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Development of Augmented Reality-Based Financial Management Learning Module to Enhance Student Engagement

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Abstract: This research aims to develop a valid, practical, and effective Financial Management learning module that incorporates Augmented Reality to enhance student engagement and improve comprehension. The study follows the 4D development model, which includes defining, designing, developing, and disseminating stages. The subjects were students from the 2021/2022 cohort of the Accounting Education Study Program at Universitas Negeri Medan who enrolled in the Financial Management course. Data collection involved expert validation surveys, user trials, and analysis of students' learning outcomes. Qualitative and quantitative analysis were used to evaluate the validity, practicality, and effectiveness of the module. Findings show that media and content experts highly rated the module, giving it strong validity and practicality scores. The module was also effective in enhancing students' understanding of financial management, as evidenced by significant improvements in t-test results. This Augmented Reality-based module is a highly innovative and effective learning resource for higher education.

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Introduction

Education is a fundamental pillar in the development of a nation, particularly in shaping a smart, high-character, and high-quality generation. Along with the advancement of time, the role of technology in education has become increasingly important and cannot be ignored. Information technology has brought significant changes to various aspects of life, including the learning process in higher education institutions (Kusumo et al, 2022). The integration of technology in education offers numerous advantages, such as improved accessibility, effectiveness, and efficiency in learning. As institutions of higher education, universities must be able to provide a learning environment that optimizes the use of technology to produce graduates who are ready to face the challenges of the modern era (Cheung, Kwok, Yang, 2021). One innovation in the digitalization of education is the use of Augmented Reality (AR) technology, which can help achieve these goals.

The Financial Management course plays a crucial role in the accounting education curriculum (Maali & Al‐Attarm, 2020). In addition to providing students with a fundamental understanding of finance, this course also develops their ability to make decisions related to investments, financing, and dividend policies. Such decision-making requires a deep understanding of financial concepts as well as strong analytical skills. However, learning Financial Management often faces various challenges, particularly in ensuring that students thoroughly understand the material and actively engage in the learning process.

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So far, the teaching of Financial Management at Universitas Negeri Medan, as in many other institutions, has largely relied on traditional learning materials such as printed modules. Although printed modules have advantages in terms of structure and systematic presentation of content, they are limited in attracting students' interest and encouraging their active engagement. Printed modules tend to be static and less interactive, making the learning process monotonous and less effective in achieving the desired learning outcomes. This aligns with findings reported by Tanucan et al. (2023), who stated that printed modules, while systematically organized and adequate for independent learning, often fail to fully activate student engagement.

In facing these challenges, Augmented Reality (AR) technology offers a promising solution. AR is a technology that allows the integration of the real world with the virtual world in two-dimensional or three-dimensional forms, projected in real-time into the real environment. This technology not only makes learning more engaging and interactive but also helps students better understand abstract concepts more concretely. According to Mustaqim & Kurniawan (2022), AR can display three-dimensional objects that appear to exist in the real world, making it possible to illustrate concepts that are difficult to visualize using traditional methods. This is highly relevant in the context of learning Financial Management, where many financial concepts are abstract and require clear visualization for students to fully comprehend.

Previous studies have shown the effectiveness of Augmented Reality (AR) in improving student learning outcomes across various disciplines. For example, research conducted by Purwandari et al. (2021) found that AR-based learning modules meet good quality standards and are feasible to be used as supplementary modules in learning. In addition, a study by Maulana et al. (2020) showed that the use of AR in mathematics learning successfully enhanced students' spatial abilities, which are also important for understanding complex geometric concepts. In the context of accounting education, research by Kariadinata et al. (2023) indicated that students' visualization abilities in solving geometric problems can be improved through the use of AR. These studies provide a strong foundation for further exploration of AR application in financial education, particularly in the development of AR-based learning modules for Financial Management courses.

Despite the growing integration of digital technologies in higher education, instructional practices in financial management courses within accounting education programs largely remain conventional, relying on lectures, textbooks, and static presentation media. These traditional approaches often fall short in engaging students or helping them grasp abstract financial concepts. While Augmented Reality (AR) has been increasingly applied in science, engineering, and medical education to enhance interactivity and conceptual understanding, its use in accounting education, particularly in the domain of financial management, remains underexplored. Moreover, there is a noticeable lack of context-specific studies that design and implement AR-based instructional modules for accounting education students in Indonesian universities, including Universitas Negeri Medan.

