Opening the gateway to effective learning: Identifying the need for android-based mobile learning media

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Article History
Received: 7 November 2024
Revised: 14 December 2024
Accepted: 16 December 2024

Keywords
educational technology
mobile learning
physics learning media

Abstract
The development of digital technology in the Industrial Revolution 4.0 era has encouraged innovation in education, one of which is through Android-based mobile learning. However, students' mobile learning media use still needs improvement. This research aims to identify special needs in developing physics learning media based on Android applications that can effectively support the teaching and learning process. The method used was a descriptive survey with a mixed-methods approach involving class XI students and high school physics teachers who had implemented technology in learning. Data was collected through questionnaires and semi-structured interviews, which were analyzed thematically and descriptively. The results showed that 90% of students are interested in physics, but 75% find it difficult. As many as 87.5% of students feel more interested when using learning media, and 80% need Android-based applications to increase interest in learning physics. However, only 25% of students have ever used application-based pocketbooks, indicating the low adoption of digital media in physics. This research concludes that developing interactive mobile learning applications that suit student needs and the curriculum is necessary to increase the effectiveness of physics learning. The implications of this research emphasize the need for collaboration between application developers, educators and educational stakeholders to create innovative and relevant learning media. The main recommendation is that schools and educational institutions consider integrating mobile learning applications in the physics curriculum and provide training to teachers to maximize the use of technology in learning.

Ardiansyah, A. A., Novia, H., & Rudiana, R. (2025). Opening the gateway to effective learning: Identifying the need for android-based mobile learning media. *Momentum: Physics Education Journal*, *9*(1), 132-143. https://doi.org/10.21067/mpej.v9i1.11064

1. Introduction

The development of digital technology in the world of Education has presented innovations that support the teaching and learning process, including mobile learning. In the Industrial Revolution 4.0 era, mobile learning has become a global trend adopted by various educational institutions. Android-based mobile learning, which integrates various media and technologies, allows learning anytime and anywhere (Hwang & Tsai, 2011). Along with the increasing use of mobile devices, the need to develop Android-based learning applications is becoming increasingly important.

M-learning allows students to access lessons according to schedule (Gupta & Kumar, 2022). In today's fast-paced and connected world, this is very important. Android-based applications are critical in this context because this operating system dominates the global market and makes it easy for most users to use (Sung et al., 2016). More flexible learning allows learning to be more tailored to individual needs and can increase accessibility.

Despite its many benefits, mobile-based learning requires good design and development. The main challenge in the development process is to ensure that mobile learning applications are easy to use and accessible to everyone, including students with different technical abilities (Garrison & Anderson, 2019). Previous studies have shown that interface design, interactivity, and media integration, such as animation, simulation, and video, have a significant impact on the effectiveness of mobile learning (Ally & Wark, 2020; Dahlan et al., 2023; Yussif & Abdullah, 2024).

However, developing these applications requires consideration of user needs, curriculum relevance, and user data security aspects (Baran, 2014; Salama & Al-Turjman, 2024) Although mobile

doi: 10.21067/mpej.v9i1.11064

ISSN: 2548-9135

learning has great potential, challenges such as the digital divide and technological access remain obstacles, especially in developing countries (Dube & Scott, 2021; Firdaus & Ritonga, 2024). In Indonesia, there is still limited research that focuses on developing mobile learning applications for specific subjects, such as physics, at the high school level, which is a gap that needs to be addressed. So, learning media must be designed to meet academic needs and stimulate students' interest in learning more (Crompton & Burke, 2018). This shows how important it is for the government and educational institutions to support equal student access to educational technology.

In addition, mobile learning allows students to learn at their own pace and learning style. Android-based mobile learning methods can adjust student learning profiles, increase student engagement and improve learning outcomes (Anuyahong & Pucharoen, 2023). In this context, developing interactive components such as gamification, quizzes, and simulations is essential to improve learning efficiency.

The research on the development of mobile learning for physics education in high schools in Indonesia has a significant and different contribution compared to previous similar studies. The main focus of this research is on physics education, which is often considered difficult by students, thus allowing the identification and handling of unique challenges in physics teaching. In addition, this research integrates relevant pedagogical approaches, considering the technical aspects of application development, how students learn, and how teachers can facilitate the process. Thus, this research provides a more holistic guide to designing learning applications that are interesting and effective in improving the understanding of physics concepts.

