
Development and Validation of a Problem-Based Learning (PBL) Mobile Application for Teaching Physics to Biology Students

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ABSTRACT

This research was motivated by the low problem-solving abilities of students in the Physics for Biology course (preliminary analysis showed a score of only 43%) and the limited availability of learning resources that contextually connect physics concepts with biological phenomena. This study aimed to develop a valid and practical Physics for Biology mobile application based on Problem-Based Learning (PBL) as an innovative learning medium. This study employed a design and development study adapted from the Plomp model. The study was limited to the Preliminary Research and Development or Prototyping phases. The developed application was evaluated through expert review, one-to-one evaluation, and small-group evaluation to determine its validity and practicality. Research data were collected through initial ability tests, needs questionnaires, expert review sheets to assess the validity of content, constructs, language, and media presentation, and lecturer and student feedback questionnaires to assess practicality. The expert review results indicated that the developed mobile application was classified as highly valid, with an average Aiken's V score of 0.88. Practicality testing through one-on-one and small group evaluations indicated it was categorized as highly practical, with scores of 84% and 85%, respectively. In conclusion, the developed PBL-based Physics for Biology mobile application has met the criteria for validity and practicality, making it suitable for use as a supporting learning medium in lectures. However, the application's effectiveness in improving students' problem-solving skills still requires further testing through field trials.

Keywords: *design research, mobile app, physics for biology, problem based learning, problem-solving skills*

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INTRODUCTION

Problem-solving skills are widely recognized as essential competencies for university students because they enable learners to analyze situations, make informed decisions, and address complex challenges in academic and professional context ([Osman & Kriek, 2021](#); [Wiyono et al., 2025](#)). In science education, problem-solving involves not only the application of formulas but also conceptual understanding, reasoning, and the ability to connect scientific knowledge with real-world phenomena. Therefore, learning environments should provide opportunities for students to actively engage in meaningful problem-solving activities.

Actual problems have been identified in the Physics for Biology course, where students' problem-solving ability remains low ([Kurniawan et al., 2018](#); [Riantoni et al., 2017](#)). The needs analysis conducted in this study revealed several challenges experienced by students, including difficulties in understanding physics concepts within biological contexts, limited ability to solve contextual problems, difficulties in relating theoretical concepts to field applications, and decreased learning motivation when studying abstract materials. These findings are consistent with previous international studies reporting that students often experience difficulties when transferring knowledge across disciplinary boundaries and applying physics concepts to explain biological phenomena ([Heim et al., 2025](#); [Rodríguez-Muñoz & Huincahue, 2025](#)). Interdisciplinary science learning requires students not only to understand concepts from individual disciplines but also to establish meaningful connections between them, which many students find challenging. Furthermore, studies on physics education for biology students have highlighted that learners frequently struggle to recognize the relevance of physics concepts in biological contexts, resulting in fragmented understanding and difficulties in problem-solving ([Redish et al., 2014](#)). These challenges are further exacerbated by the limited availability of learning resources that comprehensively integrate physics concepts with biological applications, making it difficult for students to access valid and contextual references. Therefore, innovative learning media are needed to facilitate conceptual integration while simultaneously supporting the development of problem-solving skills.

One learning approach that has consistently demonstrated effectiveness in improving problem-solving skills is Problem-Based Learning (PBL). PBL places authentic and complex problems at the center of the learning process, encouraging students to investigate issues, gather information, collaborate with peers, and develop solutions independently ([Nicholus et al., 2023](#)). International studies have consistently shown that PBL promotes deeper learning, critical thinking, and problem-solving competencies because students actively construct knowledge through engagement with authentic problems ([Dolmans et al., 2016](#); [Wijnia et al., 2024](#)). Previous studies have also reported significant improvements in students' problem-solving and critical-thinking skills following PBL implementation in both secondary and higher education settings. For interdisciplinary courses such as Physics for Biology, PBL is particularly relevant because students are expected to apply physics concepts to explain biological phenomena encountered in real-life situations.

The effectiveness of PBL can be enhanced when supported by learning technologies that align with students' learning habits. The increasing use of smartphones among university students provides opportunities to create flexible and accessible learning environments. Mobile learning applications enable students to access learning materials anytime and anywhere, promote independent learning, and increase engagement in learning activities. International reviews have highlighted the potential of mobile learning to improve student engagement, learning flexibility, and academic achievement in higher education contexts ([Crompton & Burke, 2018](#); [Naveed et al., 2023](#)). Previous studies have developed mobile applications for physics learning, including applications on Newton's law of gravitation, sound and light waves, and STEM-based general physics courses. However, most existing applications primarily focus on content delivery, simulations, or interactive exercises. Only limited attention has been given to integrating complete pedagogical frameworks such as PBL into mobile learning environments, particularly for systematically developing students' problem-solving skills.

Previous studies have demonstrated the effectiveness of PBL and mobile learning separately, research integrating both approaches within a single Android-based learning environment remains limited. Furthermore, studies focusing specifically on Physics for Biology courses are rarely reported. Existing research generally examines mobile learning applications or PBL implementation independently, with few attempts to combine them into an integrated learning medium designed to support problem-solving skill development. This gap is important because Physics for Biology requires contextual and interdisciplinary learning experiences that connect physics concepts with biological phenomena.

Therefore, this study develops an Android-based mobile application for the Physics for Biology course that integrates all phases of the Problem-Based Learning model. Unlike previous mobile learning applications that primarily emphasize content presentation or practice exercises, the developed application guides students through structured problem-solving processes using contextual biological phenomena as learning situations. This integration represents the novelty of the study and is expected to support students' problem-solving skill development more effectively. Based on the aforementioned background, this study aims to: (1) produce a valid and practical PBL-based Physics for Biology mobile application as an innovative learning medium; (2) determine the level of product validity through expert review by materials and learning media experts; and (3) determine the level of product practicality through one-to-one and small-group evaluations.

METHOD

Design Research

This study used a design and development approach to produce a PBL-based mobile application for Physics for Biology. The study was limited to evaluating the application quality in terms of validity and practicality. The development process followed the Plomp model, consisting of two phases: Preliminary Research and the Development or Prototyping Phase.

