Practicality of Mobile-Based Learning with Project-Based Learning Approach in Electric Motor Installation to Increase Student Learning Motivation

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Manuscript received December 28, 2023; revised February 19, 2024; accepted March 28, 2024; published August 19, 2024

***Abstract*—Opportunities for innovation in leveraging mobile devices for learning and integrating them with diverse learning methodologies are emerging due to the rising prevalence of mobile device usage among students, so this research investigates the practicality of mobile-based learning using a project-based learning approach in the context of electric motor installations which aims to increase student learning motivation. This research aims to examine the impact of an integrated approach on student's practical skills and motivation in electric motor installation education. The research methodology used in this research adopts a Research and Development (R&D) framework with a 4D model, which includes the define, design, develop, and disseminate stages. In this study, we carefully designed the app navigation, user interface, and mobile functionality, followed by validation, practical testing, and assessment of student motivation. Validation assessments are carried out by education and technology experts. Practicality assessment is carried out by user testing. A motivation assessment is carried out using a motivation questionnaire. The research results confirm that mobile-based learning with a project-based learning approach in learning electric motor installation meets the criteria for validity and practicality in all aspects. In addition, this integrated approach has proven to be very effective in increasing student learning motivation. Based on research findings, this integrated approach provides benefits in the form of ease of collaboration, access to material, interaction, more interactive visualization, efficiency of learning time, and self-evaluation. However, the integrated approach currently being developed is not yet integrated with Artificial Intelligence (AI), so there is still a great opportunity for further research in its integration with education.**

***Keywords*—mobile-based learning, project-based learning, electric motor installation, student motivation, research and development**

I. Introduction

Vocational education plays a pivotal role in equipping students with the essential skills and knowledge necessary to navigate the ever-evolving world of work, particularly within the field of electrical engineering [1]. As the industry undergoes rapid transformation driven by automation, artificial intelligence, and digitalization, the necessity for innovative pedagogical approaches in vocational education becomes increasingly critical. Embracing modern tools and technology is imperative to preparing students for success in the dynamic world of work, especially within the specialized domain of electrical engineering.

While the integration of modern technology into learning is crucial for both theoretical knowledge and practical competence [2, 3], adapting pedagogical methods that facilitate the construction of useful knowledge is equally vital [4]. Project-Based Learning (PjBL) is emerging as a pedagogical framework that transcends conventional approaches [5, 6], offering students not only theoretical knowledge but also the opportunity to apply that knowledge in authentic, real-world situations. PjBL fosters active collaboration, creativity, and problem-solving skills, nurturing students to become adaptable and proactive learners [7, 8]. Moreover, PjBL can enhance essential skills needed in the world of work, such as problem-solving, communication, and teamwork skills [9, 10].

Combining the PjBL approach with mobile technology holds promising potential in electrical engineering education, particularly in electric motor installations. In this context, students must develop a profound understanding of theoretical concepts and apply them in a practical environment. The reliability of mobile technology can facilitate interactive, effective, and customized learning experiences [11, 12], especially when combined with PjBL, which provides hands-on projects, critical problem-solving, and collaboration. This synergy is aligned with previous research demonstrating the benefits of PjBL and mobile technology in increasing student engagement, fostering collaboration skills, and improving critical thinking [13–16]. Thus, it is anticipated that this integrated approach can boost student learning motivation by offering a dynamic, relevant, and personalized educational journey that prepares students to confront the challenges of the modern world of work. However, previous research has not thoroughly explored how these two elements can synergistically support each other, particularly in the context of learning electric motor installation. Therefore, further research is warranted to comprehend how PjBL and mobile-based learning can be seamlessly integrated to enhance students' practical abilities and learning motivation. A significant research gap exists in the lack of focus on how the combination of mobile-based

doi: 10.18178/ijiet.2024.14.8.2141

learning and Project-Based Learning can specifically enhance students' practical abilities and learning motivation.

Recognizing this existing research gap, this study aims to bridge it through the development of mobile-based learning using the PjBL approach in learning electric motor installation, which is valid, practical, and effective in increasing student motivation. This research is poised to contribute to the enhancement of the quality of electrical vocational education, fostering learning innovation, and preparing students to meet the demands of modern industry.

II. Literature Review

The significance of vocational education in meeting the competencies required in today's dynamic job market has been underscored [17, 18]. With automation trends and digital transformation increasingly shaping the workplace, vocational education must evolve to adequately prepare students [19]. Numerous studies emphasize the need for adaptive and responsive vocational education curriculums that address technological changes and industrial demands [20, 21]. Consequently, vocational education graduates should possess not only theoretical skills, but also practical skills aligned with job market needs.

However, traditional teaching methods often fall short in imparting relevant practical skills to students [22]. As an alternative, Project-Based Learning (PjBL) is considered a more effective learning approach [23–25]. PjBL stages begin with "Problem Orientation", ensuring relevance and student involvement from the outset. Subsequent stages such as "Planning group activities" foster collaboration and communication, while "Completing the project" ensures active engagement with the concepts being taught. "Project report" creation facilitates reflection and deeper understanding, and "Presenting the report" enhances communication and presentation skills. Lastly, "Evaluation" provides feedback for continuous improvement [26–29]. Overall, PjBL encourages the integration of theory and practice, enhancing critical thinking, collaboration, and communication skills.

The widespread use of mobile devices has sparked interest in leveraging these technologies for educational purposes [30]. In addition to providing a flexible and accessible learning environment, mobile technology has the potential to revolutionize education. For instance, mobile apps can facilitate microlearning experiences accessible anytime, anywhere, complementing traditional classroom teaching [31, 32]. Features like real-time feedback, gamification, and interactive multimedia enrich the learning experience, increasing engagement and adaptability to individual learner needs [33, 34]. Furthermore, mobile technologies facilitate social learning experiences such as collaborative assignments and peer feedback, necessitating a strategic pedagogical approach for effective knowledge construction [35, 36].

Motivating students to learn is crucial for the success of vocational education. High learning motivation correlates with student engagement, persistence, and improved academic achievement [37]. Motivated students are more likely to actively participate in class, ask questions, and complete assignments enthusiastically, enhancing their understanding and skill development [38, 39].

PjBL and mobile-based learning are two approaches that can increase student learning motivation. PjBL grants students' autonomy and ownership over their learning, fostering responsibility for learning outcomes. Moreover, PjBL provides real-world relevance, enhancing intrinsic motivation. Mobile applications with 3D animation features can illustrate electric motor components, enhancing mobile learning [40]. Additionally, mobile technology facilitates document sharing and group communication, enabling convenient access to learning materials and remote collaboration [41, 42]. Several studies demonstrate promising outcomes when PjBL is combined with mobile technology, offering interactive and collaborative learning experiences [43, 44].

Although PjBL and mobile technology have been researched separately, prior studies, primarily focused on cognitive abilities, have not fully explored their synergistic support, particularly in electric motor installation learning. Based on the literature review, the research question formulated is: "How is mobile-based learning using the PjBL approach valid, practical, and effective in increasing students' learning motivation in electric motor installation?".

III. Materials and Methods

A. Research Methodology

This research uses Research and Development (R&D) methodology to create mobile-based learning with a Project-Based Learning (PjBL) approach for teaching electric motor installation in vocational high schools, through four process flows consisting of Define, Design, Develop, and Deploy (4D). The research flow is depicted in Fig. 1 below.

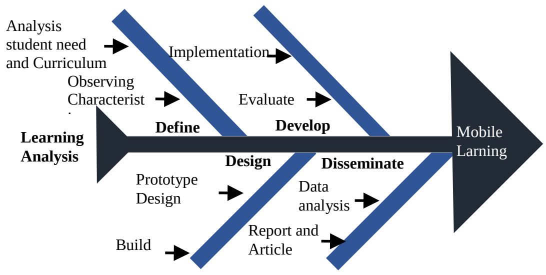

Fig. 1. Fishbone of research procedures.

Define: The first stage involves a comprehensive assessment of the needs and challenges in teaching electric motor installation at Vocational High Schools. This stage also encompasses defining the primary objectives of developing mobile-based learning using the PjBL approach. It serves as a crucial foundation for understanding the issues to be addressed and the goals to be achieved through this research.

Design: The second stage focuses on formulating the initial concept of mobile-based learning using the PjBL approach. This includes designing the learning content, application structure, and core features of the application. Additionally, this stage involves crafting a User Interface (UI) that ensures accessibility and user-friendliness for students. Furthermore, a research instrument in the form of a questionnaire is designed at this stage to measure the practicality of the developed application.

