UAD Pendidikan Program Doktor
p-ISSN: 3048-4324
e-ISSN: 3048-4316
CECE
https://journal1.uad.ac.id/index.php/CECE
Contemporary Education and Community Engagement

Android-Based Physics Learning Media with 5E Model Using Smart Apps Creator on Light Waves for Grade 11

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DOI: 10.12928/cece.v2i2.1471
Received: May 18, 2025. Revised: July 11, 2025. Accepted: July 14, 2025
Available Online: July 31, 2025. Published Regularly: July 31, 2025

ABSTRACT

Physics is a subject that contains several abstract concepts, one of which is the topic of light waves. This topic can be better understood through learning media to help students grasp the material more effectively. This study aims to determine the effectiveness of Android-based mobile learning in physics, integrated with the 5E Learning Cycle model, as a support tool for teaching light wave material in senior high school. The research employed a Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Data were analyzed using descriptive statistics by calculating the percentage scores from expert validation, student responses, and evaluation tests. The results showed an average score of 73.95% from media experts, 89.65% from content experts, and 69.44% from language experts. The overall expert validation average was 77.68%, indicating that the media is suitable and usable in schools. Additionally, the average score from student response tests was 92.71%, reflecting a very positive reaction from students. Thus, this mobile learning media is adequate for teaching light waves to 11th-grade high school students. The findings imply that integrating pedagogically grounded digital tools into science education may enhance conceptual understanding, promote independent learning, and offer scalable alternatives for remote and blended learning scenarios.

Keywords: 5E Learning Cycle, Education, Light Wave Physics, Mobile Learning

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INTRODUCTION

P21 (Partnership for 21st Century Learning) developed a framework for 21st-century learning that requires students to possess skills, knowledge, and competencies in technology, media, and information, education and innovation skills, and life and career skills [1]. Within this framework, students are expected not only to understand academic content cognitively but also to be able to access, manage, and utilize information through technology in critical and

creative ways. Therefore, the education sector must respond to this challenge by adapting its teaching approaches, including innovative and effective technology-based learning media.

Physics, as a branch of science, possesses complex characteristics—mainly due to its abstract concepts that are often difficult to visualize, such as light waves, interference, diffraction, and polarization [2]. In traditional learning settings, students often struggle to grasp these concepts due to limitations in media, a lack of laboratory tools, and less interactive teaching methods [3]. Consequently, learning media that visualize these concepts and provide contextual and enjoyable learning experiences are crucial in physics education.

In recent years, the rapid advancement of mobile technology—especially Android—has created new opportunities in education. Using smartphones as learning tools, commonly called mobile learning, allows learning to occur flexibly, beyond space and time constraints. Smartphones can serve as engaging learning media, enabling students to access subject matter in more dynamic and diverse ways [4]. In addition to broadening access to learning, Android-based media supports student self-directed learning due to its portability, interactivity, and personalization.

Preliminary observations and a survey distributed to 15 randomly selected 11th-grade students via social media revealed a high interest in Android-based learning. About 60% of students strongly agreed that Android-based press is easy to use, 66.7% felt motivated to learn with it, and 53.3% believed it made learning more interesting. These findings indicate a significant potential for utilizing Android-based learning media, particularly in improving students' motivation and conceptual understanding in physics.

However, the effectiveness of learning media does not solely depend on the platform or device used, but is also determined by the pedagogical approach underpinning its design. Therefore, it is necessary to integrate Android-based media with appropriate instructional models to ensure meaningful and deep learning. One relevant model is the 5E Learning Cycle, a constructivist approach designed to support students' conceptual change through five phases: Engage, Explore, Explain, Elaborate, and Evaluate [5], [6].

The 5E Learning Cycle model effectively enhances students’ conceptual understanding and critical thinking skills by emphasizing active student involvement in each learning phase. This model can replace conventional lab work with exploratory activities conducted online, making it suitable for digital physics learning [7]. The Engage phase aims to spark interest and connect content to students' prior experiences; Explore encourages discovery through hands-on activities; Explain provides opportunities to articulate findings; Elaborate extends conceptual understanding through new applications; and Evaluate is used to assess knowledge and provide feedback.