Participants and Context

The study was conducted in a Physics for Biology course, involving lecturers and students as participants. During the preliminary research phase, lecturers and students participated in a needs analysis to identify learning difficulties experienced throughout the instructional process. Expert validation was carried out by three validators specializing in Physics for Biology, instructional design, and educational media. For practicality evaluation, one lecturer and students from different academic ability levels were involved. The one-to-one evaluation included three students from low, medium, and high academic ability groups to assess readability and ease of use. A small-group evaluation followed, involving nine students, three from each ability group, to measure the practicality of the mobile application.

Product Development

The product developed in this study was a mobile application designed to facilitate Physics for Biology learning through the integration of the Problem-Based Learning model, packaged in Android Package Kit (APK) format and equipped with features including learning materials, instructional videos, reflection activities, assessment tools, and access to the Learning Management System (LMS). The development process consisted of two phases. The first phase, preliminary research, was conducted to identify needs and problems in the Physics for Biology course through questionnaires distributed to lecturers and students, alongside a problem-solving ability test administered to students to establish their initial competence level, with the findings serving as the foundation for product design. A literature review on mobile application development, the PBL model, and problem-solving ability indicators was also conducted as a theoretical basis. The second phase, the Development or Prototyping Phase, involved designing and refining the prototype through formative evaluation and iterative revisions, beginning with a self-evaluation by the researchers, followed by expert review from three validators with expertise in physics, biology, instructional design, and educational media, covering content, construct, language, and media display aspects. Once declared valid, practicality testing was carried out

through one-to-one evaluation involving one lecturer and three students from varying ability levels, and a small-group evaluation with nine students to assess the application's practicality in a small-scale learning setting. Product feasibility was determined based on validity data obtained from expert validation sheets and practicality data gathered from lecturer and student response questionnaires, all of which were analyzed descriptively.

Instruments and Data

This study made use of several instruments, namely needs analysis questionnaires, problem-solving ability tests, validation sheets, and practicality sheets, each serving a distinct purpose throughout the research process. The needs analysis questionnaires were used to identify learning problems and challenges faced by lecturers and students, while the problem-solving ability tests were administered to determine students' initial competency levels prior to product development. Validation sheets were completed by expert validators to evaluate the developed product across four dimensions, content, construct, language, and media display, whereas lecturer and student response questionnaires were employed to measure the application's practicality during both the one-to-one and small-group evaluation stages. Data collection was carried out at every phase of the study, where preliminary data were gathered through questionnaires and problem-solving tests, validity data were obtained from expert assessments using validation sheets, and practicality data were sourced from response questionnaires completed at both evaluation stages. All collected data were then analyzed descriptively to determine the validity and practicality levels of the developed product, with validity specifically measured using Aiken's V coefficient calculated from expert ratings on each item. The validation sheet was structured using a Likert scale consisting of five response options, namely score 1 for strongly disagree, score 2 for disagree, score 3 for neutral, score 4 for agree, and score 5 for strongly agree. Item validity was calculated using the Aiken's V formula as follows:

$$V = \frac{\sum s}{(n-1)}; s = r - l_0$$

Categories were then assigned according to the index values obtained, as shown in [Table 1](#).

Table 1. Aiken's V Index	
Interval	Category
$V < 0,80$	Not Valid
$V \geq 0,80$	Valid

Source: [Aiken, 1985](#)

Practicality was measured through percentage scores from student response questionnaires, using the formula below:

$$\text{Score} = \frac{\text{score obtained}}{\text{maximum score}} \times 100$$

Results were then categorized based on the criteria in [Table 2](#).

Table 2. Practicality category		
No.	Percentage (%)	Criteria
1	0-20	Not Practical
2	21-40	Less Practical
3	41-60	Moderately Practical
4	61-80	Practical
5	81-100	Highly Practical

Source: [Riduwan, 2013](#)

RESULT AND DISCUSSION

The results of this study describe the process and outcomes of each phase. The description of results focuses on the development process and the quality of the product produced.

Preliminary Research Results

The Preliminary Research phase in the Plomp development model aims to identify learning problems that will serve as the basis for product development. At this stage, an analysis of students' problem-solving ability, student characteristics, and learning documents was conducted. The results of the analysis of students' problem-solving ability are shown in [Figure 1](#).

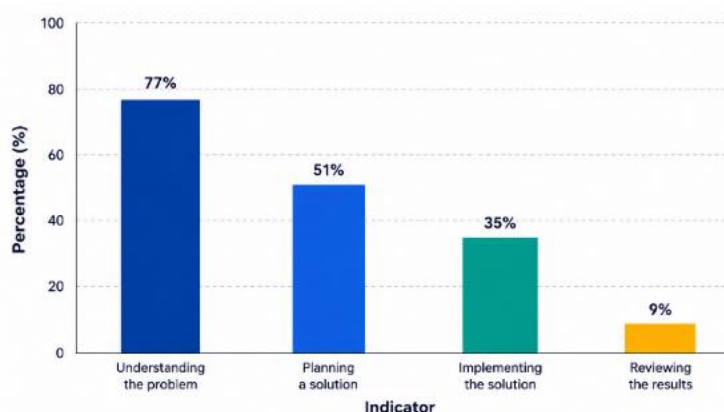


Figure 1. Students' problem-solving ability results

The preliminary research findings revealed that the re-examining results indicator yielded the lowest score among all problem-solving phases, at only 9.3%. This outcome is not incidental; it reflects a structural limitation of conventional physics learning resources that rarely embed explicit prompts for students to verify, reflect upon, or critically evaluate the solutions they have produced. Polya (2014) identifies the review phase as cognitively distinct from execution, requiring students to step back from procedural completion and interrogate the reasonableness of their answers; a habit that must be deliberately cultivated rather than assumed to develop naturally. Similarly, the OECD (2023) framework positions reflective evaluation as an independent and assessable competency within scientific problem-solving, underscoring that its absence represents a measurable gap rather than a minor oversight. These theoretical foundations directly informed the design decision to include a dedicated Reflection menu within the application, as well as assessment features that require students to evaluate their solutions before proceeding. By embedding reflective practice as a structural component of the learning sequence rather than an optional activity, the application addresses a specific metacognitive deficit that prior learning media in this course have left unresolved. Next, an analysis of the students' characteristics was carried out. The results of this analysis are presented in [Table 3](#).

Table 3. Results of student characteristics and needs analysis

Indicator	Percentage (%)	Category
Learning Difficulties	74.19	High
Use of Learning Media	82.44	Very High
Digital Habits	80.44	High
Problem-Solving Habits	70.09	High

Based on [Table 3](#), the analysis of student characteristics and needs reveals opportunities for the use of technology-based learning media. The data indicate that students' learning difficulty level is in the high category, meaning that the majority of students still experience obstacles in understanding the material. The need for learning media is very high, followed by students' digital habits, suggesting that students are accustomed to using technology in the learning process and are in great need of interactive learning media. Meanwhile, problem-solving habits are also in the high category, indicating that students have the potential for problem-solving, but this potential has not been optimally developed.

Referring to the problems described, the development of a mobile application for the Physics for Biology course based on the Problem Based Learning model is relevant as a solution to

students' problem-solving issues. The use of technology in learning as digital teaching materials constitutes a relevant learning innovation at present (Riyasni et al., 2023). The use of mobile-based applications has great potential to be integrated with innovative learning models (Sung et al., 2016). Furthermore, the use of innovative learning models such as PBL is expected not only to assist the learning process of subject matter, but also to facilitate the development of communication skills, problem-solving, creativity, and other higher-order skills among students (Warschauer et al., 2014). Following the preliminary analysis, a literature review was conducted to examine the theoretical foundations underlying product development. The results of the literature review on mobile app characteristics are shown in Table 4.

Table 4. Literature review results of mobile app characteristics

Characteristic	Description	Source
Portability / Anytime, Anywhere Access	Mobile applications allow students to access material anywhere and at any time, not limited to the classroom. Supports independent learning (Melnix & Razi, 2024; Yang & Xiang, 2024)	(Melnix & Razi, 2024; Yang & Xiang, 2024)
Interactivity / Interactive Features	Interactive features such as games, quizzes, evaluations, multimedia (video, animation), direct feedback, and interactive graphics/animations. Supports student engagement.	(Imaduddin & Damayanti, 2024)
User Friendly / Usability	User-friendly, intuitive interface design with clear navigation, low cognitive load, and visual comfort. Minimizes technical barriers.	(Melnix & Razi, 2024)
Contextual and Relevant / Local Context & Real World	Material adapted to students' local context, relevant to real experiences, using environmental, cultural, and daily situational contexts to make learning more meaningful.	(Imaduddin & Damayanti, 2024)
Feedback / Evaluation and Assessment	The application includes evaluations (quizzes, tests), immediate feedback, progress reports, and certificates. Supports reflection and improvement.	(Imaduddin & Damayanti, 2024; Mayefis et al., 2019)
Motivation and Engagement	Features that stimulate student motivation: gamification, engaging elements, visual and audio, engaging narratives, social interaction, and competitive/collaborative elements.	(Maulana & Fahrezi, 2023)
Connectivity / Social Interaction	Ability to connect to the internet/network, inter-student discussions, sharing, collaboration, teacher-student communication, and notifications.	(Maulana & Fahrezi, 2023; Yang & Xiang, 2024)
Multimedia / Rich Media	Use of videos, animations, images, audio, graphics, and other interactive media to enrich the learning experience and accommodate different learning styles.	(Arliza et al., 2019; Imaduddin & Damayanti, 2024)
Customization / Individual Adaptation	The application allows adjustment of difficulty levels, learning pace, and different learning pathways according to student ability; adapts to individual student needs.	(Islamy Risyah et al., 2023)

Subsequently, a literature review was conducted on the characteristics of the Problem Based Learning model. The results are shown in Table 5.

Table 5. Literature review results of problem based learning characteristics

Characteristic	Description	Source
Student-Centered / Learner Autonomy	Students take an active role in learning: planning, exploring problems, making decisions, and managing their own learning process. The teacher/facilitator serves as a guide.	(Lestari et al., 2023; Li & Du, 2015)

Characteristic	Description	Source
Problem-Driven / Problem-Centred	Learning begins with real or relevant problems; the problem becomes the center for driving exploration, investigation, and solution.	(Markula & Aksela, 2022; Rahman et al., 2024)
Higher-Order Thinking Skills (HOTS), Critical Thinking, Problem Solving	Focus on developing critical thinking, problem-solving, analysis, synthesis, and evaluation, not just memorization.	(Jailani et al., 2017; Nurhilyah et al., 2024)
Collaboration / Group Cooperation	Students work in groups; discuss; share ideas; help each other; build solutions together.	(Markula & Aksela, 2022; Nurtanto et al., 2018)
Real-World Relevance / Contextualization	Problems or learning materials drawn from students' real world; relevant to their lives; can increase motivation and application.	(Rahman et al., 2024; Youngerman & Culver, 2019)
Iterative Process / Reflection & Revision	The PBL process allows revision of hypotheses/solutions based on findings; reflection on process and results; evaluation and improvement.	(Markula & Aksela, 2022; Widiyaningsih & Suyitno, 2024)
Assessment Shift / Emphasis on Process & Product	Assessment not only based on the final answer, but on the process: how students solve problems, collaboration, reflection, self/peer assessment, and the final product.	(Markula & Aksela, 2022; Nurtanto et al., 2018)
Motivation / Engagement / Creativity	PBL increases student motivation, active engagement, and creativity through engaging problem-solving, significant challenges, and opportunities for innovation.	(Benu & Natonis, 2025; Wijnia et al., 2024)

Development or Prototyping Phase Results

The findings from the Preliminary Research phase served as the foundation for designing the Prototype. These findings were used as a reference for determining the display design, material structure, and learning features developed in the application. The resulting prototype consists of several main sections designed to support the learning process systematically and interactively. The mobile app was developed using the Unity application and saved in APK format, which is easy to install on students' Android devices. The following are screenshots of the developed Physics for Biology mobile app prototype based on the Problem Based Learning model. The initial display and main menu of the mobile app can be seen in [Figure 2](#).

