Data and Metadata. 2025; 4:523
doi: 10.56294/dm2025523

ORIGINAL

Android-Based Digital Learning Media: Improving Interactivity in Analysis and Design of Systems Course

Medios de Aprendizaje Digitales Basados en Android: Curso de Mejora de la Interactividad en Análisis y Diseño de Sistemas

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Cite as: Sriwhyuni T, Ambiyar A, Tasrif E, Riyanda AR, Hanafi HF, Hanafi YI, et al. