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Developing a POE2WE-Based Interactive Mobile Application to Support Physics Learning

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Abstract: Innovation in learning is an essential requirement, particularly in addressing the challenges of 21st-century education, which demand more effective, interactive, and student-centered learning processes. Fundamentally, innovation activities require strategies and skills to enhance students' learning effectiveness across the cognitive, affective, and psychomotor domains. One approach to achieving this is to implement an appropriate learning model that aligns with the characteristics of the subject matter and learners' needs. In this context, the POE2WE learning model (Prediction, Observation, Explanation, Elaboration, Write, and Evaluation) is a relevant alternative, as it promotes active student engagement and supports the development of scientific and reflective thinking skills. This study employed the McKenney development model, which consists of three main stages: Design, Development, and Formative Evaluation. In the design stage, a needs analysis was conducted, followed by the development of a learning structure and the preparation of instructional content integrated with the POE2WE syntax. The development stage focused on creating an Android-based physics learning application equipped with interactive features, learning materials, and evaluation components, aligned with the POE2WE model. Subsequently, the formative evaluation stage was conducted to assess the product's feasibility and practicality through expert validation and limited user trials. The research sample consisted of 124 respondents, including Physics Education students from Siliwangi University and Midwifery students from the Tasikmalaya Health Polytechnic. Data were analyzed using validity and practicality tests to determine the quality of the developed product. The results indicated that the application achieved a very high level of validity, with a POE2WE learning model validity score of 0.92 and a media validity score of 0.88. Furthermore, the practicality test yielded a score of 88.3%, which falls into the "very practical" category. Therefore, the developed Android-based physics learning application is considered highly valid and practical for use as an innovative learning medium to support the physics learning process.

Keywords: android application, POE2WE, and learning media.

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INTRODUCTION

Improving the quality of education in Indonesia remains a critical responsibility of the government, particularly in addressing persistent issues related to low educational standards. As highlighted by Larasati (2022), the problem of low-quality education in Indonesia stems from multiple interrelated factors, including limitations in infrastructure, teacher competence, access to learning resources, and regional disparities. Therefore, efforts to enhance educational quality cannot rely solely on government policies but require strong collaboration among all stakeholders, including schools, teachers, students, parents, and the wider community. Such collective engagement is essential to create a supportive learning ecosystem that fosters continuous improvement and equitable access to quality education. Furthermore, the rapid advancement of knowledge and technology in the

21st century has significantly reshaped the landscape of education. According to Sain et al. (2024), these developments have driven a profound transformation in educational systems, shifting them toward more dynamic, flexible, and technology-integrated approaches. Educational transformation can be understood as an ongoing process of development and renewal that responds to the evolving demands of society and global trends. This transformation not only involves integrating digital technologies into teaching and learning processes but also requires changes in pedagogical practices, curriculum design, and assessment methods to better prepare learners for complex real-world challenges.

Technological developments entering the era of the Industrial Revolution 4.0 have made the need for technology in education inseparable from education (Hoyles & Lagrange, 2010). One use of technology in education is E-Learning. Based on students' cognitive development, learning technology may be preferred for learning, especially for teaching abstract concepts (Setyawan, B., & Fatirul, AN, 2019).

The application of technology in the learning process is closely associated with mobile devices, particularly smartphones. The rapid development of information and communication technology has significantly influenced human lifestyles, leading to increasing dependence on mobile devices (Bretos et al, 2024). Smartphones have become an integral part of daily life, serving not only as communication tools but also as platforms for accessing information, entertainment, and educational resources (Arena, 2022). According to a study by the International Data Corporation (IDC), the global smartphone market reached approximately 1.42 billion units in 2018 (Scarsella & Stofega, 2018), and this number is projected to continue increasing each year. This trend indicates the widespread availability and accessibility of smartphones across different social and educational contexts.

Among various smartphone operating systems, Android is currently the most widely used platform worldwide. The open-source nature of Android, combined with its flexibility and affordability, has contributed to its dominance in the global smartphone market. The extensive use of Android devices creates significant opportunities to integrate mobile-based learning applications into educational practice (Bond et al., 2022). Android-based learning applications can be developed to provide interactive, flexible, and personalized learning experiences that align with students' learning needs and preferences.

The development and utilization of Android-based learning applications offer several advantages in the educational process. First, learning is no longer constrained by time and space, allowing students to access learning materials at any time and anywhere (Yul, 2023). This flexibility supports self-directed learning and accommodates diverse learning styles. Second, mobile learning applications enable the integration of multimedia elements such as text, images, animations, videos, and interactive simulations, which can enhance student motivation and engagement. Third, Android-based applications can support adaptive learning by allowing students to progress at their own pace and revisit learning materials as needed.

This transformation in learning media has significant implications for teaching and learning processes (Hodges et al, 2020). Interactive learning media can stimulate students' interest, encourage active participation, and foster deeper understanding (Crompton & Burke, 2018). Digital learning environments also support collaborative, problem-based, and inquiry-based learning, which are essential for developing 21st-century skills such as critical thinking, creativity, communication, and collaboration (Scheel, 2022).

In the context of science education, particularly physics, the integration of technology becomes even more crucial (Zou et al, 2025). Physics is often perceived by students as a difficult subject due to its abstract concepts, complex mathematical formulations, and the need for strong conceptual understanding. Many students experience difficulties learning physics because the content is often presented in a decontextualized, abstract manner. This challenge is exacerbated by the continued reliance on conventional learning media, such as textbooks, which may not adequately support visualization and conceptualization of physical phenomena.

Physics concepts such as force, motion, energy, waves, and electromagnetic phenomena often involve processes that are not directly observable. As a result, students may struggle to form accurate mental models, leading to misconceptions and superficial understanding. Traditional instructional methods that emphasize rote memorization and passive learning further contribute to these learning difficulties. In addition, survey results from 124 respondents show that 68% of students reported difficulty understanding physics concepts in depth, especially in relating theoretical concepts to real-world phenomena. Furthermore, most students indicated that the learning process they experienced was still predominantly conventional, characterized by lecture-based instruction and limited opportunities for exploratory learning. From a technology-use perspective, although 81% of students reported using smartphones for learning, only 39% actively used learning applications, and most of these applications did not support structured learning processes grounded in specific instructional models.

These findings are consistent with previous studies indicating that the use of technology without appropriate pedagogical design has not significantly improved student engagement or higher-order thinking skills (Scheel et al., 2022). Moreover, research by Kearney et al. (2012) emphasizes that integrating structured learning models, such as POE2WE, is essential for supporting more effective and meaningful digital learning processes.

