Vocational education in Indonesia plays a pivotal role in preparing a competent, productive, and industry-ready workforce capable of meeting the evolving demands of the labor market and the rapid transformation of the industrial sector. Accordingly, Vocational High Schools (*Sekolah Menengah Kejuruan* [SMK]) are expected not only to develop students' technical competencies (hard skills) but also to foster essential soft skills that support professional performance in the workplace. Within vocational education, these soft skills are reflected in the development of vocational character, which underpins students' readiness to perform effectively in authentic workplace settings.

In the Automotive Engineering program, particularly the Motorcycle Engineering (*Teknik Sepeda Motor*, TSM) specialization, vocational character encompasses three interrelated dimensions: work discipline, technical proficiency in following standard operating procedures, and problem-solving ability. Developing these competencies requires continuous practice supported by structured learning experiences, systematic documentation, and transparent monitoring throughout the learning process.

Although the importance of cultivating vocational character is explicitly emphasized in Indonesia's national vocational education curriculum, its implementation in classroom and workshop settings remains challenging. In many vocational high schools, the monitoring, reporting, and documentation of workshop practical activities continue to rely on conventional paper-based records. This administrative approach presents several limitations that may compromise the accuracy and transparency of vocational character assessment.

These limitations include the potential for data manipulation, such as students completing daily logbooks retrospectively without performing the recorded tasks. In addition, paper-based records are susceptible to physical damage caused by oil, grease, and other workshop contaminants. They also limit teachers' ability to

monitor students' learning progress, identify technical difficulties, and provide timely feedback during practical sessions. As a result, assessing students' vocational character based on authentic and continuous evidence becomes increasingly difficult.

The limitations of paper-based logbooks can introduce bias into the assessment of students' vocational character. In practice, teachers often rely on retrospective observations when evaluating students' discipline and practical performance, with cumulative assessments conducted at the end of the learning period rather than being supported by continuous and verifiable records. Consequently, essential workplace attributes including punctuality, accurate reporting of work procedures, and independent troubleshooting of hydraulic and mechanical brake system faults may not be consistently developed or objectively assessed. In the context of ongoing digital transformation, there is an increasing need for a digital platform that supports transparent documentation, monitoring, and assessment of automotive practical activities.

To address this challenge, this study developed an integrated Digital Logbook platform to document students' practical activities systematically. Rather than serving solely as a digital repository, the platform enables students to record each stage of their practical work, upload authentic photographic evidence of completed tasks, and track the duration of each activity. To enhance its instructional value, the platform is integrated with Student Worksheets structured according to the phases of the Problem-Based Learning (PBL) model (Barrows, 2000). This integration engages students in solving authentic troubleshooting problems involving hydraulic and mechanical brake systems, thereby promoting critical thinking, systematic problem-solving, and technical competence within an industry-oriented learning environment.

By integrating PBL-based Student Worksheets into the Digital Logbook platform, which is accessible through its official domain (<https://tsmwela.welabae.online/>), the system incorporates a sequential locking mechanism. This feature requires students to complete each stage of the workshop activity in a predetermined