Develop: The third stage entails building the prototype of mobile-based learning using the PjBL approach based on the previously designed concept and interface. This prototype serves as the basis for further refinement. The stage also encompasses validity testing with technology and education experts, accompanied by initial trials involving students from vocational schools to identify initial challenges and gather valuable feedback. Subsequently, developers incorporate improvements and modifications based on the received feedback. Finally, the application undergoes practicality testing to ensure its effectiveness in enhancing students' ability to install electric motors.

Disseminate: The fourth stage involves activities aimed at sharing research findings. This includes collecting data from a sample group of students through questionnaires and performing descriptive analysis to derive meaningful insights. The analysis results are interpreted and presented in a comprehensive research report, including key findings and recommendations. Furthermore, scientific articles are compiled for publication in reputable international journals. The primary objective of this stage is to disseminate research findings to the scientific community, electrical engineering practitioners, and other stakeholders, thereby facilitating advancements in electrical engineering education through effective utilization. Through these efforts, mobile-based learning using the PjBL approach is anticipated to prepare students for the evolving demands of the electric motor installation field in the workforce.

B. Subject of Research

The subject of this research is mobile-based learning using the Project-Based Learning (PjBL) approach for electric motor installation in vocational high schools. The respondents include five experts in education and technology who were responsible for integrating mobile-based learning using the PjBL approach into the curriculum and assessing its functionality and security. The sampling technique employed in this research is total sampling, considering the small population size, wherein the entire population serves as the sample. The sample for this research comprises 20 students from the Electrical Engineering Department of Padang 5 State Vocational High School.

C. Research Instrument

This research uses three main instruments, validity instruments, practicum instruments, and motivation instruments. The validity of the instrument as a learning tool ensures that the expansion of mobile-based learning using the PJBL approach meets validity standards. A comprehensive review of the questions raised by related research and existing literature, expertise in holding consultations in terms of educational technology to find out the critical factors in the installation of electric motors. These skills evaluate application content, structural design, and educational goals. The instrument validation assessment is as follows in Table 1 below.

Table 1. Validity sheet grid

Aspects	Indicators	No. Item
Learning Materials	Aligned with the learning materials	1,2
	Contains accurate material	3,4
	Contains up-to-date material	5,6
	Encourages student curiosity	7,8
PjBL	Relevance of the material to PjBL	9,10
Learning	Student engagement with PjBL	11,12
	Suitability of learning stages with PjBL	13,14
	Collaborative learning	15,16
Design	User interface	17,18
	Navigation function	19,20
	Responsive	21,22
	Display	23,24
Language	Straightforward language	25,26
	Interactive and dialogic language	27,28
	Language that conforms to language rules	29,30

The formula used to calculate item validity is as follows:

$$v = \frac{\sum s}{n(c-1)}$$

where:

v = index of respondents' agreement regarding item validity

s = score set by respondents minus the lowest score

n = number of respondents

c = number of choice categories filled by respondents

The test criteria are the Validity Value (V), then classified based on Cronbach's alpha criteria, if the V ≥ 0.6, then it is declared valid, if the V ≤ 0.6, then it is invalid.

The practicality of mobile-based learning using the PjBL approach is assessed through questionnaire data analysis using a Likert scale collected from students. The initial testing involves a small group of 8 students to gauge response, feedback, and performance of the developed media, with subsequent improvements made as necessary. Subsequent testing involves a larger group of 20 students, wherein the questionnaire is administered. Critical elements are converted into indicators and statements, as shown in Table 2. Prior to use, the validity of the questionnaire is confirmed using the product-moment correlation method, yielding a valid average score of 0.856 and a minimum score of 0.561. Additionally, the reliability of the questionnaire is verified through Cronbach's alpha test, resulting in an alpha value of 0.836, confirming its validity and reliability for assessing the practicality of mobile-based learning using the PjBL approach. Practicality instrument indicators can be seen in Table 2 below.