Therefore, the development of an Android-based learning application integrated with the POE2WE model represents a relevant solution to address these issues, with the expectation of improving student engagement, conceptual understanding, and problem-solving abilities in a more systematic and effective manner. The main technological focus of this study should be repositioned toward mobile learning technology and Android-based application development, combined with the pedagogical strength of the POE2WE model. The innovation of this research lies in integrating a structured constructivist learning model into a digital application. The use of information and communication technology aims to increase the efficiency and effectiveness of learning. The use of technology in learning has shifted the delivery of material from lectures to interactive learning media. Learning media that were previously print-based have transitioned to audiovisual media delivered online (Ardiansyah, 2020). Learning physics is considered one of the most difficult subjects by students. Many students experience difficulties learning physics material because the learning is contextual and seems abstract. One of them is caused by the use of conventional learning media such as textbooks.

The POE2WE (Prediction, Observation, Explanation, Elaboration, Write, Evaluation) model is a learning model developed to determine students' understanding of a concept using a constructivist approach (Kearney et al, 2012). This model can make students the subjects of learning. Students are active in discovering concepts through direct observation or experimentation, rather than memorizing from books or teacher explanations. Therefore, innovation in learning is very much needed. In essence, innovation activities require strategies and skills that can increase students' learning effectiveness, one of which is the use of the right model, such as the POE2WE learning model (Kearney et al., 2012). Therefore, improving educational quality in Indonesia requires a holistic strategy that integrates stakeholder collaboration, pedagogical innovation, and technological advancement to create a more effective, inclusive, and future-oriented education system.

Previous studies on the POE2WE learning model have generally reported positive impacts on students' conceptual understanding, learning engagement, and scientific thinking skills. However, most of these studies focused primarily on implementing POE2WE in conventional classroom settings or on its role as an instructional framework, without examining in depth how each stage contributes to specific cognitive outcomes. In many cases, the findings were limited to general improvements in learning achievement. At the same time, critical aspects such as students' problem-solving processes, reflective thinking, and learning autonomy were not analyzed in depth.

Furthermore, earlier studies tended to position technology merely as a medium for content delivery rather than as an integrated learning environment that supports the complete POE2WE cycle. As a result, the interaction between constructivist learning processes and digital learning features remains insufficiently explored. For example, the Prediction and Explanation stages, which are theoretically essential for activating prior knowledge and restructuring conceptual understanding, were often implemented through traditional discussion activities without digital scaffolding or real-time feedback mechanisms. Similarly, the Write and Evaluation stages were generally treated as supplementary activities rather than as integral components for strengthening metacognitive reflection and self-assessment.

Another limitation identified in previous research is the lack of analysis of how mobile learning environments can support continuous student interaction and independent learning. Most studies only evaluated learning outcomes quantitatively, without critically examining how digital learning features influence students' engagement, accessibility, and problem-solving strategies throughout the learning process.

Therefore, this study attempts to address these gaps by critically integrating the POE2WE model into an Android-based learning application in which each instructional stage is systematically translated into interactive digital features. Unlike previous studies, this research not only evaluates learning outcomes but also examines how implementing POE2WE in a mobile learning environment facilitates structured problem-solving, active engagement, and reflective learning.

This study clearly distinguishes itself from previous research in the field of digital physics learning development. Most prior studies have focused on technology use, such as Android-based applications or digital simulations; however, these efforts are generally limited to serving as tools for content delivery or concept visualization, without strong integration with a systematic instructional model. Other studies have examined the effectiveness of the POE2WE learning model. However, its implementation has largely been confined to conventional classroom settings or simple LMS-based environments, with few structured, interactive mobile applications. Therefore, a gap remains between the utilization of digital technology and the implementation of constructivist learning models within an integrated learning system.

The novelty of this study lies in the comprehensive integration of the POE2WE learning model with an Android-based learning application, systematically designed to align with each stage of the learning process (Prediction, Observation, Explanation, Elaboration, Write, and Evaluation). Unlike previous studies, the developed application not only functions as a content delivery tool but also facilitates students' scientific thinking in a structured manner. Each feature of the application is intentionally designed to support specific cognitive stages, thereby guiding students in constructing conceptual understanding and developing problem-solving skills in this digital era.

Based on the identified research gaps and the need to integrate an effective instructional model within a digital learning environment, this study is guided by the following research questions:

1. How can an Android-based physics learning application integrating the POE2WE model be systematically designed and developed?
2. To what extent is the developed POE2WE-based application valid in terms of learning model design and media quality?
3. How practical is the application when implemented in real learning contexts involving university students?
4. To what extent is the integration of the POE2WE model practical for students' digital learning activities?

METHOD

Research Design and Procedures

This study employed a design-based research approach using McKenney's development model, which comprises three main stages: design, development, and formative evaluation. This model was selected because it emphasizes iterative product refinement through systematic evaluation cycles, ensuring that the developed product meets both theoretical validity and practical usability requirements in educational contexts (Tinoca et al, 2022). The McKenney development model is particularly appropriate for developing educational technology products, as it integrates theory-driven design with empirical testing in real learning environments.

The design stage focused on identifying learning needs, defining instructional objectives, and determining the conceptual framework of the product to be developed. At this stage, an initial prototype of the learning application was designed with three essential product characteristics in mind: content, support, and interface. The content aspect emphasized the alignment of learning materials with curriculum standards, learning outcomes, and relevant physics concepts. Special attention was given to the accuracy, depth, and coherence of the physics concepts presented to ensure conceptual correctness and pedagogical relevance.

The support aspect encompassed language use and readability. The language employed in the application was designed to be clear, concise, and appropriate for the target users' academic level. Readability considerations included sentence structure, terminology selection, and clarity of explanations to minimize cognitive load and facilitate comprehension. This aspect was particularly important given the interdisciplinary nature of the research sample, which involved students from both physics education and midwifery programs.

The interface aspect covered the application's visual design and layout. Interface design focused on user-friendliness, consistency, and aesthetic appeal, including color schemes, typography, navigation structure, and the integration of interactive features. A well-designed interface was expected to enhance user engagement, ease of use, and overall learning experience.

The development stage involved translating the initial design into a functional prototype. During this stage, the prototype was constructed, tested, and refined through a series of microcycles. Each microcycle consisted of product development, formative evaluation, and revision. These iterative cycles allowed for continuous improvement of the product based on feedback from experts and users. The formative evaluation conducted in this stage aimed to identify weaknesses, technical issues, and pedagogical shortcomings in the prototype.