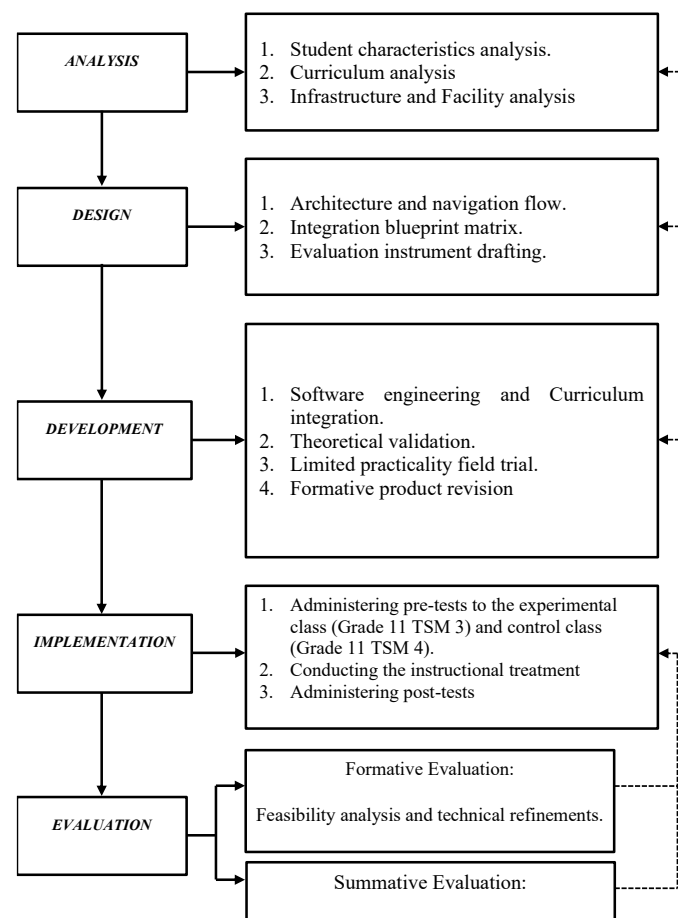
sequence, ensuring that all procedures are carried out systematically and in accordance with industry-standard operating procedures. Students must complete each instructional phase and upload authentic evidence of their work before the system grants access to the subsequent phase.

Based on this background, this Research and Development (R&D) study pursued four main objectives: (1) to develop an integrated Digital Logbook platform incorporating PBL-based Student Worksheets for Motorcycle Engineering instruction at Vocational High School (SMK) Ma'arif NU 1 Cilongok; (2) to evaluate the content validity of the media and subject-matter evaluation instruments through expert judgment; (3) to examine the practicality of the platform from the perspectives of vocational teachers as workshop instructors and students during its implementation; and (4) to evaluate the effectiveness of the PBL-integrated Digital Logbook platform in enhancing students' vocational character, particularly work discipline,

technical competence, and problem-solving skills, by comparing learning outcomes between the experimental and control groups.

## METHODOLOGY

This study employed a Research and Development (R&D) approach using the ADDIE instructional design model. According to Branch (2009), the ADDIE model provides a systematic framework comprising five sequential phases: Analysis, Design, Development, Implementation, and Evaluation. The model was selected because of its systematic, iterative, and adaptable characteristics, making it well suited for developing web-based digital learning media that require both strong theoretical validity and practical effectiveness in vocational workshop settings. The overall research and development process adopted in this study is illustrated in the operational flowchart shown below.



**Figure 1.** Operational Flowchart of the ADDIE Research and Development Model.

The Analysis phase involved identifying the key limitations of the existing analog logbook reporting system at SMK Ma'arif NU 1 Cilongok, conducting a learning needs analysis for the Motorcycle Chassis component of the Motorcycle Engineering specialization, and assessing the workshop's internet infrastructure to support the implementation of the digital platform.

The Design phase focused on developing the database architecture, designing the web-based user interface wireframes, creating the logic flow for the sequential locking mechanism, and preparing Student Worksheets (*Lembar Kerja Peserta Didik*, LKPD) for the hydraulic and mechanical brake system module.

The Development phase involved implementing the system design by developing the web application using PHP and MySQL, deploying it to its official operational domain (<https://tsmwela.welabae.online/>), and evaluating its theoretical feasibility through expert validation. The validation process involved an external panel of 11 experts, consisting of five media experts, five subject-matter experts, and one expert in vocational character psychology.

The Implementation phase consisted of two stages: a small-group readability trial involving 23 students who were not included in the main research sample, followed by a full-scale field trial. The field trial was conducted with two parallel Grade 11 Motorcycle Engineering (TSM) classes at SMK Ma'arif NU 1 Cilongok during the 2025/2026 academic year. Class XI TSM 3 was assigned as the experimental group ( $n = 36$ ) and received instruction through the Problem-Based Learning (PBL) model supported by the integrated Digital Logbook platform and Student Worksheets (LKPD). Class XI TSM 4 served as the control group ( $n = 36$ ) and received conventional practical instruction using paper-based logbooks.

