PAPER

Developing a Mobile-Assisted Project-Based Learning Model for a Learning Media Course

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ABSTRACT

The ability to create and use effective learning media is critical to students' academic success. Therefore, a customized learning model for a learning media course needs to be developed to enhance learning effectiveness. The mobile-assisted project-based learning (PjBL) model was developed under the guidance of the Dick and Carey model to improve student learning outcomes in a learning media course. The validity test conducted for this model received a good score from expert validators, with an average score of 4.50 for usability and presentation, 4.56 for display, and 4.53 for language. The effectiveness test showed a high average n-gain of 0.83 in the one-to-one trial, 0.74 in the small group trial, and 0.73 in the large group trial. In addition, student feedback on the practicality of the mobile-assisted PjBL model was very good, with an average score of 4.31, or 86% of the ideal score. Based on these results, it is highly recommended to implement the mobile-supported PjBL model when teaching a learning media course.

KEYWORDS

learning media course, project-based learning, mobile learning technology, m-learning, mobile-assisted project-based learning

1 INTRODUCTION

The skills of designing and utilizing learning media are important for students in the elementary education department. These skills will enable them to create more effective and engaging learning experiences and increase their competence in using information and communication technology as a learning tool [1], [2]. However, preliminary research conducted at Universitas Islam Negeri (UIN) Walisongo Semarang and Universitas Negeri Jakarta (UNJ) indicates that students still need guidance in understanding the concept of learning media and need more skills to create and utilize instructional media. Therefore, implementing effective learning models that

motivate students and enhance learning outcomes in the learning media course is crucial to address these challenges [3].

The learning media course is important in elementary education because it imparts essential knowledge and skills to enable students to integrate digital technology seamlessly into their learning process [4]. Through the use of multimedia, videos, and interactive software, the quality of instructions is enhanced, surpassing traditional pedagogical methods [5], [6]. Moreover, this course encourages the development of student-centered instructional models that deliver engaging and effective learning experiences [7]. Therefore, it is imperative to prioritize the learning media course and develop appropriate instructional models to strengthen the quality of elementary education.

Recent studies have indicated that project-based learning (PjBL) is an effective approach for promoting student engagement and independence [8]–[11]. Moreover, the PjBL model has enhanced students' problem-solving, decision-making, teamwork, and time-management skills [12]–[14]. Thus, PjBL can be employed to foster students' higher-order thinking skills. To implement the PjBL model, educators need practical and user-friendly learning tools. In this regard, mobile technology has emerged as a potential tool that supports the implementation of PjBL and facilitates learning in the contemporary era [15], [16].

Integrating mobile technology into PjBL can enhance the learning process as it offers greater flexibility, sophistication, and interest [17]–[19]. This integration fosters an interactive learning environment [5], [6], enhances motivation and understanding [20], [21], and improves problem-solving skills [22], [23]. Therefore, this approach encourages students to apply preferred learning methods [24], engage in collaborative work with peers [25], and reflect on their learning experiences [24]. By leveraging the PjBL model enriched with mobile technology, the effectiveness of the learning process in the learning media course can be greatly enhanced.

2 THEORETICAL BACKGROUND

The integration of digital technology and project-based learning into media education courses for students aligns with several learning theories. One of the theories is constructivism, which emphasizes the importance of students actively constructing their knowledge and understanding [26]. By utilizing digital technology and project-based learning, students can engage with learning content, access information, and collaborate with peers to construct knowledge [21], [27].

Another theory, cognitive theory, emphasizes the importance of information processing and knowledge construction in learning [28]. Students can access information resources through digital technology to expand their understanding [29]. PjBL also allows students to apply knowledge in real-world contexts, foster problem-solving skills, and enhance cognitive abilities [8]. The humanistic theory highlights the uniqueness and potential of each student in the learning process [30]. Integrating digital technology with PjBL can provide personalized and relevant learning experiences that enable students to explore their interests and talents [31].

Lastly, connectivism emphasizes the crucial role of networks and connections in the learning process [32]. The advent of digital technology has facilitated students in establishing connections with peers, educators, and resources globally [33]. Furthermore, PjBL promotes collaboration and knowledge-sharing among students [34]. Therefore, applying these theories to integrating digital

technology and PjBL provides students with active, cognitive, personalized, and connected learning experiences that align with their unique characteristics.

3   RESEARCH METHODS

3.1   Research design

We conducted this study using the research and development design developed by Dick and Carey between July 2021 and November 2022 [35]. Our research procedures included examining the learning outcomes (LO), sub-LO, and its indicators and evaluating students' characteristics and initial abilities. We also analyzed the conditions of conventional learning models and the characteristics of learning models desired by students. We developed a draft of the mobile-assisted PjBL model, tested its validity, and made some improvements; conducted a one-to-one trial and revised; conducted a small group trial and made revisions; and conducted a field trial on large groups and made a final revision.

We conducted an online field trial in accordance with the policies of Universitas Islam Negeri (UIN) Walisongo Semarang and Universitas Negeri Jakarta (UNJ), Indonesia. To ensure fairness, we utilized computer-assisted objective tests and made it clear to students that their participation in the research was optional.

3.2   Participants

This study involved six media validators and 135 students as participants. The validators must hold a doctoral degree and possess expertise in learning media, or learning technology, education, and language. Additionally, they should have experience creating teaching materials and come from diverse institutions within the research institution. The students were pursuing the elementary education program at Universitas Islam Negeri Walisongo Semarang and Universitas Negeri Jakarta. Each one-to-one session in the trial involved three students, 12 for small groups and 120 for large groups. The students in this study were randomly selected from a pool of individuals who had not yet enrolled in a learning media course.

3.3   Data collection instrument

We used a variety of instruments to gather feedback and evaluate the effectiveness of our model. These included a needs analysis questionnaire, a validity questionnaire, an effectiveness test, a practicality test questionnaire, and interview guidelines. The needs analysis questionnaire comprises 16 statement items developed from Annisah et al.'s instruments [36]. The validity questionnaire contains 22 statements that cover language, presentation, appearance, and benefits [37]. The effectiveness test includes 60 multiple-choice questions based on the question grid and sub-learning outcomes of the learning media course. The practicality questionnaire has 15 questions that assess the ease, satisfaction, and usefulness of teaching materials [38] [39]. Before data collection, all questionnaires and test items were checked for validity and reliability. We also conducted interviews using a guideline to gather student feedback on the needs for model development, readability, ease of

use, and advantages and disadvantages. These interviews aimed to gain insight into students' perceptions and experiences related to the model, which will inform its development and potential future improvements.

3.4   Data analysis

In this study, we used different methods to analyze the research data. Firstly, we used descriptive statistics to analyze the quantitative data collected from the needs assessment questionnaires. Secondly, we analyzed the experts' responses on the validity and the students' responses on the practicality using mean and percentage. We interpreted the average and percentage using Table 1. Thirdly, we used descriptive statistics, t-test statistics, and n-gain to analyze the quantitative data from the pre-test and post-test results. The n-gain results were interpreted using Table 2. Lastly, we analyzed the qualitative data from the interviews with validators and students using thematic analysis. We used this data to address the model's weaknesses.

In this study, we used different methods to analyze the research data. Firstly, we analyzed the quantitative data collected from the needs assessment questionnaires, the responses of the experts on validity, and the students' responses on practicality using descriptive statistics. After that, we interpreted the average and percentage using Table 1. Secondly, we used descriptive statistics, t-test statistics, and n-gain to analyze the quantitative data from the pre-test and post-test results. The n-gain results were interpreted using Table 2. Lastly, we analyzed the qualitative data from the interviews with validators and students using thematic analysis. We used this data to address the model's weaknesses directly.

Table 1. The interpretation of the validity and practicality of the model

Average Score (X)	Criteria (%)	Eligibility Category
X ≤ 1.79	X ≤ 35%	Very Bad/Invalid
1.79 < X ≤ 2.60	36%–53%	Bad/Less Valid
2.60 < X ≤ 3.40	53%–68%	Adequate/Acceptable
3.40 < X ≤ 4.21	69%–84%	Good/Valid
X > 4.21	X > 84%	Very good/Very valid

Source: [40].