Nevertheless, a significant research gap remains regarding developing Android-based physics learning media that explicitly integrates the 5E Learning Cycle [8]. Most prior studies focused on developing Android-based media without considering the pedagogical approach used [8]–[13], resulting in insufficient instructional guidance for implementation. Conversely, some research on the 5E model has yet to fully utilize mobile technology’s potential in enriching students’ learning experiences. There is a lack of Android-based media specifically designed for light wave material—one of the most abstract topics in high school physics—which requires a strong visual representation to support conceptual understanding. Globally, similar approaches have gained traction. The mobile learning platforms integrated with inquiry-based models significantly improved physics achievement among high school students [14], [15]. Meanwhile, China explored the impact of combining mobile applications and the 5E model in chemistry education, revealing notable gains in student engagement and critical thinking [16]. These international findings reinforce the potential of synergizing digital platforms with constructivist learning models. However, the specific application of such

integration to light wave topics in Indonesian secondary education remains underexplored, thus positioning the current study to fill this gap and contribute to the global discourse. Another identified gap is the limited use of development platforms for interactive design flexibility. In this context, Smart Apps Creator was chosen as the software tool for this study due to its strengths in designing attractive interfaces, embedding animations, audio-visual elements, and interactive navigation—features essential for digital physics learning [16].

Based on the aforementioned background and research gaps, this study aims to develop Android-based physics learning media integrated with the 5E Learning Cycle model on light waves, using the Smart Apps Creator platform. The media enhances student engagement, clarifies abstract concepts through interactive visualization, and facilitates independent learning beyond the classroom. Experts expect this media to be deemed feasible in terms of content, design, and language, and it will also receive positive responses from students as primary users. By developing media grounded in students' needs, the nature of physics content, and a strong pedagogical foundation, this research seeks to improve the quality of physics education in the digital era. Furthermore, the results of this study may serve as a reference for teachers and other educational media developers in designing contextual, adaptive, and 21st-century-oriented learning resources.

METHOD

This study employed a Research and Development (R&D) method aimed at producing a product in the form of Android-based physics learning media integrated with the 5E Learning Cycle model and testing its feasibility and effectiveness in learning contexts. The development model used was ADDIE, an acronym representing five key phases: Analysis, Design, Development, Implementation, and Evaluation [17].

The ADDIE model was selected because it provides a systematic and structured framework for designing, developing, and evaluating effective and efficient learning media that meet user needs. Each phase in the ADDIE model serves the following functions:

1. Analysis: This phase involves identifying students' needs, analyzing learner characteristics, curriculum requirements, and learning objectives. Preliminary studies were conducted through classroom observations and questionnaire distribution to determine students' preferences for Android-based learning media.
2. Design: Based on the analysis results, this stage involved designing the learning media concept, including content structure, user interface layout, navigation, and integration with the syntax of the 5E Learning Cycle model. The evaluation plan and research instruments were also developed during this stage.
3. Development: This phase covered creating the learning media product using Smart Apps Creator. The initial product (prototype) was validated by content, media, and language experts to assess the feasibility of content, design, and language usage.
4. Implementation: In this phase, the revised learning media were trialed on a small scale (small group trial) with 11th-grade senior high school students to gather initial feedback on clarity, ease of use, and media appeal.
5. Evaluation: Formative evaluation, including expert validation and small-scale trials, was conducted throughout development. Summative evaluation is planned for the subsequent stage to assess the media's effectiveness in a real classroom setting.

Data collection techniques included questionnaires and tests. Questionnaires were used in two contexts: first, for expert validation; and second, to collect student responses to the media. Tests were employed to assess the effectiveness of the media in improving students'

understanding of the light wave material. All instruments used in the study underwent validation and revision to ensure the accuracy and reliability of the data.