The Evaluation phase comprised both formative and summative evaluation. Formative evaluation was conducted throughout the development process to identify and resolve software issues based on expert feedback, whereas

summative evaluation was performed after the field trial to assess the platform's practicality and effectiveness. Data were collected using three types of instruments: expert validation rating scales, teacher and student practicality questionnaires adapted from the Technology Acceptance Model (TAM) (Davis, 1989), and standardized observation rubrics measuring students' vocational character, including work discipline, technical competence, and problem-solving skills.

The theoretical feasibility of the platform and the quality of the research instruments were evaluated through content validity and reliability analyses. The content validity of the media and subject-matter validation sheets, pre-test and post-test instruments, and teacher and student practicality questionnaires was assessed using Aiken's V coefficient (Aiken, 1980). The inter-rater reliability of all multi-rater instruments was then examined using the Intraclass Correlation Coefficient (ICC) based on the two-way mixed-effects model with a consistency definition (ICC [3,k]) (Shrout & Fleiss, 1979; Koo & Li, 2016) using SPSS version 26. Because the vocational character observation rubric was completed by a single observer, only its content validity was evaluated using Aiken's V. Item validity was interpreted based on the recommended Aiken's V threshold, whereas the reliability of the multi-rater instruments was interpreted according to established ICC classification criteria.

Practicality data were analysed using quantitative descriptive analysis based on percentage scores. The effectiveness of the platform in enhancing students' vocational character was evaluated by calculating the Normalized Gain (N-Gain) based on pre-test (pre-intervention) and post-test (post-intervention) observation scores. Differences in the mean N-Gain scores between the experimental and control groups were analysed using an independent-samples *t*-test in SPSS version 26 with a significance level of  $\alpha = 0.05$ . Before conducting the *t*-test, the assumptions of normality and homogeneity of variance were examined using the Kolmogorov-Smirnov test and Levene's test.

## RESULT AND DISCUSSION

### Theoretical Feasibility of the Product (Media and Content)

Before being implemented in workshop practical learning within the chassis laboratory, the Problem Based Learning (PBL) integrated Digital Logbook platform and all research instruments underwent theoretical validation through expert judgment.

The quality of the research instruments was evaluated by examining their content validity using Aiken's V coefficient and their inter-rater reliability using the Intraclass Correlation Coefficient (ICC). The results indicated that all

instrument items achieved Aiken's V values ranging from 0.750 to 1.000, indicating satisfactory content validity. In addition, the ICC values ranged from 0.541 to 0.838, representing moderate to high levels of inter-rater reliability. These findings indicate that all research instruments met the required validity and reliability criteria and were therefore suitable for use in this study.

The theoretical feasibility of the Digital Logbook platform, encompassing both the media and content aspects, was determined by comparing the mean scores obtained from expert evaluations with the feasibility criteria proposed by Sukardjo (2014), as presented in Table 1.

**Table 1.** Matrix of Expert Panel Theoretical Validation Results

| Evaluation Object & Test Type          | Analytical Parameter         | Number of Raters / Observers | Obtained Index | Assessment Criteria |
|----------------------------------------|------------------------------|------------------------------|----------------|---------------------|
| Media Feasibility Instrument           | Content Validity (Aiken's V) | 5 Experts                    | 0.800 – 1.000  | Valid               |
|                                        | Inter-Rater Agreement (ICC)  | 5 Experts                    | 0.541          | Moderate            |
| Subject-Matter Feasibility Instrument  | Content Validity (Aiken's V) | 5 Experts                    | 0.750 – 1.000  | Valid               |
|                                        | Inter-Rater Agreement (ICC)  | 5 Experts                    | 0.822          | High                |
| Vocational Character Observation Sheet | Item Validity (Aiken's V)    | 1 Expert in Psychology       | 0.750 – 1.000  | Highly Valid        |
|                                        | Inter-Rater Agreement (ICC)  | N/A (Single Rater)           | N/A            | N/A                 |
| Pre-Test & Post-Test Items (LKPD)      | Content Validity (Aiken's V) | 5 Experts                    | 0.750 – 1.000  | Valid               |
|                                        | Inter-Rater Agreement (ICC)  | 5 Experts                    | 0.838          | High                |
| Student Practicality Questionnaire     | Content Validity (Aiken's V) | 5 Experts                    | 0.750 – 1.000  | Valid               |
|                                        | Inter-Rater Agreement (ICC)  | 5 Experts                    | 0.802          | High                |
| Teacher Practicality Questionnaire     | Content Validity (Aiken's V) | 5 Experts                    | 0.750 – 1.000  | Valid               |
|                                        | Inter-Rater Agreement (ICC)  | 5 Experts                    | 0.762          | High                |

### Media Feasibility Aspect

The media feasibility evaluation conducted by the expert panel covered five aspects: system engineering, navigation usability, database reliability, user interface design, and the functionality of the sequential locking mechanism implemented in the web platform (<https://tsmwela.welabae.online/>).