Table 2. Practicality sheet grid

Assessment	Indicator	No. Item
Ease of Use	Intuitive user interface	1, 2, 3
	Clear navigation	4, 5, 6
	User assistance	7, 8
Time efficiency	Quick access to learning materials	9, 10, 11
	Efficient submission and feedback	12, 13,14
	Seamless communication	15, 16
Media interpretation	Clear content presentation	17, 18, 19
	Multimedia integration	20, 21
	Interactive features	22, 23, 24

The practicality measurement results are obtained through a questionnaire comprising statements to determine the product's practicality. Alternative answers include strongly agree, agree, moderately disagree, and strongly disagree. The practicality value is calculated using the formula:

$$NA = \frac{S}{M} \times 100\%$$

where:

NA = Final score

S = Score obtained
M = Maximum score

Based on the results of the practicality values obtained [45], then categorized according to the level of practicality as in Table 3 below.

Table 3. Media practicality categories

No	Achievement rate (%)	Category
1	85–100	Very practical
2	75–84	Practical
3	60–74	Practical enough
4	55–59	Less practical
5	0–54	Not practical

The effectiveness of learning motivation was evaluated using a motivation instrument administered to students following the completion of learning activities on electric motor installation. This instrument was constructed using a Likert scale with five answer choices for each statement, ranging from "Strongly Agree" with a score of 5, "Agree" with a score of 4, "Somewhat Agree" with a score of 3, "Disagree" with a score of 2, to "Strongly Disagree" with a score of 1.

Before utilization, the validity of the questionnaire was verified using the product-moment correlation method, resulting in a valid average score of 0.786 and a minimum score of 0.520. Subsequently, its reliability was assessed through Cronbach's alpha test, yielding an alpha value of 0.865, thereby confirming its validity and reliability for evaluating the effectiveness of learning motivation following the implementation of mobile-based learning with the PjBL approach. The assessment indicators for evaluating the effectiveness of learning motivation are detailed in Table 4 below.

Table 4. Motivation sheet grid

Aspect	Indicator	No. Item
Intrinsic Motivation	Desire to succeed	1, 2, 3,
	The existence of encouragement and needs in learning	4,5, 6
	The existence of future hopes and aspirations	7, 8, 9
Extrinsic Motivation	The existence of rewards in learning	10, 11, 12
	The existence of a conducive learning	13, 14, 15
	An environment that allows learning well	16, 17, 18
	The existence of interesting activities in learning	19, 20, 21, 22

The practical measurement results were collected through a questionnaire consisting of statements aimed at gauging the extent of students' motivation subsequent to utilizing the product. Alternative responses include strongly agree, agree, somewhat disagree, and strongly disagree. Practicality is assessed using the formula:

$$M = \frac{K}{X} \times 100\%$$

where:

M = Motivation Score
K = Score obtained
X = Maximum score

Based on the results of the motivation values obtained, they are then categorized according to the level of practicality, as in Table 5 below.

Table 5. Motivation categories

No	Achievement rate (%)	Category
1	85–100	Very effective
2	75–84	Effective
3	60–74	Effective enough
4	55–59	Less effective
5	0–54	Not effective

IV. RESULT AND DISCUSSION

A. Result

In the design phase, the author developed learning content specifically tailored to integrate the Project-Based Learning (PjBL) approach with mobile technology. This application encompasses six main steps following the PjBL learning model, comprising problem orientation adapted to the learning topic, planning group activities, completing the project, creating a project report, presenting the report, and evaluating.

The welcome page features the main title of the learning material, "Electric Motor Installation", accompanied by a "start" button directing users to the main page for selecting desired learning material, and an "exit" button to close the application interface. The Welcome page interface is shown in Fig. 2 below.

Fig. 2. Welcome page.

The main page serves as the application lobby, featuring several menus, including "general instructions" providing usage guidelines, "basic competency" displaying primary study material, "learning material" offering a library of learning resources, "project dashboard" containing projects to be undertaken, and a "discussion room" serving as a platform for discussion. The main page interface is shown in Fig. 3 below.

The material page houses a library offering various learning materials such as text, animation, interactive simulations, video tutorials, and quizzes. This Resource Library is designed to accommodate diverse learning styles, enabling students to select materials that suit their preferences and learn through various approaches presented in different resource types. The Material interface is shown in Fig. 4 below.