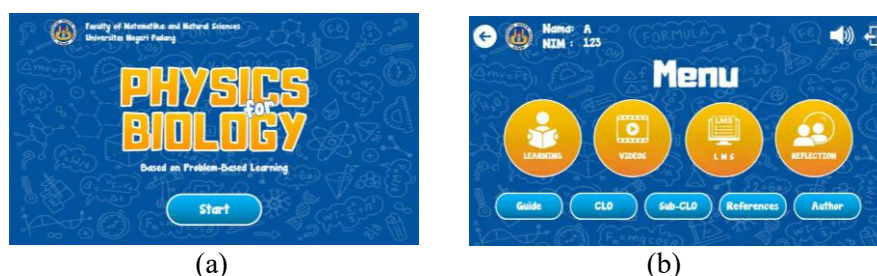


Figure 2. Initial display (a) and main menu of the physics for biology mobile app (b)

The cover page is designed as the initial identity of the application with a simple and attractive visual display, giving a good first impression to users. The main menu page serves as a navigation center that facilitates students in accessing all features within the application. The menus available include: Learning (for accessing learning content), Videos (containing all videos in the application), LMS (allowing students to access the e-learning assignment submission system), and Reflection (containing reflection content). The Learning menu displays all main topics available in the application. After students select a topic, the steps corresponding to the PBL

model will appear. This menu is also equipped with learning materials and assessments. The Learning display of the mobile app can be seen in [Figure 3](#).



Figure 3. Learning display of the physics for biology mobile app

In addition to considering the visual design and ease of navigation, the development of the prototype was also based on the Problem-Based Learning (PBL) model and problem-solving ability indicators. Each feature within the application is designed to facilitate the stages of PBL whilst supporting the development of students' problem-solving skills. The relationship between the application's features, the PBL phases, and the problem-solving ability indicators is shown in [Table 6](#).

Table 6. The Relevance of Application features, PBL model, and Problem-Solving Indicators

Application Feature	PBL Phase	Problem Solving Indicator
Learning : Orientation to Problems	Orientation to Problems	Understand the problem
Learning : Organization for Learning	Organization for Learning	Plan a solution
Videos	Organization for Learning	Understand the problem
Materials	Guidance to Investigate Problems	Implement the solution
Learning: Guidance to Investigate Problems	Guidance to Investigate Problems	Implement the solution
LMS	Guidance to Investigate Problems	Implement the solution
Learning: Developing and Presenting	Developing and Presenting	Implement the solution
Analysis and Evaluation	Analysis and Evaluation	Chek the result
Assessment	Learning evaluation	Measure all indicators of problem solving
Reflection	Analysis and Evaluation	Chek the result

The designed prototype underwent self-evaluation by the research team to re-examine the suitability of the product with validity indicators. The results of the assessment provided by the three reviewers are shown in [Table 7](#).

Table 7. Self evaluation's result

Indicator	Aiken V	Cateogory
Curse Content	0,88	Valid
Intruuctional Design	0,87	Valid
Visual Communication	0,89	Valid
Supporting Software	0,91	Valid
PBLModel	0,96	Valid
Problem Solving Skill	0,85	Valid

In addition to reviewing the completeness of the prototype, the reviewers also provided several suggestions, including typographical errors the completeness of the mobile app structure, and the PBL model components. These suggestions served as guidelines in revising the developed mobile app. Subsequently, the revised prototype underwent expert review by three experts who reviewed

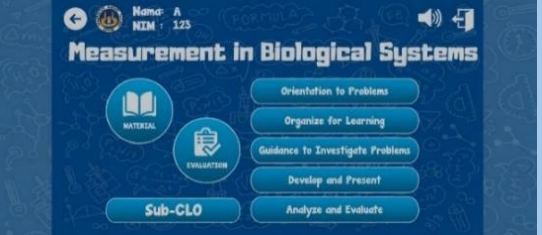
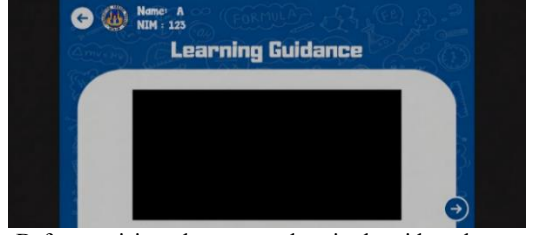
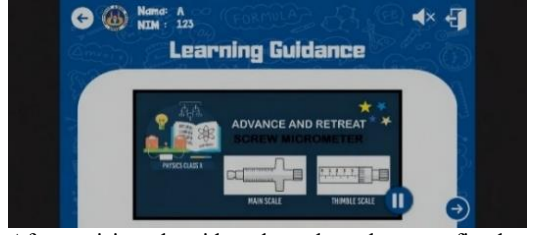
material, instructional design, and visual communication indicators. Expert comments served as the basis for prototype revision. The expert review results are shown in [Table 8](#).

Table 8. Expert review's results graph

Indicator	Aiken V	Category
Course Content	0,88	Valid
Instructional Design	0,87	Valid
Visual Communication	0,89	Valid
Supporting Software	0,91	Valid
PBLModel	0,96	Valid
Problem Solving Skill	0,85	Valid

The overall Aiken's V score of 0.88 confirms that the developed application meets the highly valid threshold across all assessed aspects; however, a closer examination of validity at the aspect level reveals important insights into the design quality of specific components. The instructional design and supporting software aspects consistently yielded the highest validity scores, which can be interpreted as evidence that the application's pedagogical architecture successfully operationalizes all five PBL phases. This level of PBL integration has not been reported in previously developed physics mobile applications, which addressed individual topics without incorporating complete PBL phase sequencing or explicit problem-solving scaffolding ([Fathurohman et al., 2023](#); [Listiaji, 2019](#); [Milinia et al., 2022](#)). The high validity scores on the PBL model and problem-solving ability aspects further confirm that the theoretical frameworks underlying the product design were accurately translated into observable application features, satisfying the internal consistency requirement central to the Plomp development model. Experts also provided suggestions for improvements to the product. A summary of the improvements is shown in [Table 9](#).

Table 9. Table of application improvements based on validators' comments

Before Revision	After Revision
 Before revision, the evaluation menu had not been added as an exercise and integration for problem-solving indicators.	 After revision, an evaluation menu was added as an integrated practice for problem-solving indicators in accordance with the problem-based learning model.
 Before revision, there was a bug in the video player, causing it to display only a black screen.	 After revision, the video player layer bug was fixed to display the video along with play-pause buttons to improve accessibility.