The expert evaluation yielded a mean score of 4.45 out of 5.00, equivalent to an achievement percentage of 89.00%. Based on Sukardjo's (2014) feasibility criteria, this score falls within the 81%–100% category, indicating that the Problem-Based Learning (PBL)-integrated Digital Logbook platform is highly feasible in terms of its media design. The platform's high feasibility is reflected in its intuitive navigation, responsive

user interface, reliable database performance, and stable implementation of the sequential locking mechanism throughout the learning process.

### Subject-Matter Feasibility Aspect

The subject-matter feasibility evaluation conducted by the expert panel focused on the accuracy of the instructional content covering the Motorcycle Chassis component, particularly the hydraulic and mechanical brake systems, as well as the alignment of the Problem-Based Learning (PBL) instructional phases integrated into the digital Student Worksheets (*Lembar Kerja Peserta Didik*, LKPD).

The expert evaluation yielded a mean score of 4.38 out of 5.00, equivalent to an achievement percentage of 87.60%. Based on Sukardjo's (2014) feasibility criteria, this score falls within the 81%–100% category, indicating that the instructional content is highly feasible. These findings indicate that the learning materials are conceptually accurate, systematically organized in accordance

with the phases of the PBL model, and appropriate for promoting students' critical thinking and troubleshooting skills in vocational learning.

### Practicality of the Digital Logbook Platform

The practicality evaluation was conducted to assess the ease of use, operational efficiency, and technical usability of the developed platform during workshop learning activities. Practicality data were collected using a questionnaire based on the Technology Acceptance Model (TAM) proposed by Davis (1989) after all learning activities on the Motorcycle Chassis component had been completed. The questionnaire was administered to three productive Motorcycle Engineering (TSM) teachers serving as workshop instructors and 36 Grade 11 TSM 3 students as the primary users of the platform. A summary of the practicality scores and their corresponding percentage achievements is presented in Table X.

**Table 2.** Summary of Percentage Achievements and Mean Media Practicality Indices

| No. | Respondent Group                | Actual Score | Ideal Score | Mean Actual Score | Achievement Percentage | Practicality Category |
|-----|---------------------------------|--------------|-------------|-------------------|------------------------|-----------------------|
| 1   | Productive TSM Teachers (n = 3) | 248          | 285         | 4.351             | 87.02%                 | Very Practical        |
| 2   | Students (n = 36)               | 2807         | 3240        | 4.332             | 86.64%                 | Very Practical        |

The results presented in Table 2 indicate a high level of practicality across both user groups. The three productive Motorcycle Engineering (TSM) teachers obtained a total score of 248 out of a maximum possible score of 285, corresponding to an achievement percentage of 87.02% and a mean score of 4.351. Based on the feasibility criteria proposed by Sukardjo (2014), this result falls within the Very Practical category.

Item-level analysis indicated that teachers assigned the highest ratings to the perceived usefulness dimension of the platform. They reported that the Digital Logbook simplified the administration of workshop activities by facilitating the monitoring of student progress,

submission records, timestamps, and photographic evidence of practical tasks through the teacher dashboard. This functionality reduced reliance on paper-based logbooks and streamlined the documentation of students' practical activities.

Similarly, the responses from the 36 students in the experimental class yielded a total score of 2,807 out of a maximum possible score of 3,240, representing an achievement percentage of 86.64% and a mean score of 4.332. According to Sukardjo's (2014) criteria, this result also falls within the Very Practical category. Students assigned the highest ratings to the perceived ease of use dimension, indicating that the platform was

easy to navigate and supported the documentation of practical activities in a structured manner. The image-upload feature and the integration of PBL-based Student Worksheets (LKPD) were also positively evaluated for facilitating systematic learning and documentation during workshop practice.