Furthermore, this research combines student perspectives and teacher experiences, which are important in developing learning applications. By involving both parties, this research can identify students' needs and expectations and the challenges teachers face in implementing new technologies. An in-depth analysis of specific needs and challenges in the context of Indonesian education is also the main focus so that the recommendations produced are more appropriate and applicable. Thus, this research not only contributes to the development of relevant applications but can also provide valuable insights for policymakers in formulating strategies that support the integration of technology in the physics curriculum, as well as increasing student engagement in the learning process.

To overcome these challenges, identifying user needs is a crucial first step in developing Android-based mobile learning applications. This study aims to identify specific needs in developing learning media that can provide optimal technical and pedagogical support for the teaching and learning process. By thoroughly understanding user needs, the developed mobile learning application is expected to improve learning quality significantly. In addition, by involving students and teachers in the development process, this study seeks to create an application that is relevant to the physics curriculum and can increase student engagement and motivation in learning. Thus, this study's results are expected to contribute significantly to educational practices in Indonesia and encourage wider adoption of technology in the learning process.

2. Method

This study uses a descriptive survey method with a mixed-methods approach (a combination of qualitative and quantitative) to explore and analyze the use of mobile learning in learning in high schools. This approach was chosen to obtain a comprehensive picture of student perceptions through quantitative data and to understand teachers' experiences and views in depth through qualitative data.

The study subjects consisted of 11th-grade students and physics teachers at a high school that had implemented technology in its learning. Students were selected as subjects to fill out the questionnaire, while physics teachers were chosen for in-depth interviews. Subject selection was carried out using a purposive sampling technique, where the purposive sampling criteria included schools that had demonstrated a commitment to integrating learning technology, with a focus on specific characteristics: (1) Having adequate technology infrastructure; (2) Having implemented the concept of blended learning and; (3) Having policies that support technology-based educational innovation. The selection of 40 11th-grade students was based on the consideration that they had sufficient experience with digital technology and had a deeper understanding of the needs of

interactive learning media. Students who had participated in technology-based learning were prioritized.

The instruments used in this study include Questionnaires and semi-structured interviews. The questionnaire was created using Google Forms and distributed to students. The questions in the questionnaire are closed and open-ended, covering aspects of the use of learning media in schools, students' experiences in using mobile learning in the learning process, students' needs and preferences for Android-based learning media, and student's perceptions of the effectiveness of mobile learning in learning. Meanwhile, interviews were conducted with physics teachers to explore information about the application of learning media in schools, obstacles faced in the use of technology, and teachers' views on the potential of mobile learning in improving learning.

The data obtained from the questionnaire were analyzed descriptively by calculating the percentage of answers to each question. The selection of this descriptive analysis technique is based on its ability to provide a clear and concise picture of students' perceptions of the use of learning media in schools and mobile learning. By calculating the percentage, researchers can quickly identify trends and patterns in the data, which allows for a better understanding of students' attitudes and needs. In addition, descriptive analysis also facilitates the communication of research results to stakeholders, such as teachers and application developers, in an easy-to-understand manner. Interview data from teachers were analyzed thematically to understand the obstacles and potentials in implementing mobile learning.

The validity of the data in this study was strengthened through method triangulation, namely by combining the results of questionnaires from students and interviews with teachers. This triangulation process was carried out in-depth using a mixed-methods approach, where quantitative data from the questionnaire were analyzed statistically descriptively and then integrated with qualitative data from interviews. By comparing data from these two sources, researchers can ensure the consistency and reliability of the findings and gain a more comprehensive perspective on the phenomenon being studied. This data triangulation not only strengthened the validity of the findings but also helped identify areas that needed further attention, providing a more substantial basis for the recommendations generated from this study. Before data collection, participants were provided with information regarding the purpose of the research and the methods used, and informed consent was obtained from each participant. The data obtained were kept confidential by not mentioning the participants' identities when reporting the research results.

3. Results and Discussion

3.1. Student Questionnaire Results

This study used a needs analysis questionnaire distributed to 40 grade XI high school students in one of the high schools in Tasikmalaya via Google Forms. In addition, interviews were conducted with physics teachers. The findings of this study include data from the needs analysis that will be used in developing physics learning media for high school students. Based on the data obtained from the questionnaire results, several important findings can be identified regarding students' interests, challenges, and needs for physics learning, especially in the context of using Android application-based learning media.

3.1.1. Interest in Physics Subjects

Figure 1 shows a diagram of students' interest in physics lessons.

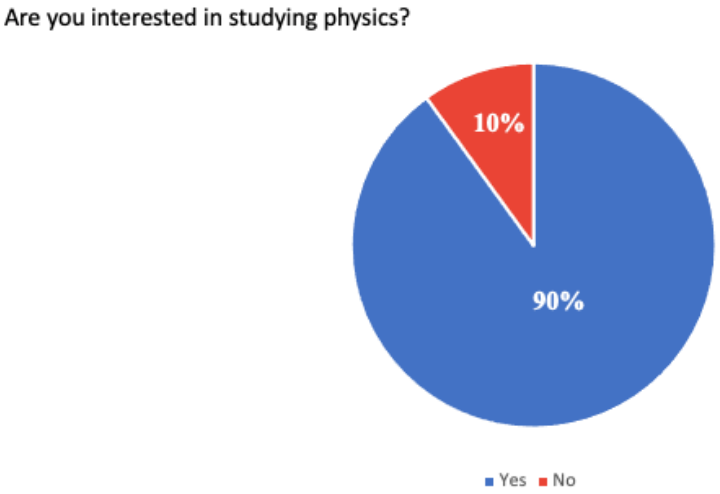

Figure 1. Diagram of Student Responses Regarding Interest in Physics

As many as 90% of students were interested in physics lessons. This high interest shows that most students have positive initial motivation towards physics subjects. However, this interest is only sometimes followed by ease in understanding the material, as will be explained further.

3.1.2. Challenges in Learning Physics

Figure 2 shows a diagram of student responses to physics learning

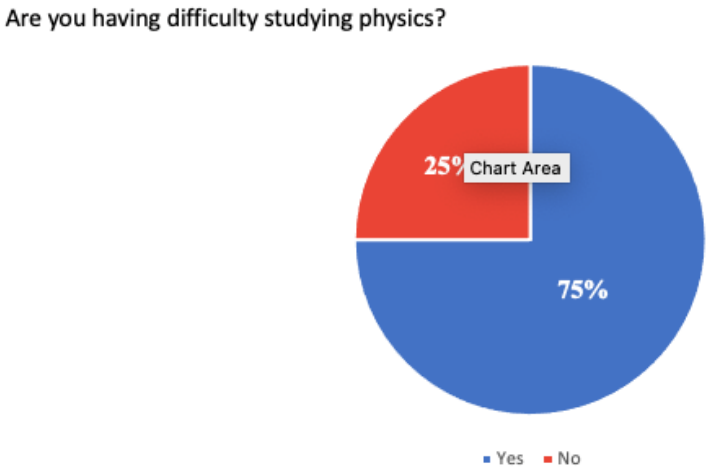

Figure 2. Diagram of Student Responses to Physics Learning at School

Although most students are interested in physics, 75% stated that learning it is difficult. This figure indicates a gap between interest and understanding. Difficulties in learning physics can be caused by various factors, including the complexity of the material, less interactive teaching approaches, and limited learning media available.

3.1.3. The Influence of Learning Media in the Physics Learning Process

Figure 3 shows a diagram of student responses to physics learning a diagram of student interest in the use of media in physics learning

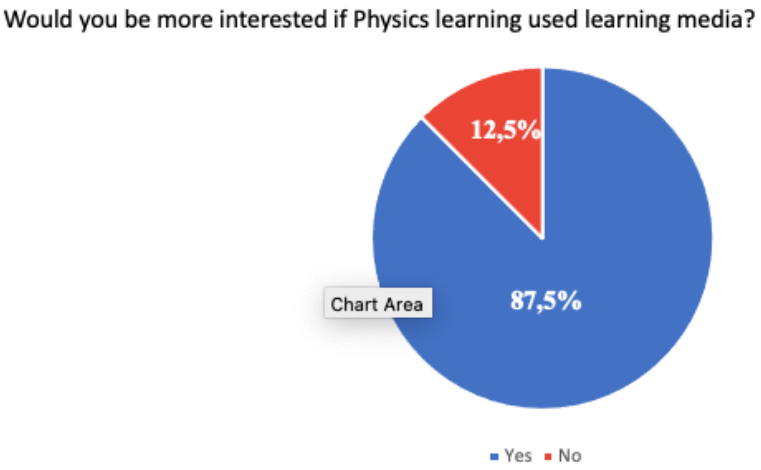

Figure 3. Diagram of Interest Responses in Media Use

As many as 87.5% of students stated that they were more interested when the physics learning process was assisted by learning media. This shows that learning media has an important role in attracting students' attention and increasing their interest in the subject matter. Interactive, visual, and easily accessible media can be a solution to overcome challenges in learning physics.

3.1.4. Use of Smartphones in Learning

Figure 4 shows a diagram of student responses to physics learning a diagram of the use of smartphones in physics learning

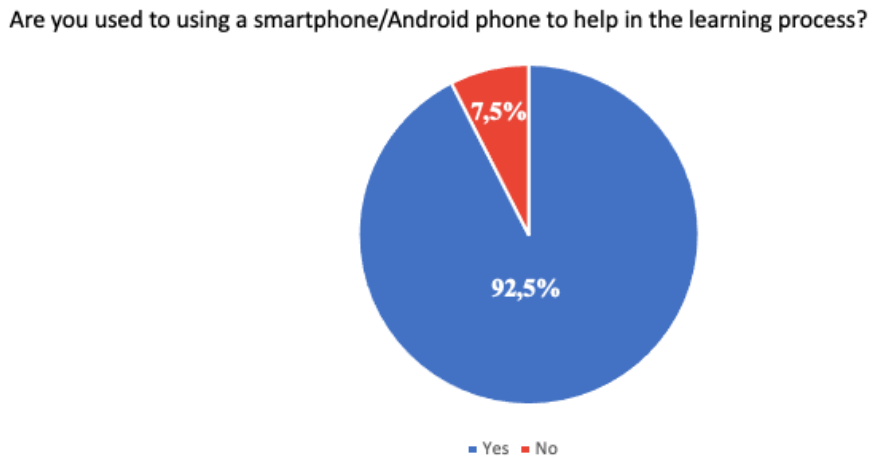

Figure 4. Student Responses Regarding the use of Smartphones in Learning

As many as 92.5% of students stated that they are used to using smartphones as a tool in the learning process. This finding shows that smartphones are a standard device students use to support their learning activities. Thus, the development of learning media based on Android applications is very relevant and has the potential to be applied in this context.

3.1.5. The Need for Interesting Learning Media

Figure 5 shows a diagram of student responses to physics learning a diagram of the need for engaging learning media in physics learning.

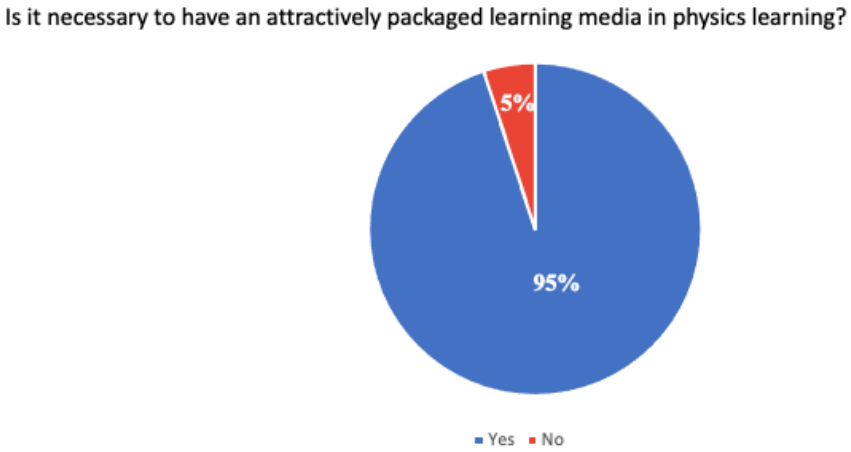

Figure 5. Student Responses Regarding the Need to Engage in Learning Media

As many as 95% of students expressed the need for learning media packaged attractively in physics learning. This need shows that in addition to being functional, learning media must also consider aesthetic and interactivity aspects in order to attract students' attention and make it easier for them to understand complex physics concepts.

3.1.6. The Need for Android Application-Based Learning Media

Figure 6 shows a diagram of student responses to physics learning a diagram of the need for media-based physics learning

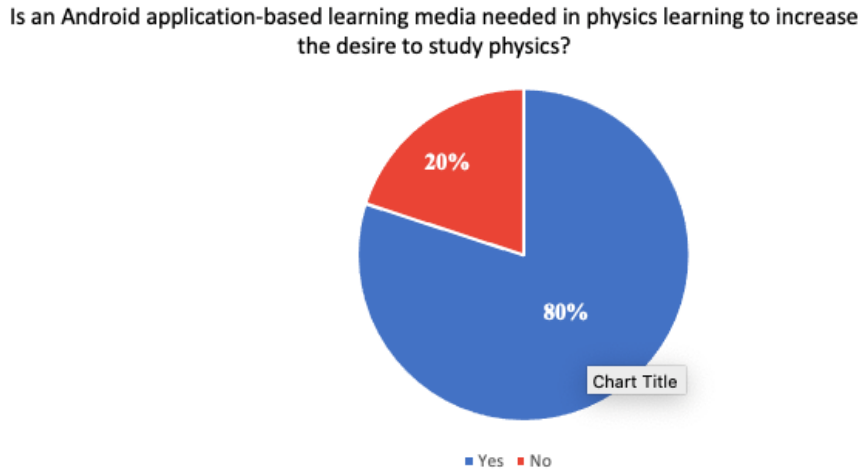

Figure 6. Student Responses Regarding the Need for Android-Based Learning Media

As many as 80% of students stated they need Android application-based learning media to increase their desire to study physics. This strengthens the urgency of developing a mobile learning application specifically for physics that can be easily accessed via smartphones. Applications that are interactive, flexible, and designed according to student needs can be an effective solution.

3.1.7. Use of Application-Based Pocket Books

Figure 7 shows a diagram of student responses to physics learning a diagram of the use of application-based pocketbooks in physics learning

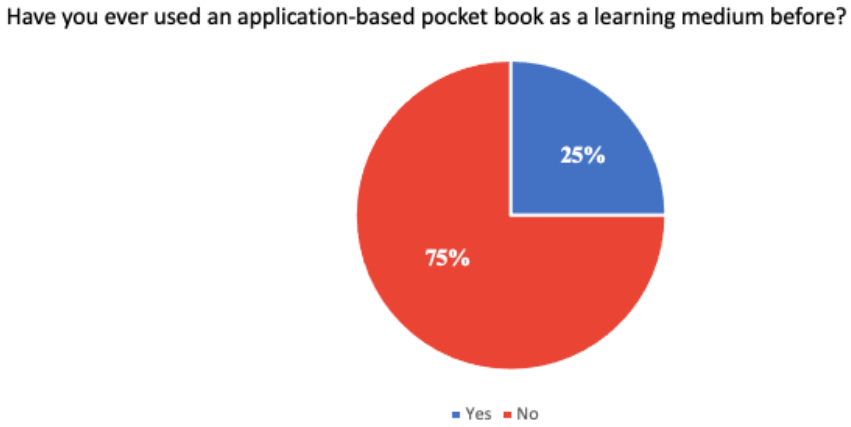

Figure 7. Student Responses Regarding the Use of Pocketbooks

Interestingly, 75% of students have never used an application-based pocketbook as a learning medium. This shows that although using smartphones in learning is shared, the adoption of specific applications, such as digital pocketbooks, still needs to grow. This low use could be due to the need for more availability of appropriate applications or the lack of socialization regarding the potential use of these applications.

From the questionnaire analysis above, it can be concluded that there is a high interest in physics lessons, but students need help understanding them. Android-based learning media is needed and is expected to increase student interest and understanding. Developing interactive, engaging, and student-appropriate mobile learning applications has excellent potential to increase the effectiveness of physics learning. In addition, further efforts are needed to introduce learning applications, such as digital pocketbooks, which can be accessed via smartphones. Providing relevant applications and Education can help students utilize technology optimally in learning.