This study addresses that gap by designing an interactive AR-based learning module tailored specifically for the Financial Management course. The module aims to support accounting education students in visualizing complex topics such as investment analysis, time value of money, and financial ratios through immersive learning experiences. The novelty of this research lies in its pedagogical innovation: merging emerging AR technology with financial education to foster greater student engagement, conceptual clarity, and digital

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readiness. By focusing on a localized educational setting, this study also contributes to the broader goal of integrating smart learning environments in teacher training institutions across Indonesia. This study aims to develop an AR-based learning module that is valid, practical, and effective for the Financial Management course. This research employed the 4-D development model by Thiagarajan et al. (1974), which consists of four systematic stages: Define, Design, Develop, and Disseminate. The 4-D model was chosen due to its structured and widely accepted framework for developing educational products, particularly those involving technological integration. In the Define stage, the need for an Augmented Reality (AR)-based learning module was identified through classroom observations and student surveys. The results indicated that technology integration in the Financial Management course was still limited, and students expressed a strong preference for more interactive and engaging learning experiences.

In the Design stage, the AR-based module was developed to present key concepts in Financial Management, such as the time value of money, investment decisions, and financial ratio analysis, using an interactive format accessible through smartphones. The content was structured based on instructional design principles to ensure clarity, alignment with course objectives, and ease of use. The Develop stage involved validation by experts in instructional media and accounting education. The validation focused on three primary criteria: validity, practicality, and effectiveness. Validity was evaluated in terms of format (visual consistency, layout, and effective use of AR), content (accuracy, conceptual clarity, and support for independent learning), and language (clarity, appropriate use of Bahasa Indonesia, and grammatical simplicity). The module was considered valid if it met the minimum expert standards across these aspects, in accordance with criteria adapted from Nieveen (2007).

Following this, the Disseminate stage involved two rounds of testing: a small-scale trial with two students, and a larger field test with 25 students from the Accounting Education program at Universitas Negeri Medan. The purpose of this phase was to evaluate the practicality of the module, defined as its usability, accessibility, and integration within the learning process. Both students and lecturers provided positive feedback, stating that the AR-based module enhanced the learning experience and improved comprehension of complex financial topics. Finally, to assess effectiveness, students' learning outcomes were measured through pre- and post-tests aligned with the course's Minimum Competency Criteria (KKM). The results showed a significant improvement in students' understanding after using the module, as confirmed by statistical analysis using a paired-sample t-test. These findings support the effectiveness of AR-based instructional media, aligning with studies such as Asmianto et al. (2022), which demonstrated that interactive digital modules contribute more positively to student achievement than traditional learning methods.

This research not only contributes to the development of a new learning module but also offers broader insights into how AR technology can be integrated into the accounting education curriculum. This innovation is expected to serve as a model for the development of other technology-based learning tools in the future. With the increasing use of technology in education, this study also contributes to the existing literature by providing empirical evidence of the effectiveness of AR in improving the quality of higher education learning.

The development of the AR-based Financial Management learning module is an innovative step in line with the demands of the times and the need for more effective and interactive learning methods. Through the use of AR technology, this module not only provides a new way for students to learn but also helps them develop the skills required in an increasingly complex workforce. Therefore, this research is not only relevant to the

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educational context at Universitas Negeri Medan, but also has broader implications in the field of education in general, particularly in leveraging technology to enhance the quality of learning.

Research Method

This study employs the 4D development model developed by Thiagarajan, Semmel, and Semmel. The 4D model involves four main stages: Define, Design, Develop, and Disseminate (Arkadiantika et al., 2020). Data collection techniques were carried out using a questionnaire with a Likert scale to measure the attitudes, opinions, and views of respondents (Sugiyono, 2022). The validity and reliability of the questionnaire were tested, and the effectiveness and efficiency of the product were assessed by involving students from the 2021/2022 cohort of the Accounting Education Study Program at Universitas Negeri Medan.