The formative evaluation stage was carried out systematically to assess the validity and practicality of the developed learning application. Evaluation activities included expert validation, small-group trials, and field testing. Feedback from these evaluations was used to iteratively revise and improve the prototype. This process continued until the product met predetermined criteria of validity, practicality, and usability. The repeated evaluation–revision cycles ensured that the final product was not only theoretically sound but also feasible and effective for use in real learning settings.

Participants

The sample for this study comprised 124 respondents, including students from the Physics Education Study Program at Siliwangi University and from the Midwifery Program at the Tasikmalaya Health Polytechnic. The inclusion of participants from different academic backgrounds provided diverse perspectives on the usability and effectiveness of the developed learning application, thereby strengthening the generalizability of the findings. The inclusion of Midwifery students in the research sample was a deliberate decision, given the interdisciplinary nature of basic physics concepts in health physics courses, which are also relevant to health sciences education.

In the context of rotational dynamics and motion concepts, these materials are connected to biomechanical principles in human body movement, joint motion, and ergonomic positioning during patient care procedures. Midwifery students are required to understand body mechanics to perform safe patient handling, assist with deliveries, and analyze movement during maternal care. Thus, although the application was developed within a physics learning framework, the concepts presented remain relevant to applied scientific contexts encountered by Midwifery students.

Moreover, the purpose of involving Midwifery students was primarily to evaluate the practicality and usability of the Android-based learning application across different educational backgrounds, rather than to compare discipline-specific physics achievement. This interdisciplinary approach supports the broader objective of developing flexible digital learning media to facilitate scientific reasoning and problem-solving across multiple academic contexts. Nevertheless, to avoid overgeneralization, the interpretation of the effectiveness results in this study is limited to aspects of learning feasibility, engagement, and conceptual support in interdisciplinary basic science learning.

Procedure Development

Overall, the research procedures for developing the physics learning application followed the systematic stages of the McKenney development model. The integration of design, development, and formative evaluation stages through iterative microcycles ensured a rigorous and reflective development process. A comprehensive overview of the research procedure based on the McKenney development model is presented in Figure 1, which illustrates the sequence of activities from initial design to the production of a valid and practical final product.

At the planning stage, researchers established the fundamental framework for developing the Android-based physics learning application. This stage aimed to ensure that the product development was grounded in pedagogical needs, technological feasibility, and contextual relevance. Several key activities were conducted at this stage. First, learning needs were

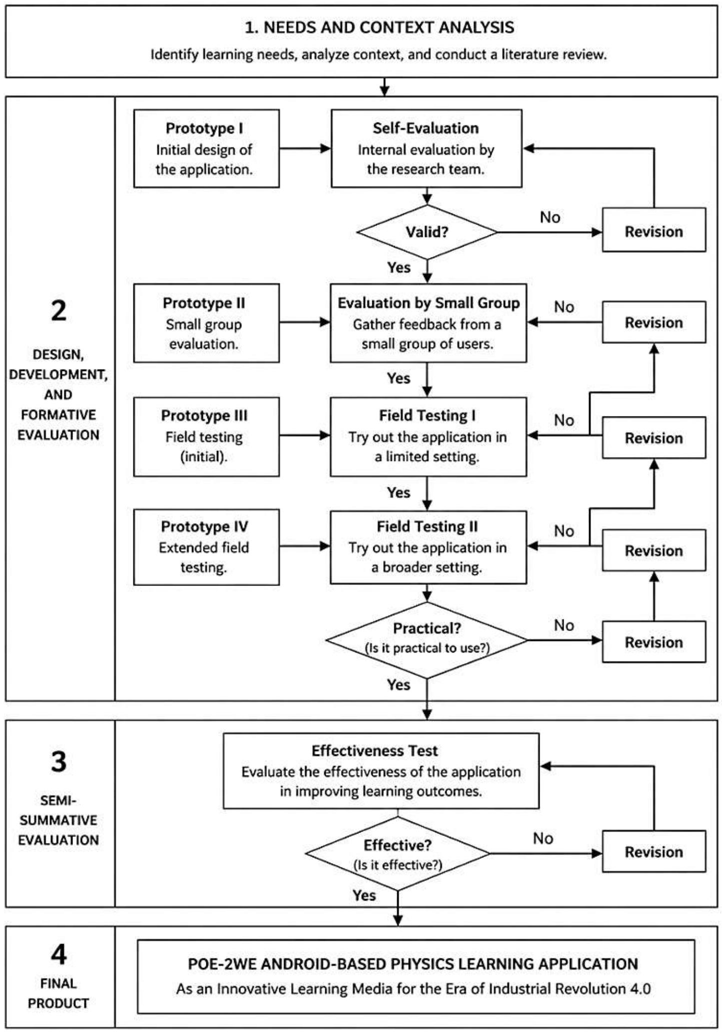

Figure 1. Procedure development

identified through preliminary observations and informal discussions with physics educators and students to pinpoint learning challenges, particularly related to abstract physics concepts and the limitations of conventional learning media. The findings indicated a strong need for interactive, visual, and student-centered learning media that could support conceptual understanding and independent learning.

Second, a literature review was conducted to examine relevant theories and empirical studies on mobile learning, augmented and virtual experiments, the POE2WE learning model, and digital learning in the context of the Industrial Revolution 4.0. This literature review served as the theoretical foundation for integrating the POE2WE model into a mobile learning environment. Third, a POE2WE model needs analysis was carried out to identify how each phase of the model could be optimally implemented in an Android-based application, including prediction activities, observation through simulations or virtual experiments, conceptual explanation, elaboration tasks, reflective writing, and evaluation components.

Furthermore, a target user definition was conducted to determine the characteristics of the intended users, including age, educational background, learning objectives, and prior experience with digital learning applications. The primary target users were students and teachers in physics-related educational contexts. Finally, budget planning was carried out to estimate the resources required for application development, including software tools, content development, expert validation, and trial implementation. This planning stage ensured that the development process was feasible and aligned with available resources.

The design stage focused on translating the conceptual framework into a concrete application design and learning plan. At this stage, researchers developed detailed application design specifications and instructional designs that integrated the POE2WE learning model into the application structure. Initial user interface (UI) sketches and user experience (UX) designs were created to ensure that the application was intuitive, visually appealing, and easy to navigate. The UI and UX designs emphasized simplicity, consistency, and accessibility to enhance user engagement and minimize cognitive load.