These findings are consistent with the Technology Acceptance Model (TAM) proposed by Davis (1989), which suggests that users are more likely to accept and adopt a technology when it is perceived as both useful and easy to use. The high ratings for these two dimensions indicate that the Digital Logbook platform was well accepted by both teachers and students in supporting workshop learning activities.

### Effectiveness of the Platform in Enhancing Vocational Character

The summative effectiveness evaluation represented the final phase of the ADDIE-based Research and Development (R&D) process and was conducted to assess the effectiveness of the Problem-Based Learning (PBL)-integrated Digital Logbook platform in enhancing students' vocational character, including work discipline, technical competence, and problem-solving skills, compared with conventional paper-based practical instruction. Comparative data on the mean pre-test scores, post-test scores, and Normalized Gain (N-Gain) scores for the experimental group (Class XI TSM 3) and the control group (Class XI TSM 4) are presented in Table 3.

**Table 3.** Descriptive Comparison of Character Scores and N-Gain Scores

| Research Sample Group         | Pre-test Mean | Post-test Mean | N-Gain Mean | Effectiveness Category | Effectiveness Interpretation |
|-------------------------------|---------------|----------------|-------------|------------------------|------------------------------|
| Experimental Class (XI TSM 3) | 56.42         | 83.03          | 0.6104      | Moderate               | Effective                    |
| Control Class (XI TSM 4)      | 55.89         | 68.11          | 0.2760      | Low                    | Ineffective                  |

Based on the descriptive statistics presented in Table 3, both groups exhibited comparable levels of vocational character before the intervention. The experimental group obtained a mean pre-test score of 56.42, while the control group achieved a mean score of 55.89, indicating similar baseline characteristics. Following the intervention, both groups demonstrated improvement; however, the experimental group achieved a substantially higher mean post-test score (83.03) than the control group (68.11).

The Normalized Gain (N-Gain) analysis further demonstrated the effectiveness of the intervention. The experimental group achieved a mean N-Gain score of 0.6104, which is categorized as moderately effective according to Hake (1998), whereas the control group obtained a mean N-Gain score of 0.2760, classified as low.

To derive valid and scientifically defensible inferential conclusions, hypothesis testing was conducted by performing an Independent Samples *t*-Test on the N-Gain scores of both

sample groups using SPSS 26. Prior to executing the *t*-test, the prerequisite statistical assumptions were verified:

1. The Kolmogorov-Smirnov data normality test yielded a  $p\text{-value} > 0.05$ , confirming that the N-Gain data distribution for both classes met normal distribution parameters.
2. Levene's Test for equality of variances yielded a significance  $p\text{-value} < 0.05$ , indicating that the variance between the two groups was heterogeneous (unequal).

Due to the violation of the homogeneity of variance assumption, the results of the independent-samples *t*-test were interpreted based on the unequal variances assumption.

Statistical analysis using the independent-samples *t*-test under the Equal Variances Not Assumed condition yielded a two-tailed significance value (*Sig.* (2-tailed)) of 0.000. Because this value was lower than the predetermined significance level ( $\alpha = 0.05$ ), the

null hypothesis ( $H_0$ ) was rejected, and the alternative hypothesis ( $H_1$ ) was accepted. The calculated mean difference between the two groups was 0.33439.

The acceptance of the working hypothesis scientifically proves that the implementation of the Problem-Based Learning (PBL)-integrated Digital Logbook platform is 33.44% more effective in accelerating the enhancement of vocational character traits among vocational high school students compared to the conventional analog paper-based logbook system.

### **Integrative Discussion and Theoretical Implications**

The greater improvement in vocational character demonstrated by students in the experimental class who used the digital platform (<https://tsmwela.welabae.online/>) can be explained by the interaction between the platform's technological features and the development of students' work habits. The improvement in the work discipline dimension was primarily associated with the implementation of the platform's sequential locking mechanism. This feature prevented students from manipulating submission timestamps or bypassing workshop procedures, as access to subsequent activities remained locked until the required tasks in the preceding stage had been completed.