Thus, the mobile app is suitable for implementation in the Physics for Biology course and can proceed to the one-to-one and small group evaluation stages. The one-to-one test was conducted with three students with high, medium, and low ability levels. Overall, the Physics for Biology mobile app was found to be easy to use. Nevertheless, several aspects still need improvement, such as: material that cannot be scrolled, videos that cannot be played, and overlapping music and video content. Students also suggested that videos should be embedded within the application rather than linked from YouTube; however, this would significantly increase the application's file size. The one-to-one test results are shown in [Table 10](#).

Table 10. One-to-one evaluation results

Indicator	Percentage	Category
User-Friendliness	88%	Practical
Visual Appeal	84%	Practical
Clarity	83%	Practical
Usefulness	83%	Practical

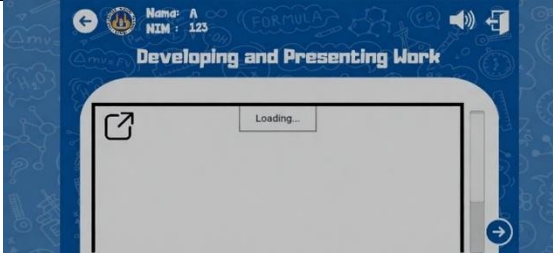
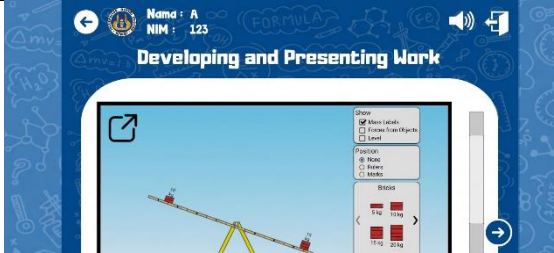
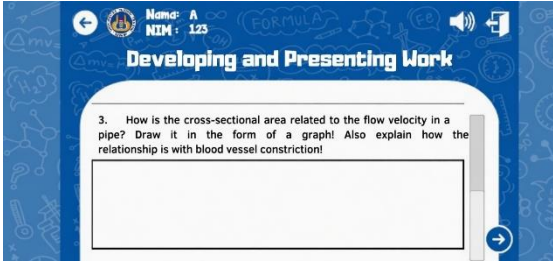
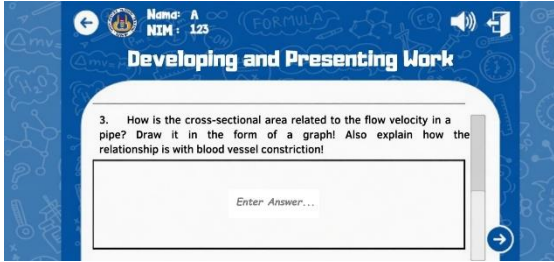
Based on [Table 10](#), it is evident that the Physics for Biology mobile app is easy to use, has high appeal, is clear, and is beneficial. The overall practicality score from the one-to-one evaluation reached 84%, which falls in the practical category. Student assessment indicates the product can proceed to the small group evaluation. The small group evaluation was conducted with nine students, three each with high, medium, and low ability levels. The small group evaluation results are shown in [Table 11](#).

Table 11. Small group evaluation results

Indicator	Percentage	Category
User-Friendliness	83%	Practical
Visual Appeal	90%	Very Practical
Clarity	80%	Practical
Usefulness	87%	Very Practical

The overall practicality score from the small group evaluation reached 85%, which falls in the highly practical category. The progression of practicality scores from 84% in the one-to-one evaluation to 85% in the small group evaluation reflects more than a marginal numerical improvement; it demonstrates the application's scalability under conditions of greater user diversity. As the evaluation expanded from three to nine students representing low, medium, and high ability levels, the sustained high practicality score indicates that the application functions inclusively across the full spectrum of student academic profiles, rather than exclusively benefiting high-achieving users. This finding is theoretically significant because it suggests the application's interface design, navigation clarity, and content presentation are sufficiently intuitive to accommodate learners with varying degrees of prior knowledge and digital literacy. This outcome is consistent with the principle of customization and individual adaptation in mobile learning, which holds that effective educational applications should adjust to diverse learner needs without imposing additional cognitive load or technical barriers ([Islamy Risyah et al., 2023](#); [Melnix & Razi, 2024](#)). The iterative revision process guided by one-to-one feedback, addressing non-scrollable material, non-playable videos, and overlapping audio, was instrumental in producing this inclusive outcome in the small group stage. Several suggestions emerged from this test, including the application not being installable on iPhone, large storage space requirements, bug in phet simulation, and bug in the answer input section, which prevented users from submitting their answers. Student assessment indicates the product can proceed to the field test. A summary of the one-to-one and small-group revisions is presented in [Table 12](#).

Table 12. Table of application improvements based on practicality comments

Before Revision	After Revision
	
Before revision, there was a bug in the PhET simulation, making it unable to run within the application.	After revision, the bug on the PhET simulation object was fixed so that it runs properly within the application (using Unity's webview).
	
Before revision, there was a bug in the answer input section, which prevented users from submitting their answers.	After revision, the answer input bug was fixed, allowing users to successfully input their answers.

The validity result of Aiken’s $V = 0.88$ confirms that the developed mobile app meets the highly valid threshold ($V \geq 0.80$), indicating that the application is theoretically grounded and internally consistent across its content, instructional design, language, and media display components. This finding is consistent with the view that a rigorous analysis of students' cognitive baseline is a prerequisite for developing valid and meaningful physics learning media (Ahzari & Akmam, 2025). The high validity score across all six assessed aspects: content substance, instructional design, visual communication, supporting software, PBL model integration, and problem-solving skills, demonstrates that the application successfully operationalizes the theoretical foundations of both mobile learning (Melnix & Razi, 2024; Yang & Xiang, 2024) and Problem Based Learning (Nicholus et al., 2023; Wijnia et al., 2024). Notably, the highest validity scores were found in the instructional design and supporting software aspects, confirming that the application's pedagogical architecture aligns well with PBL principles (Markula & Aksela, 2022; Rahman et al., 2024).