3.2. Interview Results with Physics Teacher

The results of the interview with the Physics teacher at the high school stated that the learning activities carried out in the classroom were done as usual, namely by giving a lecture explaining the material, and then the children listened to the explanation. Then, the children discuss working on the practice questions in the textbook. Later, a representative will come forward to work on the questions. Furthermore, in the use of learning media in the classroom, the physics teacher stated that the learning media that is often used is textbooks, sometimes using PowerPoint and the help of YouTube media to improve student understanding further. The interview results also obtained data that almost every student already has an Android smartphone, and the teacher wants to learn media that is packaged attractively with an Android base, hoping to increase student interest in learning physics.

3.3. Discussion

3.3.1. Interest in Physics Subjects

High student interest in physics lessons, as shown by 90% of respondents who stated that they were interested, is a positive indication of the success of the learning process. This extraordinary interest is usually driven by curiosity about natural phenomena and the relevance of physics in everyday life. According to educational psychology theory, intrinsic interest like this is an important factor in building sustainable learning motivation (Schunk et al., 2010). Students interested in a subject are more involved in learning and show more effort in understanding the material presented. This is a substantial initial capital for teachers to develop effective learning strategies to support student understanding.

However, high interest in physics is only sometimes directly proportional to the ease of understanding the material. Based on previous findings, 75% of students stated that learning physics is complex. This difficulty may be due to the complexity of abstract concepts in physics, such as the laws of motion, energy, or waves, which require in-depth understanding and good analytical skills.

Although students are interested in physics, challenges in understanding the material can reduce learning motivation if not supported by appropriate learning methods (Bøe et al., 2024). Therefore, it is important for teachers to identify and apply learning approaches that can bridge the gap between interest and understanding, for example, through interactive media, visual simulations, or problem-based learning approaches that are relevant to everyday life.

3.3.2. Challenges in Learning Physics

Although 90% of students expressed interest in physics, 75% admitted that learning it was difficult. This percentage shows that even though students are interested in physics, they still face obstacles in understanding the material. This challenge often arises because of the nature of physics, which combines theoretical and abstract concepts with applications that require deep understanding. Concepts such as Newton's laws, dynamics, and thermodynamics require strong logical reasoning and mathematical analysis, so students with insufficient foundations in both aspects may find it challenging to master physics material (Syifa & Mastul, 2023). If not addressed with a better learning approach that meets students' needs, this gap between interest and understanding can lead to frustration and reduce students' desire to learn.

Other factors contributing to students' difficulties in learning physics are less interactive teaching approaches and limited classroom learning media. In many cases, the dominant teaching methods are still conventional, such as lectures and oral explanations of materials, which need to be revised to accommodate the needs of students who prefer to learn visually or practically. In addition, the limited learning media, such as interactive simulations or virtual experiments that students can easily access, are also obstacles. Media supporting visual understanding, such as animations or Android-based applications that allow students to visualize physics concepts, have yet to integrate fully into daily learning. As a result, students need help connecting the concepts they learn with their applications in the real world, which in turn makes physics material feel increasingly abstract and difficult to understand.

3.3.3. The Influence of Learning Media in the Physics Learning Process

The survey showed that 87.5% of students felt more interested when learning media helped them learn physics. This data shows that the media is important in attracting students' attention and increasing their interest in what is being taught. Using interactive and visual learning media can make abstract ideas more accurate and easier to understand. For example, physics simulations and animations can help students see everyday life processes that are invisible, such as particle movement or energy dynamics (Syifa & Mastul, 2023). Using easily accessible media, such as mobile phone applications or interactive videos, can increase student engagement in lessons and make them more active in learning. Ultimately, this can help students understand complex physics concepts (Julia et al., 2024).