Table 2. The interpretation of the n-gain score and percentage

N-Gain Score	Category	N-Gain Percentage	Interpretation
$g > 0,7$ Tinggi	High	>76%	Effective
$g = 0,3 - 0,7$	Middle	56%–75%	Quite Effective
$0 < g < 0,3$	Low	40%–55%	Less Effective
$g = 0$	Fail	<40%	Ineffective

Source: [41], [42].

4 RESULTS

4.1 The objectives, users, and learning models of the learning media course

Upon review of the elementary education program curriculum at UIN Walisongo Semarang, it was discovered that the learning media course aims to enhance students' skills in selecting, utilizing, and creating various learning tools for elementary school students. In the UNJ elementary education program, the learning outcomes of the learning media course require students to explain the learning concept, the role of different media and learning resources, the characteristics of various types of media and learning resources, assess and select appropriate media and learning resources for specific learning needs, comprehend the concept of learning resource centers, and elucidate the principles of managing and developing learning resource centers. Based on this information, the researchers identified nine sub-learning outcomes for the learning media course, including the ability to explain the basic concepts of learning media, create and use simple three-dimensional media, simple two-dimensional media, infographic media, educational comics, learning videos, interactive learning media, web and internet technology, and e-learning web applications.

Students in elementary education who are enrolled in the learning media course are considered active Internet users and have reached the stage of formal operational thinking. However, the initial test showed that the students only scored 60, with 71% not meeting the minimum completeness criteria. Upon analyzing the students' objective test answers, it was discovered that topics that were not mastered included the selection and development of learning media, simple two-dimensional and 3-dimensional media, interactive learning media, the web and internet, and web e-learning. Furthermore, interviews with the students revealed that several factors hindered their learning, such as the complexity of learning media materials, substandard digital devices, poor internet connectivity, inadequate and impractical learning resources, short deadlines, less interactive learning methods, and a lack of learning motivation.

Based on the findings of conventional learning analysis, it was discovered that 60% of students have not used electronic books, 73% of students stated that digital resources did not help them, and 63% of students generally find traditional learning approaches unsatisfactory. Additionally, 51% of students found these models less effective in achieving learning objectives, and 56% believed they needed to be more practical in improving their ability to create and use instructional media. The questionnaire also revealed that 97% of students prefer a learning model that incorporates simulations or hands-on practice, such as learning media, video tutorials, training materials, and interactive quizzes. 99% of students agreed with developing learning models in a learning media course to improve learning outcomes. Examples of these models include project-based, problem-based, or inquiry-based learning.

4.2 Design of the mobile-assisted PjBL model for a learning media course

Following a comprehensive analysis of the material characteristics and learning outcomes indicators of the learning media course in the preceding stage, we have successfully developed a syntax for a mobile-assisted Project-Based Learning (PjBL) model. A clear and concise visual representation of the model can be observed in Figure 1.
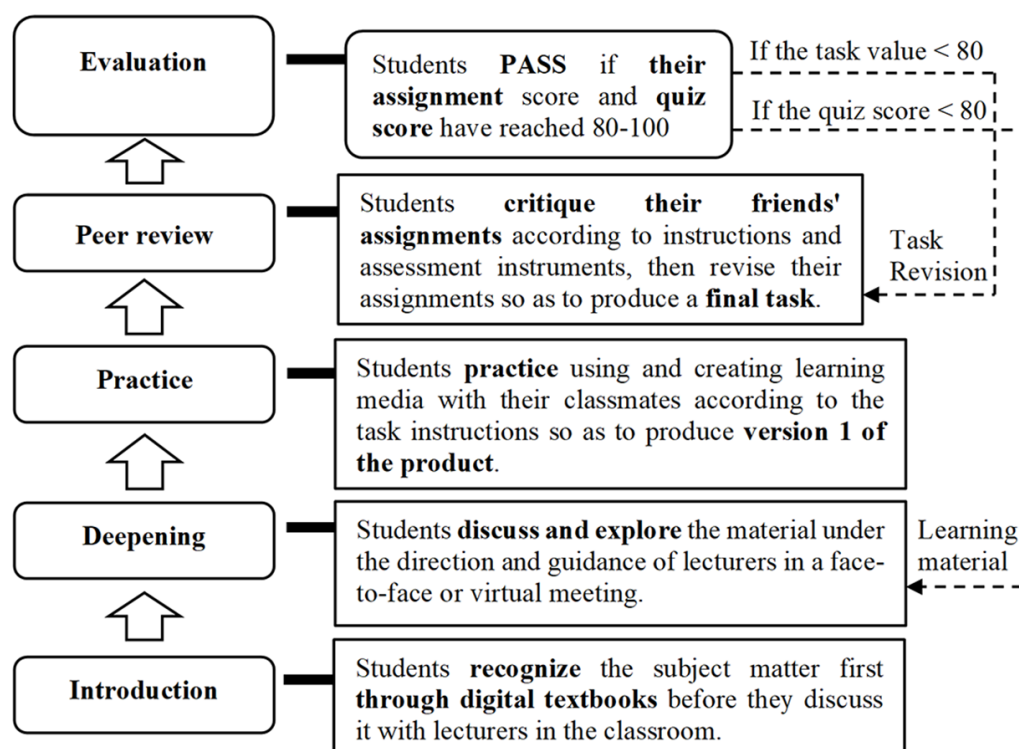
Fig. 1. Syntax of the mobile-assisted project-based learning model