The practicality scores of 84% (one-to-one) and 85% (small group) place the application in the practical and highly practical categories, respectively. This progression from individual to small-group testing reflects an improved user experience following iterative revisions guided by student feedback, which is consistent with the formative evaluation cycle within the Plomp development model (Tessmer, 2013). The high practicality scores across all four assessed dimensions, ease of use, appeal, clarity, and usefulness, align with prior research on mobile learning applications. High student acceptance of Android-based learning media has been similarly reported, attributing this to students' strong pre-existing digital habits, a pattern also confirmed by the preliminary research findings of the present study (Wahyuningtyas & Okimustava, 2023; Wiyono et al., 2025).

Several technical issues identified during the evaluation process; including incompatibility with iOS devices, substantial storage requirements, and limited in-app animation, warrant discussion beyond their status as items for future revision, as they carry implications for equitable access to the application in diverse student populations. The Android-exclusive nature of the current prototype, while technically justified by the development environment chosen (Unity/APK), creates asymmetrical access conditions in student cohorts where device ecosystems

are heterogeneous. In educational settings where mobile learning is positioned as a solution to resource limitations, platform exclusivity risks reproducing rather than reducing access inequalities ([Warschauer et al., 2014](#)). Future development iterations should therefore consider Progressive Web Application (PWA) architectures or cross-platform frameworks as design alternatives that preserve interactivity while extending accessibility. Addressing these constraints is not peripheral to the application's educational mission but is integral to it, given that the equitable distribution of learning opportunities is a foundational principle of meaningful technology integration in higher education.

The integration of the Physics for Biology mobile application with the UNP institutional Learning Management System represents a design feature that extends the application's functionality beyond conventional content delivery into the domain of connected, feedback-rich learning ecosystems. Rather than operating as an isolated repository of instructional materials, the application functions as a dynamic node within a broader hybrid learning environment, one in which students can access contextual content, complete PBL-based assessments, and submit work through a unified platform while lecturers retain the capacity to monitor engagement, provide formative feedback, and manage course administration without requiring parallel systems. This architectural decision directly addresses the connectivity and feedback characteristics identified as hallmarks of effective mobile learning ([Yang & Xiang, 2024](#); [Imaduddin & Damayanti, 2024](#)), and is particularly salient in the current higher education landscape where blended and hybrid modalities have become the normative instructional arrangement. The LMS integration thus amplifies the application's pedagogical value by ensuring that the accountability and relational dimensions of learning are preserved within a digital environment, a feature absent from the previously reviewed physics mobile applications in this field. Furthermore, the practicality of this application is enhanced by its integration with the UNP e-learning system (LMS), enabling seamless connectivity between students and lecturers, which is a key characteristic of effective mobile learning ([Yang & Xiang, 2024](#)).

The novelty of this application lies in its systematic and complete implementation of all five PBL phases, problem orientation, organizing for learning, guided investigation, development and presentation of work, and analysis and evaluation, within a single integrated Android application contextualized to biological phenomena. Previous physics mobile applications reviewed in this study ([Fathurohman et al., 2023](#); [Listiaji, 2019](#); [Milinia et al., 2022](#)) did not fully incorporate PBL phases, nor were they designed to explicitly train problem-solving skills. The present application addresses this gap, as evidenced by the validity scores on the PBL model and problem-solving ability aspects (average $V = 0.88$). This is significant because the low initial problem-solving ability of students (43%), with the weakest performance in the re-examination phase (9.3%), directly informed the design of the application's assessment features, which require students to reflect on and evaluate their solutions, a competency that aligns with both the fourth phase of problem-solving and the international mathematics and science assessment framework ([OECD, 2023](#); [Polya, 2014](#)). These findings collectively suggest that a PBL-based mobile application is a viable and effective solution to address the persistent gap in contextual physics learning resources for biology students at the university level.

CONCLUSION

The Physics for Biology mobile app is designed with four main menus: Learning (containing materials, assessments, and steps of the Problem-Based Learning model), Video, Reflection, and LMS. This app facilitates connections between students, between students and lecturers, and between students and learning resources, while also being integrated with the Learning Management System (UNP e-learning). The app's main strength lies in its integration of the Problem-Based Learning (PBL) model steps, which conceptually have the potential to facilitate students' problem-solving skills, as well as the integrated problem-based assessment feature within the app.

The Physics for Biology mobile app meets valid criteria, demonstrating that it is based on sound theory and has internal consistency between its components, a match between design

specifications and the actual product, and a link between learning objectives and the app's operational features. Practicality testing results through one-to-one and small group evaluations indicate that the app falls into the very practical category. This indicates that the app is easy to use, aligns with students' digital habits, is engaging, and helpful in supporting the Physics for Biology learning process.

These findings imply that PBL-based mobile applications can be an alternative learning medium that supports independent and interactive learning, particularly in the context of Physics for Biology. Integration with an LMS also allows for more flexible and structured learning. However, these implications are still limited to aspects of validity and practicality, so their use in improving student learning outcomes requires further study through further research.

This study has several limitations. First, the application trials were only conducted one-on-one and in small groups, so they do not represent the conditions of use in large classes. Second, this study did not quantitatively measure the application's effectiveness on improving student learning outcomes or problem-solving skills. Third, application use is still dependent on device availability and internet access, which can impact user experience. Therefore, the results of this study need to be interpreted cautiously in a broader context.

Based on these limitations, future research is recommended to test the application's effectiveness through experiments on a large class scale involving more subjects. Furthermore, further research could explore the effect of application use on improving student problem-solving skills and learning outcomes in more depth. The development of additional features, such as adaptive learning systems or the integration of artificial intelligence-based technologies, could also be a future development direction to improve the quality and usefulness of the application.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, S.R.; methodology, S.R. and P.N.; supervision, S.R.; investigation, W.K.S. and H.Y.; data collection, W.K.S. and H.Y.; formal analysis, W.K.S. and H.Y.; writing, original draft preparation, W.K.S., H.Y., S.A., P.N., and I.P.Y.; writing, review and editing, S.A. and I.P.Y. All authors have read and approved the final version of the manuscript and take responsibility for the entire content of the research.