In parallel, researchers designed the learning content structure, including the selection and organization of physics topics to be presented in the application. The learning materials were developed in accordance with curriculum standards and learning objectives. Each learning unit was structured according to the stages of the POE2WE model. For example, the prediction stage was implemented through guiding questions and problem scenarios, while the observation stage utilized virtual experiments and interactive simulations. The explanation stage provided conceptual clarification through text, images, and animations, while the elaboration stage included contextual problem-solving tasks. The write stage encouraged learners to reflect on their understanding through short written responses, and the evaluation stage consisted of formative assessments and quizzes.

Additionally, learning videos, multimedia elements, and evaluation instruments were designed to support diverse learning styles and promote active learning. The integration of these components was intended to create a cohesive and meaningful learning experience within the Android-based platform.

At the evaluation stage, researchers assessed the effectiveness, validity, and usability of the developed application and the integrated POE2WE learning model. A beta trial was conducted involving physics teachers and students as representative users. These participants were invited to use the application in real or simulated learning contexts and provide feedback on various aspects, including content accuracy, ease of use, visual design, and learning effectiveness.

Data Collection Instruments

To ensure the replicability and robustness of this study, the data were collected using structured questionnaires with a 5-point Likert scale (ranging from 1 = Very Poor/Strongly Disagree to 5 = Very Good/Strongly Agree). The instruments are divided into expert validation sheets and a user practicality questionnaire.

Instrument validity and reliability

Before being administered, the instruments themselves underwent a construct validity process (expert judgment) involving independent educational measurement experts to ensure that each item accurately measured the intended constructs. Furthermore, the practicality questionnaire was empirically tested for reliability, yielding a Cronbach's alpha of 0.85, indicating a high level of internal consistency and reliability in data collection. The detailed specifications of each instrument are described as follows:

1. Material expert validation sheet

Source of Adaptation: Adapted from the standard textbook evaluation framework by the Indonesian National Education Standards Agency (BSNP, 2014) and modified to fit the POE2WE pedagogical syntax. Indicators Measured: (1)

Relevance of the Material to the higher education physics curriculum, (2) Organization of the Material conforming to the POE2WE phases, (3) Quality of Evaluation Items, (4) Depth of the Content, and (5) Impact on Cognitive Learning. Sample Item: "The physics concepts and formulas presented in the 'Explanation' phase are scientifically accurate and free from theoretical misconceptions."

2. Media expert validation sheet

Source of Adaptation: Adapted from the Learning Object Review Instrument (LORI) developed by Nesbit et al. (2007), specifically modified for mobile-based learning applications. Indicators Measured: (1) Media Relevance, (2) Software Engineering (application stability, navigation, and responsiveness), (3) Interactivity of features, and (4) Visual Aspects (UI/UX design, typography, multimedia integration). Sample Item: "The application's navigation is intuitive, allowing users to transition smoothly between the learning stages without experiencing technical glitches/errors."

3. Learning practitioner validation sheet

Source of Adaptation: Synthesized from the pedagogical evaluation framework by Walker & Hess (1984) and aligned with the constructivist nature of the POE2WE model. Indicators Measured: (1) Language Clarity and Readability, (2) Learning Strategy Effect, and (3) Material Organization from an educator's perspective in facilitating student-centered learning. Sample Item: "The application effectively facilitates the 'Observation' phase by providing clear, accessible, and highly engaging virtual simulations."

4. User practicality questionnaire

Source of Adaptation: Adapted from the System Usability Scale (SUS) combined with instructional media evaluation items, consisting of 20 statement items. Indicators Measured: (1) Ease of use, (2) Clarity of digital instructions, (3) Accessibility, and (4) User engagement in learning abstract physics concepts through the mobile platform. Sample Item: "I find it easy to operate the virtual experiments on my smartphone during the observation stage."

Data Analysis

Data were collected using questionnaires and interview guides to obtain both quantitative and qualitative feedback. The questionnaires were designed to capture users' perceptions of the application's functionality, clarity, and instructional value, while interviews provided deeper insights into users' experiences and suggestions for improvement. In addition to usability evaluation, researchers also assessed the effectiveness of the POE2WE model enhancing users' understanding of physics concepts. This evaluation was conducted using learning outcomes tests administered before and after trial implementation.

The evaluation results were analyzed and used to revise and improve the application. Identified weaknesses, technical issues, and pedagogical shortcomings were addressed through iterative refinements to ensure that the application met established quality standards.

Following the evaluation and revision process, the application entered the launch stage. At this stage, researchers conducted final improvements based on evaluation results and prepared marketing and dissemination strategies to introduce the application to target users. Promotional efforts included social media dissemination, academic forums, and collaboration with educational institutions. Subsequently, the application was officially launched on the Google Play Store and other Android application distribution platforms, making it accessible to a broader audience.

The final stage involved maintenance and continuous development to ensure the application's sustainability and long-term relevance. Routine maintenance activities were conducted to address technical issues, update content, and ensure compatibility with new versions of the Android operating system. Additionally, researchers considered further development by adding new learning content, enhancing features, or integrating emerging technologies to continuously improve the application's quality and effectiveness.

The sampling technique used in this study was purposive sampling, with participant selection based on characteristics such as age, educational background, and prior user experience with digital learning applications. Data collected from expert validation and user trials were analyzed using the Aiken's V index to determine the validity of the learning materials and media components. This analysis provided quantitative evidence of the application's content and media validity, supporting the conclusion that the developed Android-based physics learning application was valid, practical, and suitable for implementation in educational settings.

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

With,

v : index of agreement of respondents about validity item

s : score Which set respondents reduced score Lowest ($s = r - 1$)

r : score selected category to respondents

n : amount respondents

c : amount category Which filled respondents

Table 1. Product validity criteria (Retnawati, 2016)

Range mark V	Range mark V in %	Level Validity
0.81-1.00	81-100	Very Valid
0.61-0.80	61-80	Valid
0.41-0.60	41-60	Enough Valid
0.21-0.40	21-40	Not enough Valid
0.00-0.20	0-20	Very less Valid

The practicality of the product being developed is identified based on student responses after learning. Students respond to learning by choosing 20 statements of their own accord, with a rating scale of 1-5. Next, the data were analyzed using the following equation.

$$\text{Percentage} = \frac{\sum \text{score obtained}}{\sum(\textit{maximum score})\,(\textit{number of respondents})} \times 100\%$$

The percentage of student responses is interpreted based on the product practicality criteria presented in Table 2

Table 2. Product practicality criteria (Arikunto, 2009)

Average (%)	Category
85-100	Very Practical
70-84	Practical
55-69	Enough Practical
54-59	Not enough Practical
0-49	No Practical