This instructional model features an interactive quiz, which comprises 90 multiple-choice questions that are segregated into nine themes. The interactive quiz was created with Quizizz software and delivered via a digital module that can be accessed through a QR code or hyperlink. Moreover, the digital module developed for a learning media course contains learning outcomes, comprehensive descriptions of the materials complemented by illustrative images, sample files for learning media, and video tutorials that demonstrate the procedures for creating and utilizing learning media. Furthermore, the students are assigned several project tasks that require them to develop plans for using learning media, create three-dimensional learning media projects, design module books for elementary school students, produce infographic media, develop comic scenarios, create compelling videos, design interactive learning media, compose blogs, and construct virtual classrooms using web-based learning applications that comprise different types of activities and learning resources.

4.3 Validity of the mobile-assisted PjBL model

The effectiveness of the mobile-assisted PjBL model created in this research was established through expert validation. The validation process included selecting validators based on predefined criteria. After that, the validators' willingness was confirmed, and the issues underlying the model's development were explained. The model's validity was assessed by asking relevant questions and incorporating suggestions for improvement provided by the validators. In the second round, further questions were asked, and necessary actions were taken to enhance the model based on the feedback received from the validators [43].

To ensure a rigorous validation process, a panel of six expert validators was selected based on their respective areas of expertise. This distinguished group included a

professor of educational technology at Antasari State Islamic University of Banjarmasin, a professor of science education management at State Islamic University of Salatiga, a professor of information technology at Lambung Mangkurat University, a lecturer of the learning media course at Yogyakarta State University, a lecturer in teaching material development at Sunan Kalijaga State Islamic University of Yogyakarta, and a professor of linguistics at Sultan Ageng Tirtayasa University. The results of their assessments have been compiled and presented in Table 3.

Table 3. Validity of a mobile-assisted project-based learning model

Indicators	The Average Value of Each Validator						Overall Average	Eligibility Criteria
	P1	P2	P3	P4	P5	P6		
Language	4.33	4.50	4.17	4.50	4.83	4.83	4.53	91% (very good)
Presentation	4.00	4.67	4.33	4.67	5.00	4.33	4.50	90% (very good)
Appearance	4.00	4.88	4.38	4.50	5.00	4.63	4.56	91% (very good)
Benefit	4.20	4.80	4.00	4.80	4.60	4.60	4.50	90% (very good)
Overall average value	4.13	4.71	4.22	4.62	4.86	4.60	4.52	90% (very good)

As Table 3 indicates, the validity level shows that the mobile-assisted project-based learning model is highly valid for a learning media course. The model has great validity in language (91%), presentation (90%), appearance (91%), and usefulness (90%). The overall average score is 90%. These positive results indicate that the learning model is worth testing on potential users. However, the validators suggested some improvements, such as adding success criteria, clarifying task instructions, improving flowcharts, and enhancing digital book legibility. Overall, the model has a high level of validity and potential for success.