For example, upon entering the chassis workshop, students were initially required to complete the work-readiness stage before gaining access to the PBL-based Student Worksheet (LKPD). As part of this process, they were required to upload authentic photographic evidence showing that they were wearing complete personal protective equipment (PPE). If the submission exceeded the allocated time limit, the system automatically recorded the entry as late, and the information was integrated into the discipline records displayed on the teacher dashboard. This sequential workflow encouraged students to develop greater self-regulation by reinforcing punctuality and adherence to standard operating procedures.

The improvement in procedural technical skills and problem-solving ability can also be attributed to the integration of the Problem-Based

Learning (PBL) model within the digital worksheets. At the beginning of each practical session, students were presented with authentic troubleshooting scenarios involving motorcycle brake system malfunctions and were required to analyze the potential causes and propose appropriate repair procedures before performing the practical tasks. This structured learning process promoted critical thinking and systematic problem-solving throughout the workshop activities.

During the practical sessions, students documented technical measurements, such as brake pad thickness and brake disc runout, and uploaded them as authentic evidence through the platform. This digital learning environment positioned students as active participants in the learning process while enabling teachers to monitor their progress continuously. These findings are consistent with Hake's (1998) theory of interactive engagement, which suggests that learning environments requiring active student participation produce greater learning gains and improved long-term retention than traditional teacher-centered instructional approaches.

### **CONCLUSION**

Based on the complete sequence of Research and Development (R&D) procedures implemented using the ADDIE framework and evaluated through theoretical validation and empirical testing in the motorcycle chassis workshop at SMK Ma'arif NU 1 Cilongok, the following conclusions can be drawn:

1. Product Development Process Based on the ADDIE Model: The Digital Logbook platform integrated with Problem-Based Learning (PBL)-based Student Worksheets (LKPD) for Motorcycle Engineering learning was systematically developed through five ADDIE phases. The Analysis phase identified the limitations of conventional paper-based practical reporting systems and examined workshop infrastructure requirements. The Design phase involved developing the database architecture, web interface design, activity workflow locking logic, and instructional

content framework. The Development phase translated the design specifications into a web-based application using PHP and MySQL, followed by deployment and theoretical validation by an external expert panel. The Implementation phase involved readability testing and a full-scale field trial with Grade 11 Motorcycle Engineering students. Finally, the Evaluation phase included formative evaluation to improve system functionality based on expert feedback and summative evaluation to assess the product's effectiveness.

2. **Theoretical Feasibility Quality of the Product:** All data collection instruments and the digital platform developed in this study demonstrated exceptionally strong theoretical feasibility criteria for scientific measurement. Based on comprehensive evaluations by a multi-rater expert panel (comprising media experts, subject-matter experts, and vocational character psychology specialists), all indicator items across the media evaluation instruments, automotive chassis content, test assessment tools, and practicality questionnaires exhibited high content validity. Furthermore, inter-rater reliability was consistent, stable, placed in the reliable category, and free from rater subjectivity bias.
3. **Operational Practicality Index of the Media:** The Digital Logbook platform demonstrated a high level of operational practicality for implementation in a vocational workshop environment. Evaluated through the Technology Acceptance Model (TAM) dimensions, productive Motorcycle Engineering teachers acting as workshop instructors confirmed substantial perceived usefulness, as the platform significantly reduced administrative workloads by automating daily student score compilations in real time. Concurrently, students as direct users experienced optimal perceived ease of use due to the application's interactive navigation structure, responsiveness, user-friendly interface, and intuitive image submission features, functioning without

significant technical obstacles during benchwork activities in the workshop.

4. **Product Effectiveness in Enhancing Vocational Character:** The PBL-integrated Digital Logbook platform proved significantly effective in enhancing students' vocational character profiles, encompassing dimensions of work discipline, procedural technical skills, and problem-solving capacities. The N-Gain analysis indicated that the experimental class achieved a moderate level of improvement and significantly outperformed the control class receiving conventional paper-based practical instruction. The sequential locking mechanism supported the development of students' self-regulation and adherence to procedural workflows, while the integration of PBL-based worksheets encouraged critical thinking and systematic problem-solving in addressing motorcycle chassis-related problems.

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