3.3.4. Use of Smartphones for Education

As many as 92.5% of students said that they were used to using smartphones as a learning aid. The results show that smartphones have become a familiar and important device to help students learn inside and outside the classroom. Smartphones are flexible and easy to use, making them excellent tools for finding information, accessing digital learning materials, and interacting with students and teachers (Rung et al., 2014). The development of Android-based learning media is significant, considering the high use of smartphones. Mobile applications designed for learning can improve learning outcomes and provide students with a more personalized and interactive learning experience that suits their learning styles (Arain et al., 2018). Therefore, smartphones have great potential to support student engagement and understanding of subject matter in physics learning.

3.3.5. The Need for Inspiring Learning Media

95% of students in physics learning said they need learning media packaged attractively. These results show that aesthetic elements and interactivity in learning media are essential because this media can not only be used to disseminate information but can also help students become more motivated to learn. Visually attractive and interactive media can make learning more interesting, especially in physics concepts often considered abstract and complex (Liliana et al., 2020). For example, students can more easily understand complex concepts such as the laws of motion or the principles of thermodynamics using animations, videos, and interactive simulations. In addition,

gamification media, such as interactive challenges or quizzes, can make learning fun and increase student participation (Clark & Mayer, 2023). Therefore, when developing an Android-based physics learning application, the design of attractive learning media should be a top priority.

3.3.6. The Need for Android-Based Learning Media

80% of students said Android-based learning media is needed to foster their interest in physics. Data shows that mobile-based learning applications specifically designed for physical learning support the learning process. Interactive and easily accessible smartphone applications allow students to learn anytime and anywhere. This meets the needs of students in the modern technological era (Lazaro & Duart, 2023). Android-based applications designed with interesting content, interactive features such as simulations and quizzes, and the ability to be adjusted to students' ability levels can effectively increase students' motivation to learn and understand physics material (Alqahtani & Rajkhan, 2020). With the high penetration of smartphones among students, developing a mobile physics learning application for the curriculum and student needs is a strategic step that can improve the quality of physics learning in schools.

3.3.7. Application-Based Pocket Book Usage

Interestingly, 75% of students said they had never used an application-based pocketbook as a learning medium. Although the use of smartphones in learning is shared, the adoption of special applications such as digital pocketbooks still needs to grow. This low level of use can be caused by several factors, such as the need for more availability of applications that suit students' needs or limited information and socialization regarding the potential and benefits of using digital pocketbooks in learning (Alqahtani & Rajkhan, 2020). Digital pocketbooks have great potential as practical learning resources, mainly because of their compact form and ability to be accessed anytime via mobile devices. With material summaries, sample questions, and interactive quizzes, pocketbook applications can be an effective alternative to support learning, especially when access to printed materials or face-to-face classes is limited (Lena et al., 2020). Therefore, developing and promoting Android-based pocketbook applications must be improved to optimize students' learning experiences.

Overall, in the discussion section, it is important to compare the main findings of this study with relevant recent literature to provide a broader and deeper context. The finding that 90% of students showed high interest in physics lessons aligns with previous studies showing that student interest contributes positively to learning (Schunk et al., 2010). This high interest can be a major driver in learning because interested students are more active and involved in learning activities. However, the challenges faced by students, where 75% found it difficult to understand physics material, reflect the results of other studies showing that the complexity of physics concepts is often a barrier for students (Christensen & Thompson, 2010). This indicates a gap between interest and understanding, which needs to be addressed so that the learning process outcomes can occur effectively.

3.3.8. Challenges of Using Android-Based Applications

An in-depth analysis of the challenges of using Android-based applications in physics learning must also be considered. Although these applications offer great potential to increase student engagement, challenges in developing appropriate content and accessibility of applications are important factors that must be overcome. One of the main challenges is ensuring that the application is designed with an intuitive and easy-to-use interface so students feel comfortable using it. Good design improves the user experience and can influence students' motivation to continue using the application. In addition, the content presented in the application must be relevant and by the applicable curriculum so that students can relate learning to the material they are studying in class. This is important to ensure that the application functions as a tool and a practical learning resource.

Another obstacle often faced is the limited internet connection and student devices. In some areas, unstable internet access can hinder the optimal use of Android-based applications. Therefore, developing applications that can function offline or have features allowing students to download materials without an internet connection is important. Thus, students can learn anytime and anywhere without technical problems. This approach will not only increase accessibility but will also provide opportunities for students to learn independently, which is an important aspect of modern education.