4.4 Effectiveness test results of the mobile-assisted PjBL model

Tests were conducted to determine the effectiveness of the mobile-assisted project-based learning model on the intended audience. The trial was divided into three stages: a one-to-one trial, a small-group trial, and a large-group trial. The n-gain average score in the one-to-one trial was 0.83, which falls under the "very good" category. Additionally, the overall average value of student feedback regarding the practicality of using the mobile technology-assisted PjBL model in a learning media course was 4.58, also falling under the "very good" category. During the one-to-one trial, the students suggested several improvements, including the clarification of student worksheets with instructions for completing assignments, reinforcing the introductory section of digital books with real problems, clarifying instructions for using models, adding video tutorials, and increasing the duration of interactive quiz work from 30 seconds to 45 seconds per question.

A small group trial was conducted with 12 students, including four with moderate abilities, four with above-moderate abilities, and four with below-moderate abilities. The results of the small group trial showed that the post-test average was 82.92, which is considered very good, and the average n-gain was 0.74, indicating a middle level of improvement. Student feedback on the use of the mobile-assisted PjBL model for a learning media course was positive, with an average rating of 4.57 for practicality, 4.60 for usefulness, 4.58 for ease of use, and 4.53 for satisfaction.

Suggestions for improvement included adding video tutorials, increasing time allocation for assignments, and enhancing the design guide pages. Additionally, students recommended that the book materials should include topics of two-dimensional simple media and simple three-dimensional media.

A large group trial was conducted with 120 students, and their average scores in the pre-test, post-test, and n-gain scores are displayed in Table 4.

Table 4. The average score of students on the pre-test and post-test

	Pre-Test	Post-Test	N-Gain
UIN Walisongo Semarang	34.7	81.4	0.72
Universitas Negeri Jakarta	35.3	83.6	0.75
Average	35.0	82.5	0.73

The results presented in Table 4 indicate that students from UIN Walisongo Semarang achieved an average n-gain of 0.72, which falls within the high category. Similarly, UNJ students had an average n-gain of 0.75; the total population's n-gain average was 0.73, also classified as high category. Furthermore, a normality test was conducted as a preliminary step for the t-test. The significance value (2-tailed) for the pre-test data of UIN Walisongo Semarang was 0.680, and for the post-test data, it was 0.406. For students of the State University of Jakarta, the significance value (2-tailed) was 0.118 for pre-test data and 0.220 for post-test data. These findings suggest that both UIN Walisongo Semarang and UNJ students' pre-test and post-test data were normally distributed. Finally, Table 5 presents the t-test results.

Table 5. T-test results on pre-test and post-test data

	Paired Differences					T	df	Sig. (2-Tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
UIN WS	46.67	4.59	0.59	45.48	47.85	78.71	59	0.000
UNJ	48.37	2.94	0.38	47.61	49.13	127.4	59	0.000

The t-test results, as Table 5 indicates, show that the sig. (2-tailed) value for students of UIN Walisongo Semarang and UNJ data is 0.000, which is less than 0.05. The calculation results indicate a significant difference in students' knowledge before and after using the mobile-assisted PjBL model for a learning media course at both universities. Tables 4 and 5 demonstrate that the mobile-assisted PjBL model effectively improves student learning outcomes. Finally, the findings suggest that this model is a valuable tool for enhancing student performance.

4.5 Practicality test results of the mobile-assisted PjBL model

The mobile-assisted PjBL model has received overwhelmingly positive feedback from students. The learning model has achieved a practicality average score of 4.31,

equivalent to 86% of the ideal score, falling under the very good category. It has been highly rated for its usefulness, with an average score of 4.26, or 85% of the ideal score, falling under the very good category. Students have found the learning model easy to apply, with an average score of 4.33, or 87% of the ideal value, which also falls into the very good category. Moreover, students have expressed high levels of satisfaction with the learning model, with an average score of 4.33, or 87% of the ideal value, also falling under the very good category.

According to interviews with students who utilized the online survey sheets, mobile technology proves to be a beneficial teaching tool due to its accessibility, portability, convenience, interactive features, and detailed learning media instructions. However, using mobile technology for teaching the learning media course comes with challenges, such as the absence of standardized digital devices and unstable internet networks that can hinder access to video tutorials, interactive quizzes, and web e-learning. Moreover, students encounter difficulties in reading on mobile device screens and require assistance in comprehending the functions of Android-based teaching materials.