RESULT AND DISCUSSION

Product Development

This study successfully implemented a design-based research approach utilizing the McKenney development model, which systematically progressed through three core stages: Design, Development, and Formative Evaluation. During the initial planning and analysis phase, preliminary observations and rigorous needs assessments were conducted to identify students' persistent difficulties in understanding abstract physics concepts and solving complex contextual problems. The empirical findings revealed that students experienced low engagement in conventional lecture-based learning environments and urgently required interactive digital learning media to facilitate structured scientific thinking. Based on these contextual needs, an Android-based physics learning application integrating the POE2WE learning

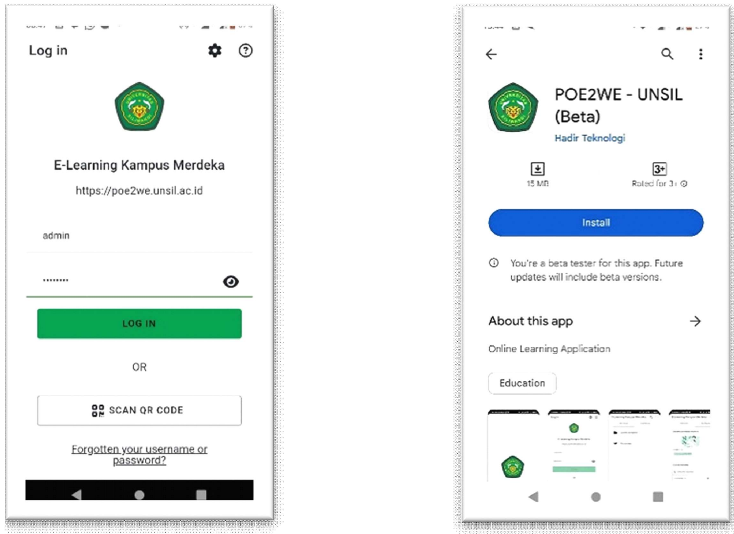

Figure 2. Initial appearance of the application

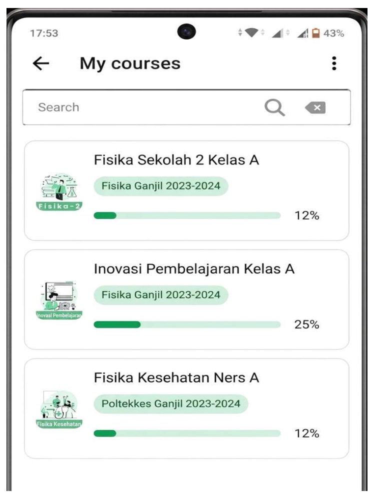

Figure 3. Physics materials in applications

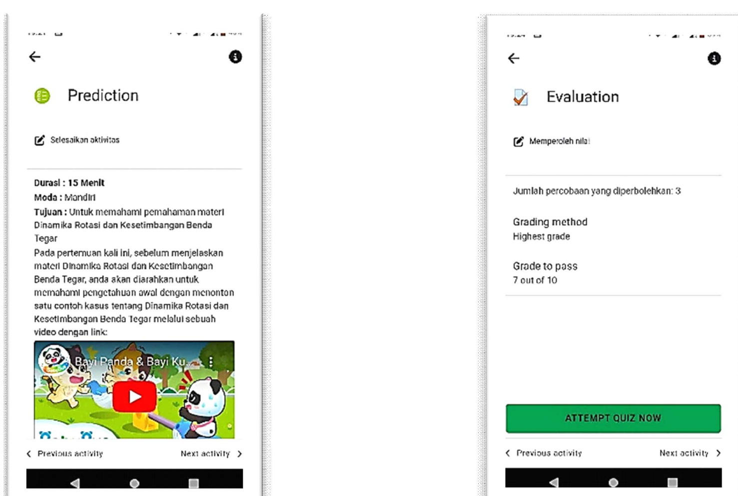

Figure 4. Learning in applications with the POE2WE model

model was systematically designed and developed through iterative microcycles.

The developed application includes several main features aligned with the stages of the POE2WE model: Prediction, Observation, Explanation, Elaboration, Write, and Evaluation. The Prediction feature allows students to formulate hypotheses and activate prior knowledge before learning activities begin. The Observation stage presents interactive simulations, animations, and contextual visualizations to support conceptual exploration. The Explanation feature facilitates conceptual clarification through guided discussion and multimedia content. The Elaboration stage provides contextual problem-solving tasks connected to real-life situations, while the Write feature encourages reflective learning through written responses and summaries. Finally, the Evaluation feature includes quizzes, automated feedback, and self-assessment activities to measure students' conceptual understanding and learning progress.

Compared with previous digital learning media, the developed application offers several innovations. First, the application systematically integrates the entire POE2WE learning cycle into a mobile learning environment rather than merely presenting digital content. Second, the application emphasizes structured scientific reasoning and problem-solving processes supported by interactive multimedia features. Third, the mobile-based design increases learning flexibility and accessibility, allowing students to engage in independent learning activities at any time and anywhere. These innovations distinguish the developed application from conventional LMS-based or presentation-oriented learning media.

Table 3. Validation results

Validation Aspect	Score	Category
Content Validity	0.92	Very Valid
Media Design Validity	0.88	Very Valid
Learning Model Integration	0.90	Very Valid
User Interface Design	0.86	Valid

The media validation process involved experts in physics education, instructional design, and educational technology. Validation focused on content appropriateness, instructional design quality, interface usability, interactivity, and alignment with the POE2WE framework. The validation results demonstrated that the developed application achieved content validity (0.92) and media design validity (0.88), both categorized as "very valid." The validators highlighted that the application successfully integrated constructivist learning principles with interactive digital learning features. However, several suggestions were provided, including improving navigation consistency, simplifying several instructions, and enhancing visual clarity in simulation activities.

Qualitative feedback from validators indicated that the application was highly interactive and pedagogically appropriate for supporting conceptual learning and scientific reasoning. Nevertheless, revisions were conducted based on expert recommendations, particularly regarding interface readability, button placement consistency, and simplification of instructional wording.

Material Validation

The validity of the learning material was analyzed using Aiken's V index to assess the conceptual alignment between the physics content and the POE2WE pedagogical syntax. Based on the expert evaluation, the developed application achieved an overall content validity index of 0.92, placing it firmly within the "Very Valid" category.