AI DISCLOSURE STATEMENT

The authors declare that this research was prepared, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

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REFERENCES

- Ahzari, S., & Akmam, A. (2025). Analyzing Students Critical Thinking as a Basis for Developing Interactive Physics Multimedia with Generative Learning and Cognitive Conflict Strategies. *Jurnal Pendidikan Fisika*, 13(2), 163–176. <https://doi.org/10.26618/jpf.v13i2.17702>

- Aiken, L. R. (1985). Three Coefficients for Analyzing the Reliability and Validity of Ratings. *Educational and Psychological Measurement*, 45(1), 131–142. <https://doi.org/10.1177/0013164485451012>
- Arliza, R., Setiawan, I., & Yani, A. (2019). Pengembangan Media Pembelajaran Interaktif Berbasis Android Materi Budaya Nasional dan Interaksi Global Pendidikan Geografi. *JURNAL PETIK*, 5(1), 77–84. <https://doi.org/10.31980/jpetik.v5i1.493>
- Benu, S., & Natonis, H. Y. (2025). Improving Students' Creative Thinking Abilities through Problem Based Learning Model. *International Journal of Christian Education and Philosophical Inquiry*, 2(3), 42–51. <https://doi.org/10.61132/ijcep.v2i3.346>
- Crompton, H., & Burke, D. (2018). The Use of Mobile Learning in Higher Education: A Systematic Review. *Computers and Education*, 123. <https://doi.org/10.1016/j.compedu.2018.04.007>
- Dolmans, D. H. J. M., Loyens, S. M. M., Marq, H., & Gijbels, D. (2016). Deep and Surface Learning in Problem-based Learning: A Review of the Literature. *Advances in Health Sciences Education*, 21(5). <https://doi.org/10.1007/s10459-015-9645-6>
- Fathurohman, A., Oklilas, A. F., Marlina, L., Kurdiati, L. A., Susiloningsih, E., Azhar, A., & Samsuryadi, S. (2023). Effectiveness of Using the Mobile Learning App for STEM-Based High School Physics Materials as Indonesian Student Learning Resources on Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 9(3), 1018–1023. <https://doi.org/10.29303/jppipa.v9i3.2991>
- Heim, A. B., Lawrence, G., Agarwal, R., Smith, M. K., & Holmes, N. G. (2025). Perceptions of Interdisciplinary Critical Thinking Among Biology and Physics Undergraduates. *Physical Review Physics Education Research*, 21(1). <https://doi.org/10.1103/PhysRevPhysEducRes.21.010138>
- Imaduddin, M., & Damayanti, N. S. (2024). Pengembangan Aplikasi Mobile Learning (SIMOBILE) Berbasis Android pada Muatan Pembelajaran IPA SD. In *Jurnal Ilmu Pendidikan Sekolah Dasar* (Vol. 11, Number 3).
- Islamy Risyah, P., R Pratama, A., & Paputungan, I. V. (2023). Analisis Penggunaan Aplikasi Pendidikan di Perangkat Bergerak Oleh Warganet Indonesia. *JURNAL FASILKOM*, 13(02), 196–204. <https://doi.org/10.37859/jf.v13i02.5213>
- Jailani, J., Sugiman, S., & Apino, E. (2017). Implementing the problem-based learning in order to improve the students' HOTS and characters. *Jurnal Riset Pendidikan Matematika*, 4(2), 247. <https://doi.org/10.21831/jrpm.v4i2.17674>
- Kurniawan, B. R., Reyza, M., Taqwa, A., & Fisika, P. (2018). Pengembangan Instrumen Tes Kemampuan Pemecahan Masalah Fisika pada Materi Listrik Dinamis. *Jurnal Pendidikan*, 3(1), 1451–1457.
- Lestari, A. A., Suryanti, S., & Sulistijowati, S. H. (2023). Upaya peningkatan keaktifan belajar matematika menggunakan model Problem Based Learning (PBL) dengan pendekatan Student Centered Learning (SCL). *Journal.Umg.Ac.Id*, 29(2), 271–228.
- Li, H., & Du, X. (2015). Teachers' Perspective of their Role and Student Autonomy in the PBL Context in China. *International Journal of Learning, Teaching and Educational Research*, 10(2), 18–31.
- Listiaji, P. (2019). Pengembangan Aplikasi Mobile Smartphone Berbasis Android sebagai Penunjang Pembelajaran Fisika SMA Materi Hukum Gravitasi Newton. *WaPFI (Wahana Pendidikan Fisika)*, 4(2), 216–223. <https://doi.org/10.17509/wapfi.v4i2.15365>
- Markula, A., & Aksela, M. (2022). The key characteristics of project-based learning: how teachers implement projects in K-12 science education. *Disciplinary and Interdisciplinary Science Education Research*, 4(2), 1–17. <https://doi.org/10.1186/s43031-021-00042-x>
- Maulana, D. Y., & Fahrezi, A. (2023). Pembelajaran Bisnis Online: Pengembangan Media Mobile Learning Menggunakan Glide Apps Berbasis No-Code Aplikasi. *Jurnal Manajemen Dan Penelitian Akuntansi (JUMPA)*, 16(1), 26–39.