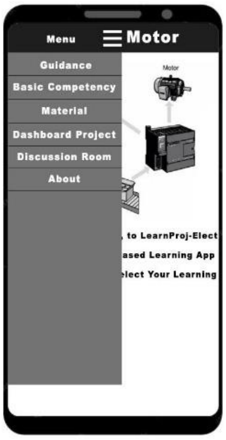

Fig. 3. Main page.

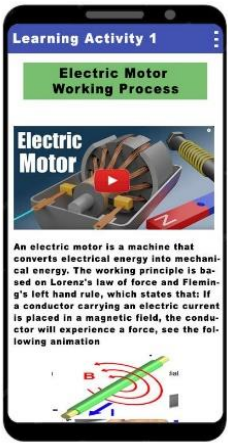

Fig. 4. Material page.

Project Dashboard is where students encounter a “Project Description” upon login, providing insights into the goals, scope, and expectations of the projects they are undertaking. Subsequently, the “Work Step” guides students through each project stage, serving as a roadmap outlining necessary steps. Upon project completion, students can easily upload their reports via the “Upload Report” feature. Additionally, the “Upload Presentation Project Video” feature allows students to share videos of their presentations, demonstrating the process and results of their projects to teachers and classmates. The Project Dashboard interface is shown in Fig. 5 below.

Fig. 5. Project dashboard.

Discussion room is specifically designed to facilitate communication and discussion among students regarding various project aspects. Here, students can initiate new discussion topics to seek perspectives, suggestions, or solutions from peers when encountering obstacles or problems during project work. Moreover, students can engage with existing topics, enriching discussions with diverse views and experiences. Additionally, recognizing that students may require guidance or clarification from teachers, the application includes a chat feature enabling direct communication between students and teachers. Through this feature, students can promptly receive answers or additional guidance, enhancing the flexibility and responsiveness of the learning process to individual student needs. The Discussion room interface is shown in Fig. 6 below.

Fig. 6. Discussion room.

The development stage involves testing the validity and practicality of the created product. The validity testing process initiates by presenting the learning material in Mobile-based learning using the PjBL to five technology and education experts experienced in the field of electric motor installation learning. These experts are then tasked with evaluating the content based on the provided questionnaire. Throughout the evaluation process, the experts offer valuable input regarding potential improvements and enhancements to the content. The assessments given by the experts were analyzed to obtain results as depicted in Fig. 7 below.

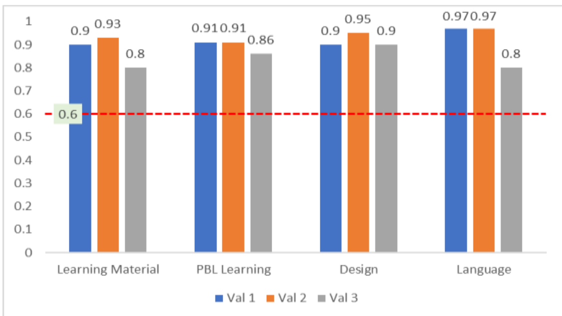

Fig. 7. Validity result.

The results of the validity test indicate that all aspects serving as indicators in assessing the validity of learning media, namely learning materials, PjBL learning, design, and language, are deemed valid by the five validators involved in the evaluation process. The validator group’s average score for the learning material aspect is 0.87. Additionally, the presentation aspect receives an average score of 0.89, while the design aspect receives an average score of 0.92. Furthermore, the language aspect also receives a high score, with an average score of 0.91. Consequently, the overall validity value reaches 0.89, significantly surpassing the minimum validity threshold of ≥ 0.6. Therefore, based on the results of this validity test, the Mobile-based learning using the PjBL mobile application is deemed valid. This suggests that the learning content within this application has been declared valid and pertinent by experts in the field. This high validity serves as strong evidence that Mobile-based learning using the PjBL has the potential to be an effective tool in supporting electric motor installation learning.

The practicality test entails the use of Mobile-based learning using the PjBL by 20 students and teachers of electric motor installation subjects from SMK Negeri 5 Padang. Respondents are requested to provide assessments and responses based on the provided questionnaire. A rating scale is employed to evaluate each aspect, offering rating options ranging from "Very Good," "Good," "Medium," "Poor," to "Very Bad." The collected data is subsequently analyzed, and the results obtained are summarized in Table 6 below.