5   DISCUSSION

This study has successfully developed a mobile-assisted PjBL model that is well-suited for a learning media course. The effectiveness of this model in enhancing students' learning outcomes has been confirmed, and its practicality has been demonstrated by its ease of use, usefulness, and high degree of student satisfaction. The results of this study indicate that the adoption of an affordable and practical learning model can stimulate interest in learning, facilitate independent learning, and increase students' confidence in their ability to learn. Moreover, integrating mobile technology into PjBL can contribute to implementing paperless programs [44], and enhance student engagement in online learning environments through interactive quizzes, video tutorials, and collaborative project assignments [45].

The findings suggest that mobile technology can be a viable teaching tool when considering language, presentation, appearance, and usefulness [37]. These findings align with Rusdi's notion that expert validation is crucial to evaluating a model or product during development [43]. Additionally, the study supports previous studies indicating that a model's design quality and appropriateness to user needs determine its acceptance among users [46], [47].

The results of this study support the idea that video tutorials are a valuable resource for improving student learning outcomes [48], [49]. Furthermore, providing step-by-step instructions through video recordings can effectively improve students' comprehension of procedural concepts [50]. Task collection tools and online discussion forums on e-learning platforms are also beneficial in increasing students' participation and engagement in the learning process [18], [51]. Additionally, integrating interactive quizzes into mobile technology can boost student motivation and improve learning outcomes [40], [52], [53].

The use of the mobile-assisted PjBL model in the learning media course has been proven both theoretically and empirically to be highly practical. Validators have confirmed its validity, making it ideal for facilitating lectures and enhancing students' learning outcomes. Additionally, students have responded positively to its usefulness, convenience, and overall satisfaction with the model. These results align with the notion that teaching materials are considered practical if they are user-friendly and beneficial to users [54].

Research and development on mobile technology-assisted PjBL models have successfully addressed challenges faced by previous researchers regarding the affordability and practicality of digital books [55], [56]. Unlike earlier studies, students in this study had no issues utilizing digital textbooks [55]. This research also provides solutions for implementing the mobile-assisted PjBL model in educational institutions with limited access to digital technology and the internet, such as allowing students to print PDF versions of digital books and downloading video tutorials before sessions start. It is also recommended that lecturers discuss non-digital learning media, including realia media, media models, two-dimensional images, blackboards, bulletin boards, subject books, module books, student workbooks, and other printed materials.

Before conducting any future research, it is very important to acknowledge the study's limitations. The limitations of this study are due to several factors, including the number of participants, the duration of the study, and the variables examined. In this product field trial, only 135 students from two universities were included in the sample size, which limits the applicability of the findings to tertiary education exclusively. Additionally, the trial was conducted solely in an online learning environment that relied on standardized digital devices and stable internet connectivity, which may affect the practicality and efficiency of the mobile-assisted PjBL model. Moreover, the accessibility of these resources may impact the model's effectiveness. Lastly, the research did not incorporate data on extracurricular activities that could influence students' performance. Hence, future research should adopt a more comprehensive approach by including data from other relevant variables to better understand appropriate learning models.

6 CONCLUSION

The results of this study indicate that the implementation of the mobile project-based learning (PjBL) model has a significant positive impact on students' academic performance. This result can be attributed to the well-designed structure and compatibility of the learning model with a learning media course. The validity test results showed that the mobile-based PjBL model has good display, language, presentation, and usability. The effectiveness test results also significantly improved student learning outcomes, with high average n-gain values across different experimental settings. These results indicate that the model is highly valid and can effectively meet the diverse learning needs of college students.

The positive feedback from students regarding the practicality of the mobile-assisted PjBL model supports its implementation as a valuable and convenient teaching tool. However, the use of the mobile-assisted PjBL model must also take into account Internet connectivity, digital device specifications, and reading time limitations on digital screens.

Based on these research findings, the use of the mobile-assisted PjBL model is strongly recommended for courses related to learning media. In addition, this model has proven effective and practical in improving learning outcomes and increasing student engagement with course material.

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