Data analysis techniques included both quantitative and qualitative approaches. Quantitative analysis was used to calculate the percentage results of expert validation and student response questionnaires, based on the feasibility percentage interpretation guidelines. Qualitative analysis was employed to interpret expert comments and suggestions and open-ended student responses, which were then used to revise and refine the learning media product.

Table 1. Media Feasibility Criteria

Percentage	Description
81% - 100%	Very Feasible
61% - 80%	Feasible
41% - 60%	Moderately Feasible
21% - 41%	Less Feasible
0 - 20%	Not Feasible

Source: [18]

Table 2. Student Response Criteria

Percentage	Description
81% - 100%	Very Good
61% - 80%	Good
41% - 60%	Fair
21% - 41%	Poor
0 - 20%	Very Poor

Source: [19]

Due to COVID-19-related school closures, the study was limited to formative evaluation through expert validation and a small-scale trial. The implementation and summative evaluation phases were not conducted, which would typically assess direct learning outcomes. As a result, while the feasibility and user acceptance of the media can be affirmed, claims regarding its learning effectiveness must be interpreted with caution and are considered preliminary. Further experimental research is needed to validate the impact of the media on students' academic performance.

RESULTS AND DISCUSSION

As previously described, this study employed a Research and Development (R&D) method using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation [17], [20]. However, due to the nationwide school closures caused by the COVID-19 pandemic, this study was limited to the Development phase only. The development results of the Android-based learning media are presented as follows:

1. Content Expert Validation
   Three content experts were involved in this stage: two lecturers and one physics teacher. The results of the content expert validation are shown in Table 3.

Table 3. Validation Results from Content Experts

No.	Indicator	Statement Summary	Avg. Score
1	Curriculum Alignment	Content aligned with competencies and indicators, easy-to-understand indicators	91.11%
2	Content Quality	Accurate concepts, concise explanations, relevant examples and formulas, supportive multimedia	84.17%
3	Instructional Model	Relevance and effectiveness of 5E Learning Cycle integration, engagement, and scientific skills	86.67%
4	Attractiveness	Media reduces student dependence on the teacher and minimizes misconceptions	96.67%
		Total	89.65%

Based on the results above, the average content expert validation score was 89.65%, categorized as Very Feasible, and the media was considered eligible for trial after revisions.

2. Media Expert Validation

Three media experts and three physics lecturers were involved. Their evaluation results are presented in Table 4.

Table 4. Validation Results from Media Experts

No.	Indicator	Statement Summary	Avg. Score
1	Design	Media title, layout, color scheme, font size, image quality, video clarity, consistency of design	78.52%
2	Functionality	Accessibility (online/offline), ease of navigation, and command clarity	70.00%
3	Layout	Proper placement of images, buttons, and video content	73.33%
		Total	73.95%

The average score of 73.95% indicates that the media is in the Feasible category and ready for limited trial use after expert-based revision.

3. Language Expert Validation

The validation was conducted by three language experts who assessed the product based on writing and language indicators. Their evaluation focused on typography, structure, sequence, readability, language accuracy, clarity, and word arrangement. The average scores obtained from the three validators are presented in Table 5.

The language validation score of 69.44% falls under the Feasible category, and the media was considered eligible for use after revisions.

Table 5. Validation Results from Language Experts

No.	Indicator	Statement Summary	Avg. Score
1	Writing	Typography, structure, sequence, and readability	72.22%
2	Language	Use of standard Indonesian, clarity, precision, and word arrangement	66.67%
		Total	69.44%

The researcher conducted a small group trial by distributing a response questionnaire to students via Google Forms due to the COVID-19 pandemic. This trial aimed to assess students'

responses to the developed learning media. The questionnaire was administered to 15 senior high school students from various schools in the Greater Jakarta area, selected using random sampling. After analyzing the collected data, the results of the student responses to the Android-based learning media were obtained. These findings are presented in Figure 1.