Table 6. Practicality data from Students Response Questionnaire

Assessment	Indicator	Score (%)	Categories
Ease of Use	Intuitive user interface	87	Very Practical
	Clear navigation	91	Very Practical
	User assistance	87	Very Practical
Time efficiency	Quick access to learning materials	89	Very Practical
	Efficient submission and feedback	89	Very Practical
	Seamless communication	91	Very Practical
Media interpretation	Clear content presentation	87	Very Practical
	Multimedia integration	96	Very Practical
	Interactive Features	91	Very Practical

The results of the practicality test reveal that all aspects used as indicators in measuring the practicality of the learning media have been deemed valid. Assessments are conducted by several students and teachers, the primary users of the learning media. In terms of practicality, the "Ease-of-Use" aspect garners an average score of 0.88, indicating that users, including students and instructors, perceive the user interface of this application as easy to navigate. Moreover, the "Time Efficiency" aspect also receives a high score, averaging 0.89, suggesting that users find mobile-based learning and the PjBL approach conducive to time-saving in the learning process. The "Media Interpretation" aspect achieves a high scorer, averaging 0.91, implying that users can adequately comprehend the learning material presented through this application. With an overall practicality value of 0.89, the Mobile-based learning using the PjBL application is deemed practical. These results demonstrate that Mobile-based learning using the PjBL effectively supports the learning process and enhances students' abilities in electric motor installation. A summary of the motivation instrument results is presented in Table 7 below.

Table 7. Motivation data from students response questionnaire

Aspect	Indicator	Score (%)	Category
Intrinsic Motivation	Desire to succeed	83	Effective
	The existence of encouragement and needs in learning	80	Effective
	The existence of future hopes and aspirations	77	Effective
Extrinsic Motivation	The existence of rewards in learning	80	Effective
	The existence of a conducive learning	85	Very Effective
	An environment that allows learning well	84	Effective
	The existence of interesting activities in learning	88	Very Effective

Based on the recapitulation of the motivation questionnaire given to students in participating in learning activities, it can be concluded that the motivation aspect of students in learning through this platform is very positive. In particular, the indicator "Desire to succeed" received the highest score, namely 0.83, reflecting the strong motivation of students to achieve success in the learning process. Furthermore, the indicator "There is encouragement and need for learning", and the indicator "There are hopes and aspirations for the future" also received significant scores, reaching 0.8 and 0.77 respectively. The indicator "There are rewards in learning" and the indicator "a good learning environment conducive" is also an important factor influencing student motivation, with scores reaching 0.80 and 0.85 respectively. In addition, students assess their learning environment as enabling effective learning, as evidenced by the indicator "Environment that enables good learning" with a score of 0.84. As well as the indicator "The existence of interesting learning activities was rated highly by students with a score of 0.88. Overall, the results of the questionnaire showed that the use of mobile learning had a positive effect on students' learning motivation. High scores on various indicators indicate that students not only feel motivated to succeed but also feel supported and optimistic about the future, while assessing their learning environment as conducive and engaging. These findings provide a positive picture regarding the effectiveness of using mobile learning in increasing student learning motivation in a project-based learning environment.

B. Discussion

The findings of this research affirm that mobile-based learning with the PjBL approach successfully meets the required validity and practicality criteria. Mobile-based learning using PjBL enables students to integrate theoretical knowledge with meaningful practical experience. Additionally, it proves effective in enhancing student motivation. One of its key advantages lies in the provision of a Project Dashboard, allowing students to engage in projects that mirror real-world workplace challenges. This dynamic, project-oriented approach inherently captures students' interest, fostering a desire for successful project completion.

Furthermore, mobile-based learning using PjBL incorporates valuable features such as the Project Dashboard, facilitating efficient communication and collaboration between students and teachers through various tools like chat, discussion boards, and document sharing. This collaborative aspect is essential in maintaining a supportive learning environment conducive to effective learning. The interactive nature of mobile-based learning, coupled with a project-based approach, cultivates enthusiasm, camaraderie, and a positive learning atmosphere, thus enhancing motivation levels. Moreover, the Resource Library in this application offers diverse learning resources, including text, animation, simulations, video tutorials, and quizzes, providing varied and engaging learning activities. This integration of technology and PjBL not only supports theoretical understanding but also promotes interactive and enjoyable learning experiences, further boosting student motivation. The positive correlation between mobile-based learning using the PjBL approach and increased motivation is in line with existing research that emphasizes the motivational benefits of innovative pedagogical methods and technology integration [46]. Other research also found that PjBL penetrating chatbots can improve students' collaboration abilities in handling project work [47]. With its potential to facilitate communication, collaboration, and deeper understanding, this application can be a very relevant and effective solution for supporting vocational education and preparing students to face the challenges of the ever-evolving world of work.