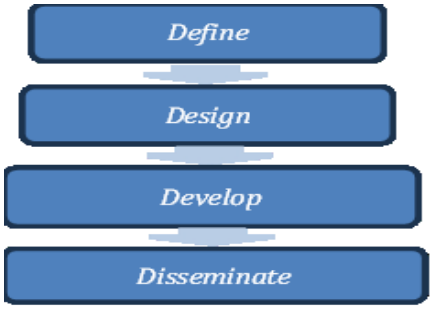

Figure 1. Media Development Stages

Define, this stage aims to establish and define the necessary learning requirements. In this process, the researcher determines the product to be developed and conducts a needs analysis. The needs analysis is carried out through research and relevant literature studies. The results of this analysis serve as the foundation for developing a learning product that aligns with the needs of the target users. This stage is a crucial initial step to ensure that the developed product can effectively and accurately achieve the intended learning objectives.

Design, this stage focuses on designing the learning tools, including the preparation of the learning media to be developed. Activities at this stage include conceptualizing the media and preparing the elements or objects to be used in the learning media. The design phase includes detailed planning on how the learning media will be structured and implemented, ensuring that all necessary components are well-prepared before the media is further developed to support the learning process.

Develop, the development stage aims to produce an initial product in the form of an AI-Based Financial Management Learning Module. In this stage, the product undergoes assessment or validation by experts, including media and subject matter experts, to evaluate the feasibility of the developed product. This validation process, known as experts' judgment, ensures that the module meets quality standards and is suitable for use in the learning process.

Disseminate, the dissemination stage is carried out in two steps. First, the learning module is distributed to a small group consisting of two first-semester students from the Faculty of Economics at UNIMED. Then, the module is tested on a larger group, consisting of 25 students. The purpose of this process is to test the module's effectiveness on different scales before its wider implementation.

A normality gain test is used to analyze the differences in learning outcomes before and after the use of the e-module. In educational product development, three main criteria are used to assess quality: validity, practicality, and effectiveness. Validity is determined by the

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consistency and quality of the content as well as expert evaluations, while practicality is assessed based on the ease of use of the product in teaching. Effectiveness is measured through student learning outcomes, which are evaluated using an N-Gain-based test.

Results and Discussion

The development of Android-based learning media in the form of a Digital Pocket Book follows the 4D development model, which consists of four stages: Define, Design, Develop, and Disseminate. The implementation process of each development stage in the study is explained in the following description:

1) Define
   This study originated from observations of students in the Accounting Education Study Program at the Faculty of Economics, UNIMED, which revealed that 100% of students own smartphones and 85% own laptops or PCs. However, the use of learning media remains limited, resulting in suboptimal learning experiences and underdeveloped student creativity. This has led to low learning outcomes and poor understanding of the Financial Management course, as well as lower GPAs. Although lecturers have utilized printed teaching materials and online modules, the lack of engaging design has made learning feel monotonous and less interactive. The use of modules is important as it helps students learn independently and understand the material more effectively.
2) Design
   The process of creating an Augmented Reality (AR) application in Unity begins by creating a new project and setting the platform to Android. Next, download and install the Vuforia Unity Extension to add the AR Camera and ImageTarget to the project. Define the marker in Vuforia by uploading an image and obtaining a License Key, then enter it into Unity. Create a database and marker in Vuforia, then import them into Unity to link with a 3D object. Audio can also be added by importing audio files and modifying the Default Trackable Event Handler script to play the sound when the object is detected.
3) Develop
   In the validation stage of the AI-Based Financial Management Learning Module, assessments were carried out by media experts, subject matter experts, and users (instructors and students). The media expert validation resulted in a total score of 7400, with several key aspects evaluated, such as the accuracy of terminology, ease of understanding the material, and the attractiveness of the design. The subject matter expert validation yielded a total score of 10,200, with emphasis on the alignment of the content with learning objectives, conceptual accuracy, and clarity of examples. In addition, student validation showed a positive response with a total score of 82, indicating that the text was easy to read, the material was well-structured, and the media facilitated the learning process. Revisions were made based on this feedback to improve the module's quality and effectiveness.
4) Disseminate
   The dissemination stage was carried out in two phases. First, the learning module was distributed to a small group consisting of two first-semester students from the Faculty of Economics at UNIMED. Second, it was distributed to a larger group consisting of 25 students.

The validation of the accounting learning material was conducted by the lecturer responsible for the Financial Management course. This validation process used a questionnaire with four response options: Very Good, Good, Not Good, and Very Poor. In the

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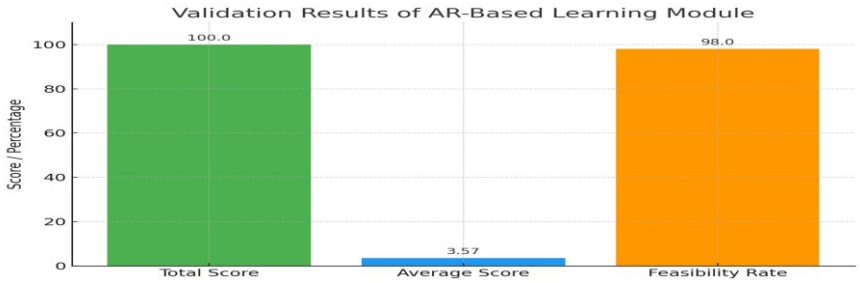
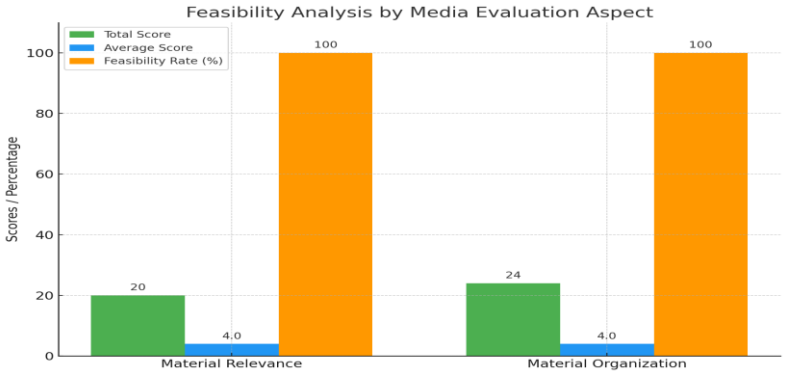
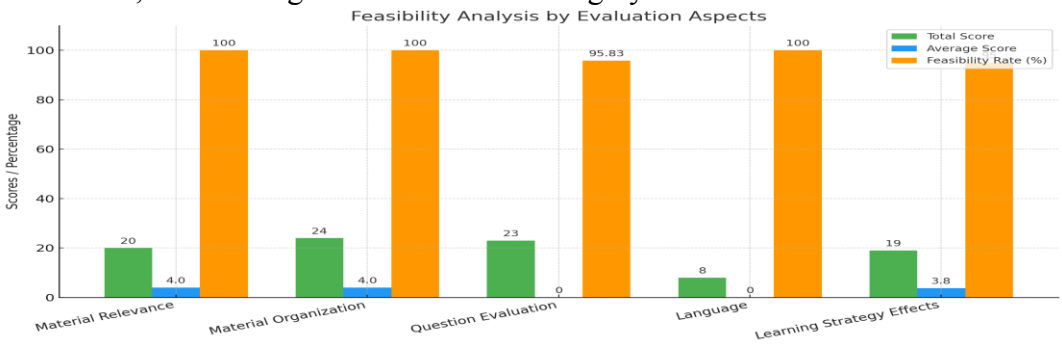
evaluation of the learning media, 28 indicators were assessed, resulting in a total score of 100 and an average score of 3.57, which falls into the Very Good category with a feasibility rate of 98%.



The feasibility analysis of the media was also conducted based on specific aspects. In the aspect of material relevance, with five indicators, a total score of 20 was obtained, with an average of 4.0 and a feasibility rate of 100%. In the aspect of material organization, with six indicators, the total score reached 24, with an average of 4.0 and a feasibility rate of 100%.



For the evaluation and language aspects, the learning media received a total score of 23 with a feasibility percentage of 95.83% for question evaluation, and a score of 8 for the language aspect with a feasibility percentage of 100%. Lastly, in the aspect of learning strategy effects, five indicators produced a total score of 19 with an average of 3.8 and a feasibility percentage of 95%. Overall, the learning media was deemed highly feasible for use.



The media expert's assessment of the learning media in the aspect of software engineering involved six main indicators. The media achieved a total score of 20.00 with an average of 3.50, placing it in the "Very Good" category. Some of the evaluated indicators included creativity and innovation, ease of using touch and drag functions, operational ease, media reusability, and ease of management and maintenance. Based on the evaluation results, the media was deemed to have a feasibility rate of 88%, indicating that it is highly suitable for use in the learning process.

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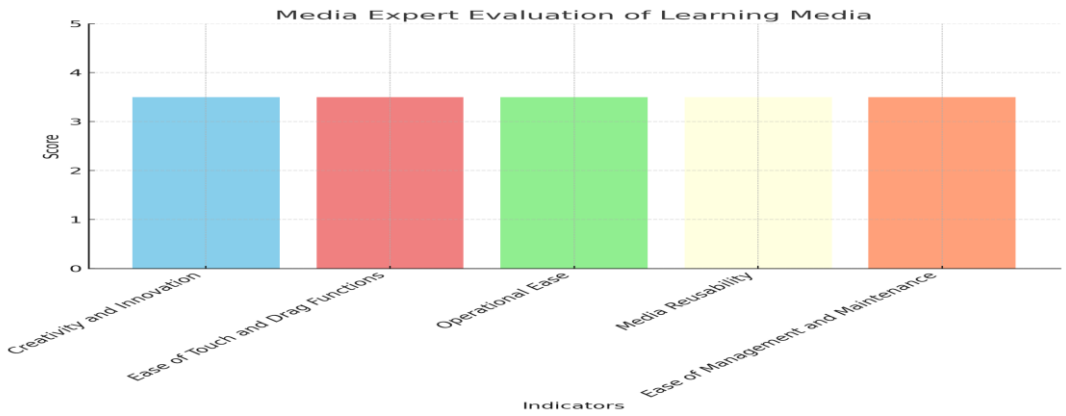
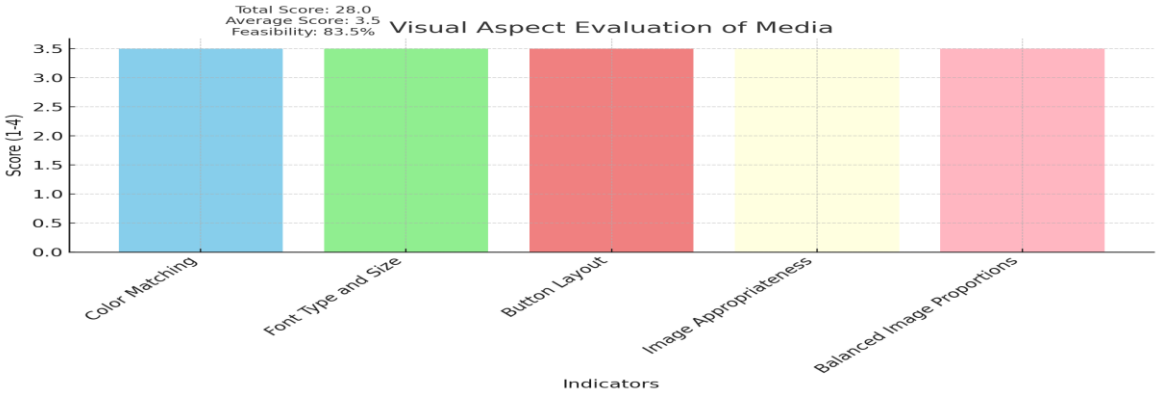
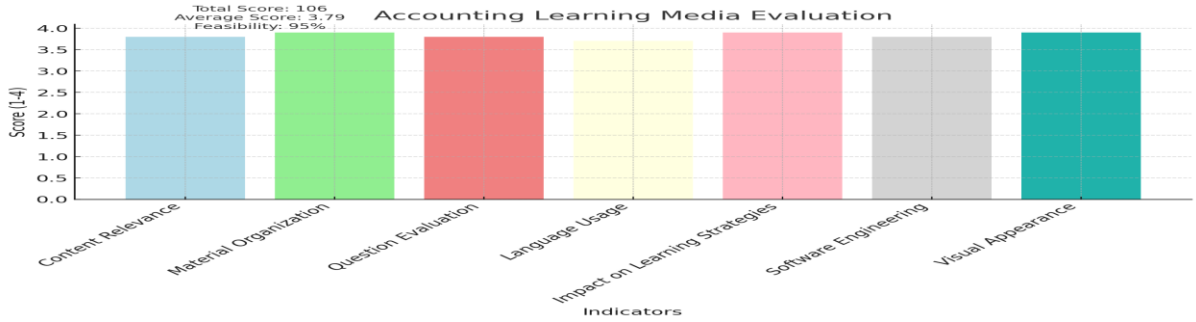