As illustrated by the specific assessment dimensions in Figure 5, the index for *Relevance of the Material* reached 0.92, *Organization of the Material* scored 0.88, *Evaluation Items / Practice Questions* yielded 0.92, *Depth of the Content* stood at 0.80, and *Impact on Learning* obtained 0.88. This high index indicates that the physics content, particularly the rotational dynamics module, is systematically integrated into the Prediction and Explanation phases on the Android platform.

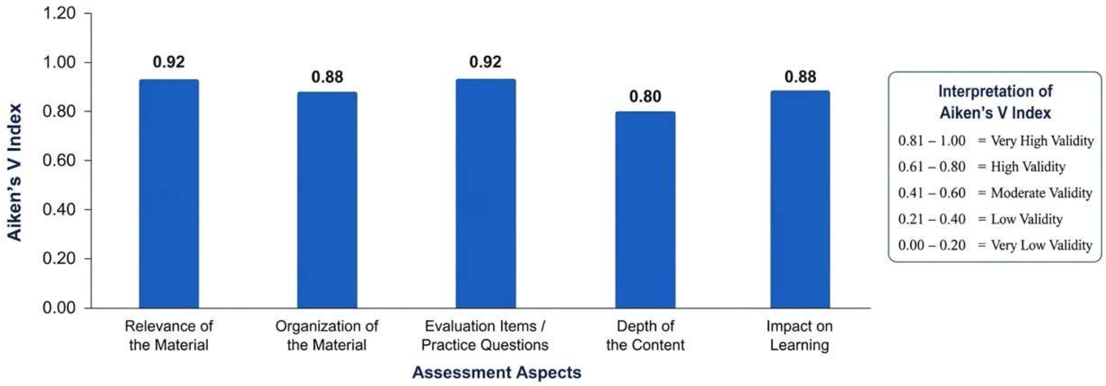

Figure 5. Material validation results diagram

Unlike conventional printed textbooks, the instructional design embedded in this application prompts students to confront their initial preconceptions before being exposed to formal theoretical definitions. This finding strongly aligns with the foundational theoretical framework of the POE2WE model, which asserts that structured digital elaboration of physics concepts significantly mitigates student misconceptions and meets the rigorous cognitive demands of higher-education physics standards.

Media Validation

The media validation process focused primarily on software engineering, visual aesthetics, and the interactivity of the application interface. The quantitative analysis using Aiken's V index yielded a design media validity score of 0.88, which falls within the "Very Valid" category.

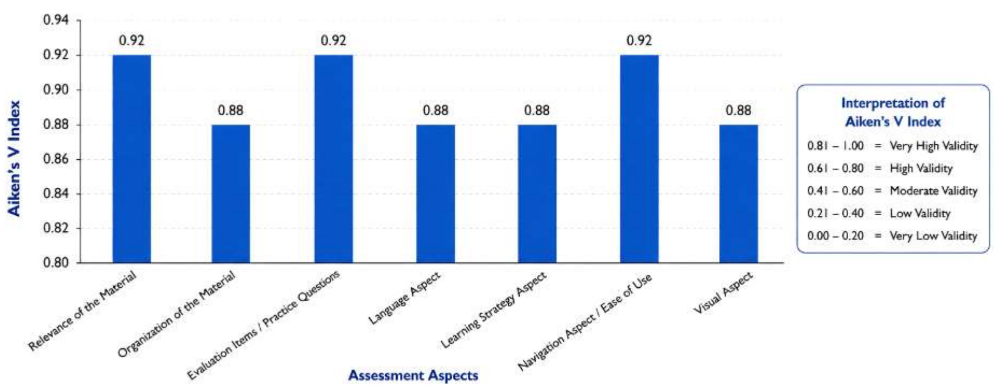

Figure 6. Diagram of media expert validation results

According to the data distribution presented in Figure 6, the specific Aiken's V values for each indicator are as follows: *Relevance of the Media* (0.92), *Organization of the Material* (0.88), *Evaluation Items / Practice Questions* (0.92), *Language Aspect* (0.88), *Learning Strategy Aspect* (0.88), *Navigation Aspect* (0.92), and *Visual Aspect* (0.88). The seamless integration of responsive multimedia components, such as embedded instructional videos designated for the *Observation* phase, effectively translates abstract physical phenomena into tangible digital formats without inducing cognitive overload.

This outcome reinforces prior empirical research indicating that Android-based virtual laboratories and digital visualization tools significantly enhance visual learning and conceptual retention among digital-era learners. By bridging interactive visual assets with the constructivist flow of POE2WE, the media architecture successfully meets the technological integration benchmarks required in the Industrial Revolution 4.0

Learning Practitioner Validation

The validation by learning practitioners was conducted to gauge the empirical pedagogical feasibility of the application from an educator's standpoint in facilitating student-centered learning environments. As computed using Aiken's V index, the learning model's integration achieved a high validity score of 0.90 (Very Valid).

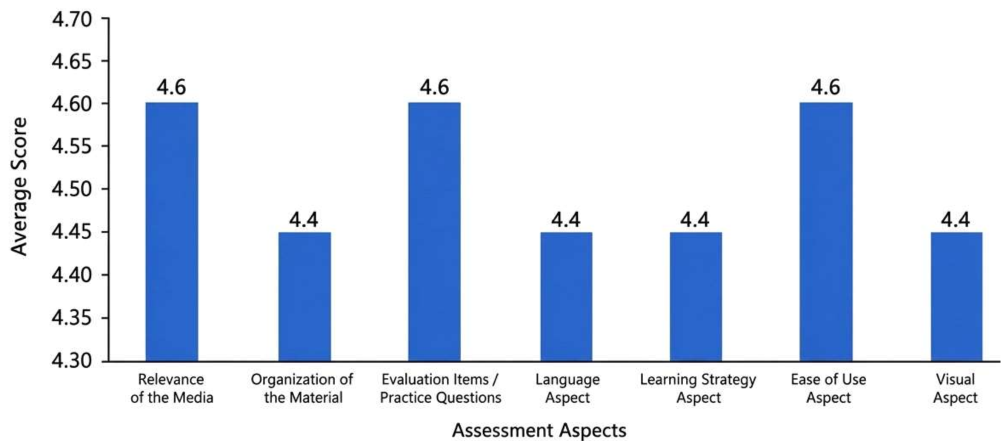

Figure 7. Diagram of learning expert/practitioner validation results

The breakdown of Aiken's V indexes shown in Figure 7 reveals that *Relevance of the Media*, *Evaluation Items/Practice Questions, and Ease of Use Aspect tied for the highest score of* 0.92. Meanwhile, the indicators for *Organization of the Material*, *Language Aspect*, *Learning Strategy Aspect*, and *Visual Aspect* remained consistently stable at 0.88.