This research surpasses previous studies in several aspects. Firstly, its success in integrating mobile technology with the PjBL approach delivers a comprehensive learning experience. Secondly, it provides evidence that mobile-based learning with the PjBL approach effectively enhances student motivation. Thirdly, rigorous testing ensures the validity and practicality of mobile-based learning with the PjBL approach, offering robust empirical evidence regarding the application's practicality. Ultimately, this research sheds light on how mobile technology can enrich practical learning in vocational education, significantly equipping students for the demands of the dynamic workforce.

These findings are in line with the theory of intrinsic and extrinsic motivation, which states that interactive and meaningful learning experiences obtained through mobile-based learning with the PjBL approach can increase students' intrinsic motivation. Through challenging projects, students feel personally involved and have a desire to learn further, consistent with aspects of intrinsic motivation theory. Apart from being involved in practical projects, students are faced with challenges that require critical thinking and active problem-solving, which are under the principles of active learning. Through discussion, collaboration, and exchange of ideas with fellow students, students feel supported and involved in learning together, which is in accordance with the concepts of social theory and collaborative learning. Thus, the findings of this study are in line with intrinsic and extrinsic motivation theories, cognitive theory, and social learning theory.

This research has limitations related to the limited sample size, where this research only involved a relatively small number of respondents. This can affect the generalization of research results to a broader population. In addition, the use of total sampling techniques in selecting primary respondents can cause bias in the data because random selection is not carried out. This can limit student representation in other vocational schools. Even though the motivation instrument has been tested for validity and reliability, limitations of the research instrument may still exist. Unmeasured factors, such as previous experience using mobile technology, may influence study results. Recognizing these limitations, this research opens the door to various promising research opportunities in the future with research involving a larger sample size, in addition to strengthening the findings of this research, a combined approach from quantitative and qualitative methods. While quantitative methods can provide empirical solid data, qualitative approaches can give deep insight into students' experiences and perceptions of the learning involved, as well as the context and factors that influence their motivation. Thus, using quantitative and qualitative methods together can provide a more holistic understanding. Therefore, this research paves the way for innovation and continuous improvement in vocational education in the digital era.

V. Conclusion

Overall, this research successfully implemented mobile-based learning, integrating the Project-Based Learning (PjBL) approach for teaching electric motor installation in vocational high schools. Test results indicate that this application meets the required validity and practicality standards while effectively enhancing student motivation. It offers active, collaborative, and real-world learning experiences, empowering students to acquire critical skills essential in today's dynamic work environment. In the context of vocational education, which emphasizes practical applications, mobile-based learning using PjBL has the potential to enhance student learning and equip them to tackle the increasingly complex demands of the workforce. Beyond boosting student motivation, this approach also fosters the development of practical skills relevant to the job market and enhances student engagement through effective collaboration and communication. These findings offer valuable insights for vocational education researchers and practitioners, guiding the development of relevant and effective learning methods in the digital age. Looking ahead, there are vast opportunities for further research, including deeper integration with artificial intelligence and the creation of similar platforms for diverse learning fields. This evolution promises to bridge the gap between education and the ever-evolving world of work, preparing students more effectively for success in their future careers.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Radinal Fadli: Methodology; Writing - original draft; Writing—review & editing. Herman Dwi Suryono: Supervision. Ratna Candra Sari: Supervision. Wagiran: Validation. Juli Sardi: Conceptualization; Resources; Funding acquisition. Fivia Eliza: Resources. Habibullah: Resources. Sani Suhardiman: Project administration. Ridho Dedy A.B: Software. Witri Ramadhani: Formal analysis; Data curation. Muhammad Hakiki: Visualization. Yayuk Hidayah: Validation. All authors had approved the final version.

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