In terms of the visual aspect, the evaluation was based on eight indicators, including color matching, font type and size, button layout, image appropriateness, and balanced image proportions. This aspect obtained a total score of 28.00 with an average of 3.50, also falling into the "Very Good" category. The feasibility percentage for the media's visual appearance reached 83.5%, indicating that visually, the media is highly suitable for use. Overall, the evaluation results show that the media has met the criteria for high feasibility, both in terms of software development and visual appearance.



The evaluation results of the accounting learning media by practitioners showed very satisfactory outcomes. Based on the presented data, the media was assessed across several aspects, such as content relevance, material organization, question evaluation, language usage, impact on learning strategies, software engineering, and visual appearance. Out of 28 assessment indicators, the media achieved a total score of 106 with an average of 3.79, categorized as "Very Good," with a feasibility percentage of 95%.



Aspect-by-aspect analysis showed that content relevance obtained an average score of 3.80, material organization 4.00, question evaluation 3.83, and language usage received a perfect

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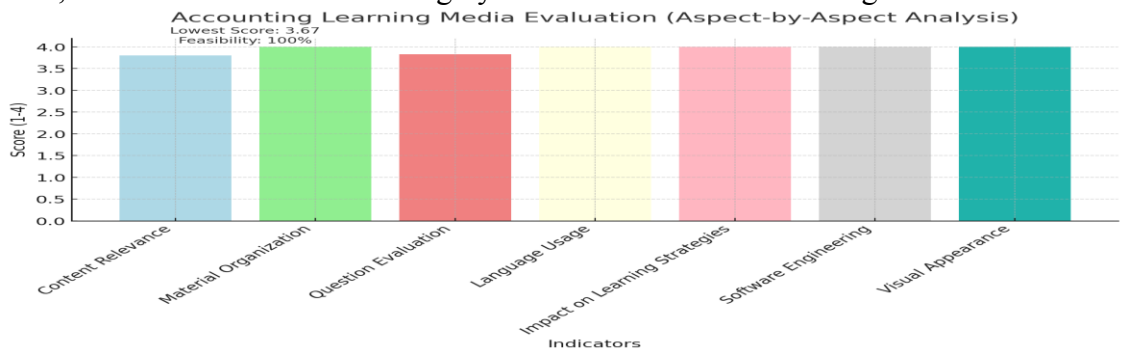
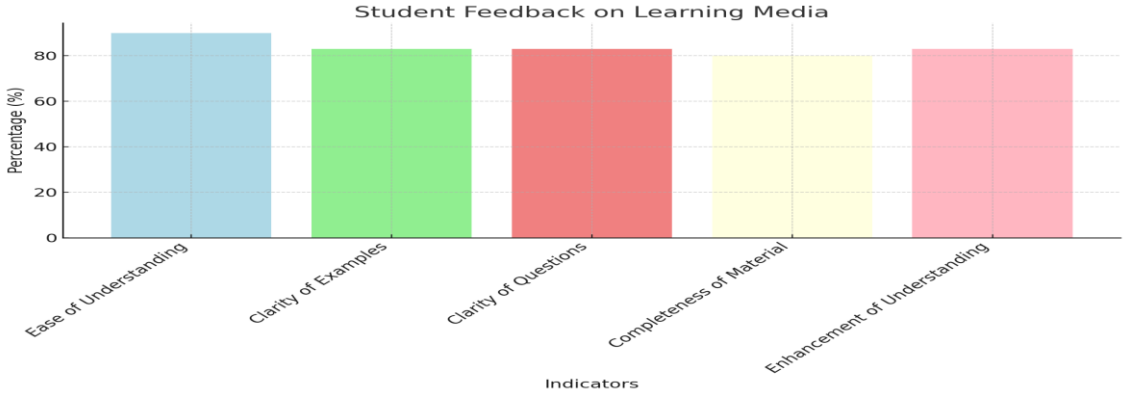
score of 4.00. Other aspects, such as impact on learning strategies, software engineering, and visual appearance, also achieved scores of 4.00 with a feasibility rate of 100%. The highest scores were found in the aspects of language, learning strategies, and visual appearance, while the lowest score, 3.67, was observed in the aspect of evaluation or practice questions. Overall, the media was considered highly feasible for use in accounting education.