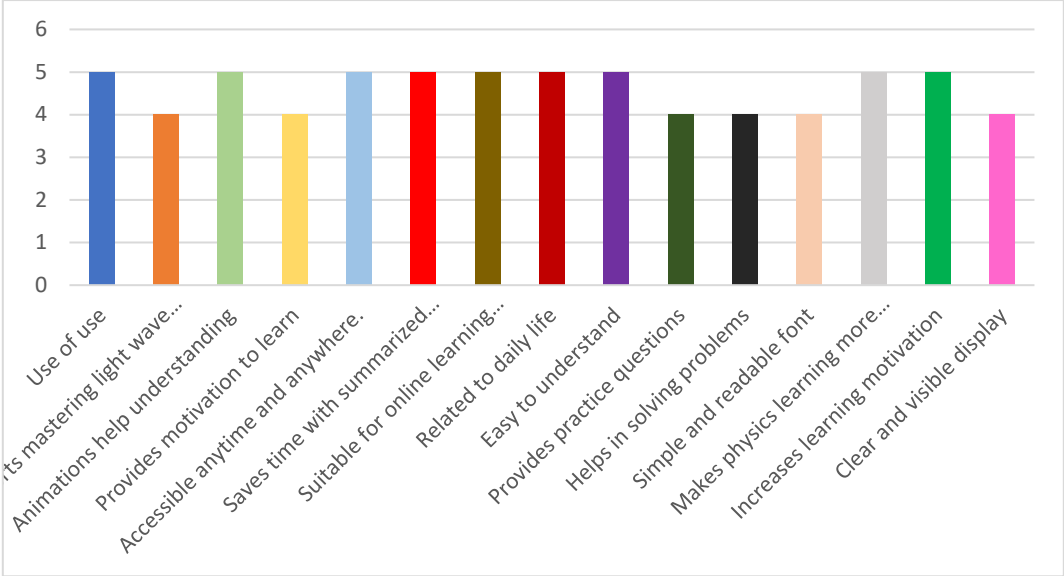

Figure 1. Student Response Data on the Android-Based Learning Media

Figure 1 presents average student scores across 15 questionnaire items using a Likert scale of 1–5. All indicators show high ratings, particularly in ease of use, video presentation, and animation. The figure presents the results of student responses gathered from 15 eleventh-grade senior high school students. The questionnaire consisted of 15 items, each assessed using a 5-point scale. After analyzing the student response data, the average response score was 92.71%, which falls into the "Very Good" feasibility category.

Following expert validation and the student response test, the overall average expert validation score was 77.68%, and the student response score was 92.71%. Based on these findings, the developed Android-based learning application is categorized as feasible and highly recommended.

The findings of this study highlight the promising role of Android-based learning media integrated with the 5E Learning Cycle model in improving students' conceptual understanding in physics, particularly on the topic of light waves. The high average validation scores from content (89.65%), media (73.95%), and language experts (69.44%), along with a very favorable student response (92.71%), support the feasibility and effectiveness of the developed media. These results offer several significant implications when examined through the lens of theory, pedagogical best practices, and current trends in educational technology.

First, the validation results align with the theoretical foundation of multimedia learning and constructivist pedagogy. According to Mayer's Cognitive Theory of Multimedia Learning [21]Students learn better when information is presented visually and verbally. Using Smart Apps Creator, the developed media employed animations, audio-visual content, and interactive navigation, allowing students to more tangibly process abstract physics concepts such as light diffraction and polarization. This multimodal design addresses the issue of cognitive load, as students can engage with content at their own pace and revisit materials as needed, an advantage particularly beneficial for abstract scientific content.

In terms of pedagogy, the integration of the 5E Learning Cycle was a strategic choice. The 5E model's emphasis on inquiry-based, student-centered learning is particularly suitable for science education [22]. Students' prior knowledge was activated during the Engage phase and misconceptions were identified. The Explore and Explain stages promoted active participation and conceptual construction, while Elaborate encouraged deeper application, and Evaluate allowed for meaningful assessment. Through this sequence, the media did not merely function as a content delivery tool but as a scaffold that guides learners through a structured thinking process.