Overall, the challenges developers and educators face in using Android-based applications in physics learning require serious attention. By understanding and addressing these challenges, we can create more inclusive and effective learning environments, improving students' understanding of complex physics concepts.

3.3.9. Physics Teacher Interview

The results of interviews with physics teachers at the high school showed that classroom learning practices are still dominated by conventional methods such as lectures and discussions. The teacher explains the material verbally while students listen and take notes. After that, students usually work on exercises from textbooks in group discussions, where representatives from each group are asked to come forward and present the results of their discussions. This approach is commonly applied in many schools and aims to strengthen understanding of fundamental physics concepts. However, the limitations of this method are the lack of interactivity and variation, which can make learning more enjoyable for students, especially in learning complex physics concepts.

In the use of learning media, physics teachers stated that the most frequently used media were textbooks. On the other hand, digital media such as PowerPoint and videos from YouTube were only used occasionally as a complement to clarify material that needed to be explained. Teachers admitted that although digital media can help, its use still needs to be improved due to time constraints and skills in developing interactive media. Research shows that using varied learning media, such as interactive simulations and concept visualizations, can improve students' understanding of physics material (Nyirahabimana et al., 2023). These limitations in the use of digital media highlight the need for learning media that are more interactive and easily accessible to teachers and students.

Interestingly, the interview results also revealed that almost all students already have Android smartphones, which opens up great opportunities to develop mobile learning-based learning media. Teachers stated that Android-based learning media that are packaged attractively can help increase students' interest and involvement in physics learning. Mobile learning applications designed for physics learning can provide students with a more interactive and enjoyable learning experience (Wijaya et al., 2021). Therefore, the development of Android-based learning media that meets the needs of teachers and students is not only important but can also help improve the quality of physical learning in schools.

3.4. Limitations of the Study

This study has several limitations. First, the limited geographical coverage of one high school in Tasikmalaya and the small sample size (40 students and a few physics teachers) may limit the generalizability of the results to a broader population. In addition, the data obtained through questionnaires and interviews are potentially subject to social desirability bias and may not fully reflect actual learning needs. This study did not include direct classroom observations or analysis of existing mobile learning applications, which could have provided additional insights.

3.5. Practical Implications

These findings have important implications for educators, technology developers, and policymakers. Teachers need training to integrate mobile learning with traditional approaches effectively. Educational technology developers can use these insights to design interactive and engaging Android-based physics applications. For policymakers, the results highlight the importance of supporting the adoption of mobile learning through infrastructure, teacher training, and policies that facilitate technology integration in education.

4. Conclusion

This study shows that learning technology through Android-based mobile phones is very relevant for physical learning in the modern era. However, most students like physics lessons, and understanding complex materials takes much work. Conventional approaches that are still often used in learning need to meet the needs of students, especially those with a strong understanding of abstract concepts. These results indicate that interactive and visual learning media, such as Android-based mobile phone applications, can effectively increase student engagement and understanding. In addition, developing interactive components such as gamification and simulations is essential to make learning more engaging and meet students' unique needs.

Even though smartphones are already popular, specific learning applications such as digital pocketbooks still need to be used. This shows that further socialization and development are needed to provide applications that meet students' needs and maximize the learning process. Teachers need to have more interactive and easily accessible learning media. As a result, a strategic step that can be taken to improve the quality of physical learning in schools is to create physical learning applications on mobile phones that are interesting, interactive, fit the curriculum and meet the needs of teachers and students. Ultimately, this study emphasizes that innovation in learning media that allows interactivity, personalization, and accessibility to improve student learning outcomes is significant.

5. Recommendations for Further Research

Future research needs to address multiple aspects to expand on these findings. Longitudinal studies are recommended to examine the long-term impact of Android-based mobile learning on physics learning outcomes and student engagement. In contrast, comparative studies across regions can reveal variations in mobile learning needs and challenges. Experimental research is needed to test the effectiveness of specific applications and the potential of technologies such as augmented reality and artificial intelligence. In addition, further research should evaluate the cost-effectiveness and sustainability of implementation, including infrastructure and technical support needs. Finally, teacher professional development and the role of school leadership in supporting technology integration are also significant to investigate further.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

Funding

No funding support was received.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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