Practitioners highly commended the built-in *Evaluation* and *Write* modules, which are intentionally structured to lock the learning pathway sequentially. This digital scaffolding effectively prevents students from skipping critical cognitive phases a systemic flaw frequently encountered in unstructured, open-ended educational apps. Consequently, the application operates as a robust digital facilitator that shifts the educational paradigm from conventional teacher-centered instruction toward self-regulated, structured student learning.

User Response (Practicality Test)

The practicality test was conducted by 124 respondents, comprising Siliwangi University Physics Education students and Tasikmalaya Health Polytechnic Midwifery Students. To ensure a rigorous methodological approach and to avoid the limitations of a single combined average, the practicality data were analyzed separately for each group, taking into account their distinct academic backgrounds.

Based on data collected from the Physics Education students (n=74), the application achieved a very high practicality score of 4.7 (93.5%). The high score from this group indicates that integrating the POE2WE model into the application aligns well with their pedagogical needs and structured scientific inquiry. As prospective educators, this group found the sequential learning phases highly relevant and easy to follow.

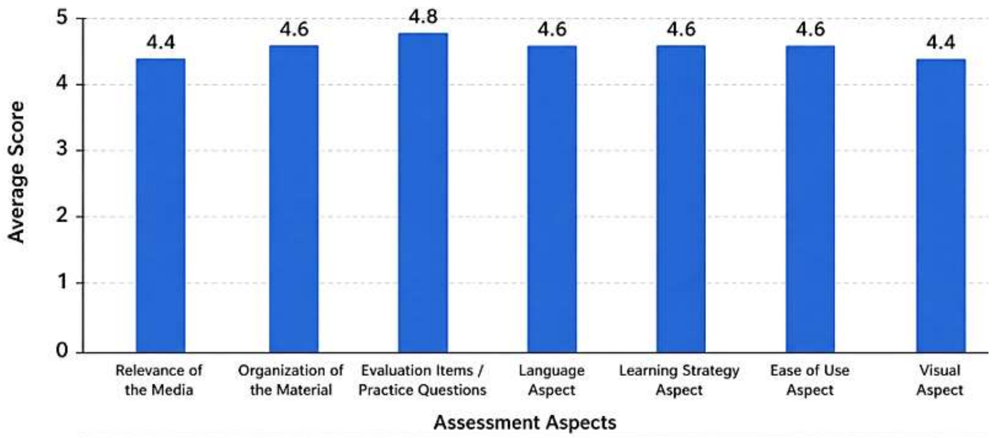

Figure 8. Practicality test results diagram

For the Midwifery students (n=50), the practicality test yielded a score of 4.4 with a percentage of 88.3%. This result also falls into the "very practical" category. It demonstrates that the application's interface and clear explanations helped non-physics majors bridge the gap in their understanding of basic physics concepts in a health context without causing cognitive overload.

Combining both groups yields an overall average practicality score of 4.6 (91.4%). This is strong evidence that the product is in a very practical category. The application has proven itself to be a highly usable and well-received medium in supporting learning activities, opening up huge opportunities for more efficient education through technology. The relatively small differences between the two groups demonstrate that the developed application is practical and can be implemented across diverse student populations. These findings support previous studies indicating that mobile learning applications integrated with constructivist learning models can enhance user engagement, accessibility, and learning flexibility. Overall, the average practicality score of 88.3% falls within the "very practical" category, indicating that the application is suitable for broader implementation in digital learning environments.

Overall, this study successfully developed an Android-based physics learning application using the POE2WE (Prediction, Observation, Explanation, Elaboration, Write, *Evaluation*) model. The development process ensured the product met the criteria of validity and practicality.

The quality was confirmed through expert validation. The validity of the POE2WE learning model integration was assessed by learning experts, indicating a validity value of 0.92 (very valid), demonstrating that each phase was appropriately embedded. In addition, media validity, evaluated by media experts, was 0.88 (very valid), highlighting the application's high standards in interface design, visual presentation, and technical functionality.

Supported by the high practicality score from user testing (91.4%), the application reflects positive user perceptions of its ability to support independent learning. Students reported that interactive features, such as virtual experiments and formative assessments, helped them better understand abstract physics concepts. Furthermore, educators noted that the application can serve as an effective supplementary learning tool that aligns with contemporary instructional strategies in the digital era.

The exceptionally high overall practicality score (91.4%) is driven by the application's accessibility and self-paced nature. The Android platform allows students to complete the Elaboration and Evaluation phases anytime, anywhere, accommodating different individual learning paces. The high user engagement is closely linked to the constructivist core of the POE2WE model, which transforms students from passive readers into active digital explorers. This conclusion supports the assertions of Wirjawan et al. (2020) and Scheel et al. (2022), who stated that mobile learning platforms equipped with clear, stage-by-stage pedagogical designs yield significantly higher user practicality, self-organization, and satisfaction than generic digital reading tools.

Qualitative Evidence of Student Engagement and Problem-Solving Processes

To complement the quantitative findings, qualitative data were collected through classroom observations and open-ended feedback obtained during the pilot implementation of the POE2WE-based Android learning application. The qualitative findings provide additional insights into students' engagement and problem-solving processes while interacting with the application.

Student Engagement

Observation results indicated that students actively interacted with the learning materials, simulations, and quizzes embedded within the application. Most students completed all learning stages independently and frequently revisited specific content sections before answering the quiz questions. Several students reported that the multimedia features and structured learning sequence increased their motivation to learn physics.

Pilot Study Result

A pilot study was conducted to evaluate the initial feasibility, usability, and comprehensibility of both the application and research instruments before large-scale implementation. The pilot study involved a small group of students representing the target users of the application. The primary objectives were to identify technical issues, examine students' understanding of the learning instructions, evaluate the flow of interactions within the application, and assess the suitability of assessment instruments.

The pilot study findings showed that students responded positively to the interactive features and multimedia components integrated into the application. Observation results indicated that students were more actively engaged during learning activities, particularly in the Prediction and Observation stages. Questionnaire results also showed that most students considered the application easy to use, visually attractive, and helpful in understanding physics concepts.

Table 4. Pilot study practicality results

Aspect Evaluated	Percentage	Category
Ease of Use	89%	Very Practical
Learning Engagement	91%	Very Practical
Interface Attractiveness	87%	Very Practical
Clarity of Instruction	84%	Practical
Overall Partically	88.3%	Very Practical

Effectiveness test result

The effectiveness test results showed that implementing the POE2WE-based Android learning application improved students' learning outcomes and problem-solving abilities. The average pre-test score was 58.2, while the average post-test score increased to 81.4. The N-gain analysis yielded a score of 0.67, which falls into the medium-to-high improvement category.