Compared to conventional instruction, this approach is advantageous, especially in distance learning environments. The pandemic-induced shift to remote learning has exposed significant gaps in students' ability to grasp abstract science content without teacher mediation [23]. However, with the development of this Android-based application, students can experience guided discovery and self-paced exploration, filling the void often left by the absence of face-to-face explanations.

Furthermore, the validation results from content experts suggest that the media were well-aligned with curriculum standards, indicators, and competencies. The strong score in the "Attractiveness" category (96.67%) also implies the media's potential in reducing student dependence on the teacher, a critical feature in fostering independent learning. These findings are supported by Wijngaards-de Meij and Merx [24], who emphasized the importance of instructional alignment in developing media that meet educational objectives and engage students meaningfully.

The student response data, showing a 92.71% satisfaction rate, reflects today's learners' increasing digital literacy and learning preferences. Students expressed that the media was easy to use, motivating, and more engaging than traditional materials. This correlates with research by Pramuda et al. [25], who found that mobile learning media enhances student interest and motivation through its interactive and familiar interface. Mobile learning is not just a substitute for conventional tools but a facilitator of deeper, student-directed learning [26].

However, it is essential to acknowledge the moderate score from language experts (69.44%), which points to areas for improvement while still within the “Feasible” range. Precise and accurate language is critical in science education, where terms are often technical and nuanced. Future media iterations could benefit from refined proofreading, enhanced clarity in instructions, and contextual adaptation of scientific terminology. The development process itself demonstrates the practicality and accessibility of using Smart Apps Creator as a platform [27]. Unlike other programming-intensive authoring tools, Smart Apps Creator allows educators with limited technical backgrounds to develop interactive content. This feature democratizes media development, making it more attainable for teachers to tailor instructional materials according to their students' specific needs and learning styles.

From a broader perspective, this research supports the idea that educational innovation is not limited to hardware or software sophistication, but lies in the intentional pedagogical integration of technology. The 5E model is the backbone of conceptual development, while the Android platform is the vessel. When these two elements are combined effectively, they create a learning experience that is both engaging and pedagogically sound.

This study also contributes to the discourse on the sustainability of educational interventions. While many digital resources are created during project-based funding or emergencies like the pandemic, few are designed with pedagogical longevity. The structured, modular nature of the 5E model embedded in the media ensures that the application can be adapted, reused, and enhanced for future physics topics, not just limited to light waves [28], [29]. The evaluation was confined to a small group trial and relied predominantly on descriptive statistics. Future research should involve a larger, more diverse sample and employ

experimental designs to assess learning outcomes pre- and post-intervention. Investigating long-term retention and transferability of knowledge acquired through the media would also be beneficial.

Teacher perceptions and classroom integration should also be considered in future studies. While this research focuses on students' responses, the successful implementation of educational technology depends significantly on teachers' acceptance, training, and ongoing support. Incorporating teacher feedback into media refinement would ensure greater classroom relevance and integration. The development of Android-based physics learning media using Smart Apps Creator and anchored in the 5E Learning Cycle has proven feasible, effective, and engaging tool for enhancing student understanding of light wave concepts. It bridges the gap between abstract science content and students' cognitive processes, especially in remote learning contexts. As education continues to evolve in the digital era, this study serves as a model for integrating instructional design theory with mobile technology to create meaningful and sustainable learning experiences.

CONCLUSION

This study demonstrates that the Android-based physics learning media developed using the 5E Learning Cycle model with Smart Apps Creator is deemed feasible for use, as indicated by validation results from media experts (73.95%), content experts (89.65%), and language experts (69.44%). Furthermore, the media received a positive response from students, scoring 92.71%. The media effectively enhanced students' conceptual understanding of light wave material through an interactive, engaging, and accessible learning approach. The implications of these findings suggest that integrating digital learning media with a cycle-based instructional model can serve as an effective solution for physics education, particularly in the context of online learning and in addressing abstract concepts.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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