A total of 27 students provided feedback on the learning media through a Guttman scale questionnaire, offering two response options: "Yes" or "No." The questionnaire included six statements covering various aspects related to the learning media. Based on the responses from 32 students, all indicators showed positive feedback with percentages above 70%. Some of the evaluated indicators included ease of understanding the material (90%), clarity of examples (83%), clarity of questions (83%), completeness of material (80%), and the media's ability to enhance understanding (83%).



Based on the results obtained, this learning media is considered very good, appropriate, feasible, and suitable for use in learning activities, particularly in enhancing students' understanding of accounting concepts. In addition to student evaluations, the development process also considered input and suggestions from experts in media design and subject matter. Moving forward, the media will be tested on a larger scale to evaluate various aspects, such as the quality and implementation of learning, media quality, as well as student assessments and evaluation outcomes.

The use of Augmented Reality (AR) technology in education is increasingly recognized as an effective tool to enhance student engagement and understanding, especially in fields that require visualization of abstract concepts like accounting. The development of an Android-based Digital Pocket Book integrated with AR technology in this study offers an interactive, innovative, and relevant learning approach that aligns with the current needs of students. Research shows that AR can transform how students interact with learning materials by providing a more visual and immersive learning environment, supporting deeper understanding of complex subjects (Ali et al., 2023). Furthermore, AR not only increases

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learning motivation but also helps improve learning outcomes through visualizations and simulations that closely mimic real-world experiences (Allcoat et al., 2021).

In the context of social learning theory, AR technology supports the principles of social constructivism, emphasizing that knowledge is built through social interaction and direct experience. By leveraging AR, students are not merely passive learners but active participants who interact with virtual objects that help them better grasp the material (Ozcakir & Cakiroglu, 2021). According to Hajirasouli & Banihashemi (2022), this technology allows students to learn through well-designed experiences where they can see, hear, and manipulate objects that are difficult to understand through text or static images. AR also creates a collaborative environment where students can discuss and work together to solve problems, supporting project-based and group learning.

At the design development stage, the use of the Unity platform and Vuforia for AR integration enabled the creation of learning media that students can easily access through their smartphones. Research indicates that mobile-based learning media like this provide flexibility for students to learn anytime and anywhere, according to their own pace and learning style (Gudoniene & Rutkauskiene, 2019). Moreover, AR-based learning media can create a more inclusive learning environment, where students with different learning styles can effectively adapt to the presented content (Garzón & Acevedo, 2019).

The validation conducted by subject matter and media experts showed that the AR-based Digital Pocket Book is highly effective in presenting complex accounting material in a simpler and more easily understood manner. Additionally, AR enables the visualization of difficult concepts, such as the accounting cycle or financial analysis, in an interactive and engaging way, which helps enhance students' absorption of the material (Ahmed & Lataifeh, 2024). In the validation carried out by students, the media was also considered highly practical and supportive of independent learning. AR technology in education also allows for personalization, enabling students to control their learning pace and adjust their learning methods according to their individual needs (Marín-Rodriguez et al., 2023).