Table 5. Effectiveness test result

Variable	Pre-test	Post-test	N-gain	Category
Learning Outcomes	58.2	81.4	0.67	Medium-High
Problem-Solving Ability	55.6	79.3	0.64	Medium

These findings indicate that the developed application effectively supports students' understanding of physics concepts and facilitates structured learning processes through the stages of Prediction, Observation, Explanation, Elaboration, Write, and Evaluation. The interactive features integrated into the application also contributed to increasing students' engagement and participation during the learning process. The results are consistent with previous studies indicating that mobile learning, integrated with constructivist learning models, can significantly enhance conceptual understanding and problem-solving skills in physics.

In addition, students' problem-solving ability showed substantial improvement, with the average score increasing from 55.6 on the pre-test to 79.3 on the post-test, resulting in an N-gain score of 0.64, categorized as medium improvement. This finding indicates that the application not only enhanced students' mastery of physics concepts but also strengthened their ability to analyze problems, formulate solution strategies, and evaluate results systematically.

The application's effectiveness can be attributed to the structured implementation of the POE2WE learning model, which comprises six interconnected stages: Prediction, Observation, Explanation, Elaboration, Write, and Evaluation. These stages guided students through an active and reflective learning process. During the Prediction stage, students were encouraged to activate prior knowledge and formulate initial hypotheses. In the Observation stage, they interacted with digital simulations and learning materials to verify their predictions.

The Explanation and Elaboration stages enabled students to construct conceptual understanding and connect theoretical concepts to practical contexts. Meanwhile, the Write stage facilitated reflective thinking and knowledge consolidation, and the Evaluation stage provided opportunities for self-assessment and feedback. Moreover, integrating the POE2WE model into an Android-based platform significantly enhanced access to learning and engagement. The mobile application enabled students to access learning materials anytime, anywhere, promoting flexible, self-directed learning. Its interactive features, including multimedia content, guided exercises, immediate feedback, and structured learning pathways, contributed to increased motivation, active participation, and sustained engagement throughout the learning process.

The effectiveness findings are consistent with previous studies indicating that mobile learning environments integrated with constructivist instructional models can significantly improve conceptual understanding and higher-order thinking skills, particularly in science and physics education. The combination of pedagogically structured learning and digital accessibility appears to provide an optimal learning environment that supports both cognitive development and learner autonomy.

Following the evaluation and revision process, the POE2WE-based Android learning application can be considered an effective and innovative learning medium for supporting physics education in the digital era. Its successful implementation demonstrates the potential of integrating constructivist learning models with mobile technology to enhance students' academic performance, problem-solving abilities, and overall learning experiences.

Implications for Practice

The findings of this study provide several important implications for educational practice, particularly in the integration of digital learning technologies and constructivist instructional models in physics education. For lecturers and teachers, the POE2WE-based Android learning application offers an alternative instructional medium that facilitates active, student-centered learning. The integration of Prediction, Observation, Explanation, Elaboration, Write, and Evaluation stages enables educators to guide students systematically through scientific reasoning and problem-solving activities rather than relying solely on conventional lecture-based instruction. The mobile learning format also supports flexible learning environments, allowing students to access instructional materials both inside and outside the classroom.

For educational institutions, the developed application demonstrates the potential of integrating mobile learning technologies into digital learning ecosystems to support 21st-century competencies such as critical thinking, independent learning, collaboration, and problem-solving skills. The findings suggest that mobile-based constructivist learning media can enhance student engagement and learning outcomes, particularly in science-related subjects that require conceptual visualization and inquiry-based activities. Therefore, schools and universities may consider integrating similar digital learning innovations into curriculum implementation and blended learning strategies.

For educational media developers, this study highlights the importance of combining technological innovation with pedagogically grounded instructional design. The effectiveness of the developed application was determined not only by multimedia features but also by the systematic integration of the POE2WE learning model into its structure. This finding emphasizes that educational technology should function not only as a content delivery platform but also as a facilitator of cognitive and metacognitive learning processes.

From a policy perspective, the study underscores the growing need for digital transformation in education, particularly the development of interactive and adaptive learning media. Educational policymakers may use these findings as a reference for encouraging the integration of mobile learning applications and constructivist instructional approaches into science education programs. In addition, the study provides recommendations for broader implementation of mobile-based learning systems to improve accessibility, flexibility, and learning quality in higher education.

Limitations of the Study

Despite the positive findings, this study has several limitations that should be acknowledged critically. First, the research employed a relatively small sample of students from only two academic programs, which may limit the generalizability of the findings to broader educational contexts. Although the interdisciplinary inclusion of Midwifery students was intended to assess the application's flexibility and practicality across diverse educational backgrounds, variations in prior physics knowledge may have influenced learning outcomes.

Second, the effectiveness evaluation used a one-group pretest–posttest design without a control group. Consequently, the observed improvement in learning outcomes and problem-solving abilities cannot be attributed exclusively to the developed application without considering other potential external factors. Future studies are therefore recommended to employ more rigorous experimental designs, such as quasi-experimental or randomized controlled designs, to strengthen causal inference.

Third, the implementation period was relatively short and focused primarily on the initial evaluation of effectiveness. Long-term impacts of the application on students' retention, higher-order thinking skills, and independent learning behaviors were not comprehensively investigated. In addition, the study mainly relied on quantitative evaluation instruments, while deeper qualitative exploration regarding students' learning experiences and interaction patterns within the application remains limited.

Nevertheless, these limitations do not diminish the study's overall contribution. Instead, they provide important directions for future research and further refinement of the developed learning application. The present study still offers meaningful contributions to the integration of constructivist learning models and mobile learning technologies in physics education, particularly in supporting interactive, flexible, and problem-oriented digital learning environments.

CONCLUSION

Overall, the results demonstrate that the Android-based physics learning application developed using the POE2WE model is valid, practical, and feasible for use in educational settings. These findings suggest that integrating the POE2WE learning model into an Android-based platform provides a highly valid and practical digital learning environment that facilitates students' learning. Consequently, this application represents a promising innovation in digital physics learning media and provides a foundation for further research and large-scale implementation.

DECLARATION OF GENERATIVE AI USAGE IN THE WRITING PROCESS

During the writing of this manuscript, the author(s) employed AI tools to assist with language. The author(s) have reviewed and edited the content generated by this tool and assume full responsibility for the content of the published article.

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