- Mayefis, R., Sukardi, S., & Usmeldi, U. (2019). Validity of Android Based Mobile Learning Media in Computer and Based Network Vocational High School. *Journal of Education Research and Evaluation*, 3(4), 239. <https://doi.org/10.23887/jere.v3i4.22869>
- Melnix, F., & Razi, P. (2024). Analisis Kebutuhan Pengembangan Aplikasi Mobile Learning Berbasis Android Sebagai Media Pembelajaran Fisika. *Jurnal Pendidikan Tambusai*, 8(1), 9518–9524.
- Milinia, G., Trisna, S., & Yanti, I. R. (2022). Pengembangan Media Pembelajaran Fisika Mobile Learning Berbasis Android Pada Materi Gelombang Bunyi dan Cahaya. *Jurnal Pendidikan Fisika*, 10(2), 271. <https://doi.org/10.24127/jpf.v10i2.5031>
- Muhassanah, N. (2023). Analysis of Problem Solving Ability Polya Stages of Open University Students in Mathematics Courses. *International Journal of Research in Mathematics Education*, 1(1), 76–89. <https://doi.org/10.24090/ijrme.v1i1.8618>
- Naveed, Q. N., Choudhary, H., Ahmad, N., Alqahtani, J., & Qahmash, A. I. (2023). Mobile Learning in Higher Education: A Systematic Literature Review. *Sustainability (Switzerland)*, 15(18). <https://doi.org/10.3390/su151813566>
- Nicholus, G., Muwonge, C. M., & Joseph, N. (2023). The Role of Problem-Based Learning Approach in Teaching and Learning Physics: A Systematic Literature Review. In *F1000Research* (Vol. 12). <https://doi.org/10.12688/f1000research.136339.2>
- Nurhilyah, D., Zulfiani, Mahmudah, L., & Mardiaty, Y. (2024). The Influence of The Ill-Structured Problem Based Learning Model on Students' Science Literacy Ability in Environmental Change Concept. *EDUSAINS*, 16(1), 37–48. <https://doi.org/10.15408/es.v13i2.39444>
- Nurtanto, M., Nurhaji, S., Baser, J. A., & Yadin, Y. (2018). Problem-Based Learning Implementation: Improvement in Learning Process and Results in Vocational Higher Education. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 24(2), 203–212. <https://doi.org/10.21831/jptk.v24i2.19519>
- OECD. (2023). PISA 2022 Assessment and Analytical Framework. In OECD Publishing.
- Osman, A., & Kriek, J. (2021). Science Teachers' Experiences when Implementing Problem-based Learning in Rural Schools. *African Journal of Research in Mathematics, Science and Technology Education*, 25(2), 148–159. <https://doi.org/10.1080/18117295.2021.1983307>
- Polya, G. (2014). How to solve it: A new aspect of mathematical method (2nd ed). In Princeton University Press.
- Rahman, A. A., Mushlihuddin, R., 'Afifah, N., Refugio, C. N., & Zulnaidi, H. (2024). Problem-Based Learning Innovation Through Realism and Culture: Impact on Mathematical Problem Solving and Self-Efficacy in Primary School Students. *Al-Jabar: Jurnal Pendidikan Matematika*, 15(1), 251–264. <https://doi.org/10.24042/ajpm.v15i1.21932>
- Redish, E. F., Bauer, C., Carleton, K. L., Cooke, T. J., Cooper, M., Crouch, C. H., Dreyfus, B. W., Geller, B. D., Giannini, J., Gouvea, J. S., Klymkowsky, M. W., Losert, W., Moore, K., Presson, J., Sawtelle, V., Thompson, K. V., Turpen, C., & Zia, R. K. P. (2014). NEXUS/Physics: An Interdisciplinary Repurposing of Physics for Biologists. *American Journal of Physics*, 82(5). <https://doi.org/10.1119/1.4870386>
- Riantoni, C., Yuliati, L., & Mufti, N. (2017). Kemampuan Pemecahan Masalah Materi Listrik Dinamis pada Pembelajaran Guided Inquiry Berbantuan PhET pada Mahasiswa S1 Pendidikan Fisika. *Jurnal Riset Dan Kajian Pendidikan Fisika*, 4(1), 40. <https://doi.org/10.12928/jrkpf.v4i1.6468>
- Riduwan. (2013). *Varibel-variabel Penelitian*. Alfabeta.
- Riyasni, S., Purnama Yani, I., Kemala Sari, W., & Zulhendra. (2023). Analisis Kebutuhan Pengembangan Bahan Ajar Digital Fisika Berbasis Project Based Learning Terintegrasi Pendekatan STEM. *Journal on Education*, 06(01), 5849–5858.
- Rodríguez-Muñoz, C., & Huincahue, J. (2025). Interdisciplinary Practices for Teaching Biology: A Systematic Review. *Journal of Biological Education*, 59(5). <https://doi.org/10.1080/00219266.2024.2399516>

- Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The Effects of Integrating Mobile Devices with Teaching and Learning on Students' Learning Performance: A Meta-analysis and Research Synthesis. *Computers and Education*, 94, 252–275. <https://doi.org/10.1016/j.compedu.2015.11.008>
- Tessmer, M. (2013). Planning and Conducting Formative Evaluations. In *Planning and Conducting Formative Evaluations*. <https://doi.org/10.4324/9780203061978>
- Wahyuningtyas, D., & Okimustava, O. (2023). Media Pembelajaran Berbasis Android Guna Penunjang Belajar Siswa di Era Society 5.0. *Semnas Ristek (Seminar Nasional Riset Dan Inovasi Teknologi)*, 7(1), 750–755. <https://doi.org/10.30998/semnasristek.v7i1.6410>
- Warschauer, M., Zheng, B., Niiya, M., Cotten, S., & Farkas, G. (2014). Balancing the One-To-One Equation: Equity and Access in Three Laptop Programs. *Equity and Excellence in Education*, 47(1), 46–62. <https://doi.org/10.1080/10665684.2014.866871>
- Widiyaningsih, B., & Suyitno, H. (2024). Integrating Flipped PDF Professional to Develop a PBL E-worksheet for Students' Critical Thinking. *International Journal on Emerging Mathematics Education*, 8(1), 15–22. <https://doi.org/10.12928/ijeme.v8i1.29589>
- Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M. J. P., & Loyens, S. M. M. (2024). The Effects of Problem-Based, Project-Based, and Case-Based Learning on Students' Motivation: a Meta-Analysis. *Educational Psychology Review*, 36(1), 29. <https://doi.org/10.1007/s10648-024-09864-3>
- Wiyono, K., Fathurohman, A., Patriot, E. A., Saparini, S., & Adiputro, R. (2025). Peningkatan Motivasi Belajar Peserta Didik Melalui Penerapan Pembelajaran PBL Pada Mata Pelajaran IPAS. *Gawi: Journal of Action Research*, 5(1), 45–51. <https://doi.org/10.59329/gawi.v5i1.194>
- Yang, H. L., & Xiang, J. J. (2024). Mobile Learning and Students' Academic Achievement: A Second-order Meta-analysis Study. *Journal of Educational Computing Research*, 62(4), 961–983. <https://doi.org/10.1177/07356331241226589>
- Youngerman, E., & Culver, K. (2019). Problem-Based Learning (PBL): Real-World Applications to Foster (Inter)Disciplinary Learning and Integration. *New Directions for Higher Education*, 2019(188), 23–32. <https://doi.org/10.1002/he.20342>