AR offers significant advantages for lecturers as well, as it presents complex information in a simpler way, thus reducing students' cognitive load. A study by Mystakidis et al. (2022) shows that AR helps students process information faster and more effectively compared to traditional learning methods. Moreover, AR creates a more engaging and interactive learning experience, increasing student engagement and making them more interested in the subject matter (Booyoesen, 2023).

In addition to supporting individual learning, AR also facilitates collaborative learning, allowing students to share ideas and work together to solve problems presented through AR applications. This aligns with symbolic interaction theory, which emphasizes that meaning is formed through interactions among individuals and their environments (Chang et al., 2022). Through AR, students can better understand abstract concepts via manipulable visual representations, ultimately strengthening their comprehension of the material (Kuanbayeva et al., 2024).

The findings of this study imply that the integration of Augmented Reality (AR) technology into accounting education, specifically through the development of an Android-based Digital Pocket Book, holds significant potential to transform traditional learning practices. The module's high scores in validity, practicality, and effectiveness demonstrate that AR is not only feasible in educational settings, but also beneficial in enhancing students' understanding of complex financial topics. This supports the global shift toward technology-enhanced learning, where digital tools are leveraged to create more interactive, engaging, and

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student-centered learning environments (Zappatore, 2022). Additionally, the AR-based module encourages independent exploration and fosters creative thinking by allowing students to visualize abstract concepts and interact with the learning content directly. As highlighted by Weng (2023), AR can strengthen students' learning experiences through immersive, experience-based approaches that promote autonomy and deeper engagement.

The use of smartphones as the primary platform for the AR module further emphasizes accessibility and flexibility, making this innovation highly relevant in the post-pandemic educational context where mobile learning has become increasingly essential. This approach ensures that learning is not limited by physical classroom settings or costly technological infrastructure. Moreover, the success of this development suggests that institutions should consider incorporating AR-based media into the formal curriculum to enrich content delivery and better prepare students for the demands of a technology-driven world. Ultimately, this research contributes to the broader discourse on educational innovation by demonstrating how AR can support meaningful, scalable, and inclusive learning in higher education.

Conclusion

The development of the Augmented Reality (AR)-based Digital Pocket Book for the Financial Management course successfully fulfills the objectives of creating a valid, practical, and effective learning medium. The integration of AR technology has proven to simplify the delivery of complex accounting concepts, enhance student engagement, and foster independent and collaborative learning. The findings confirm that AR-based media not only enrich students' learning experiences but also support deeper conceptual understanding, reduce cognitive load, and align with social constructivist learning theories. Therefore, the use of AR technology in higher education, particularly in accounting education, offers a promising and innovative approach to improving learning outcomes and preparing students to meet future challenges.

Recommendation

Based on the findings of this study, lecturers are encouraged to take a more active role in integrating Augmented Reality (AR) into the learning process, particularly by expanding its use beyond Financial Management to other accounting subjects that involve abstract or technical material. Courses such as auditing, financial reporting, and taxation can benefit greatly from the use of AR to visualize complex concepts in a more interactive and comprehensible way. Lecturers should also seek opportunities to collaborate with instructional media developers and educational technology experts in designing AR-based learning tools that are aligned with the curriculum and student learning needs. In addition, they are advised to carry out classroom-based evaluations or action research to monitor the long-term impact of AR on student learning outcomes and engagement levels.

Lecturers are encouraged to systematically evaluate the long-term impact of AR-based learning modules by collecting feedback and analyzing student performance over time. Collaborative workshops or study groups with fellow educators can foster shared insights and inspire innovative ways to incorporate AR into various courses, enhancing cross-disciplinary learning. Staying informed about the latest AR trends through professional development opportunities, such as conferences and online courses, will equip lecturers with updated tools to refine their teaching strategies. Institutions should also support lecturers by providing the necessary infrastructure, including high-quality devices, stable internet access, and technical

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support, to ensure smooth integration of AR into the classroom. This collective effort will enhance the quality and effectiveness of the learning experience, keeping it relevant and engaging for students. To maximize the effectiveness of AR media, lecturers must also anticipate and address practical barriers, such as differences in students' device capabilities, internet access, and varying levels of digital literacy. Providing accessible support materials, offering offline versions of AR content, and ensuring that students receive adequate orientation and guidance will help overcome these challenges.

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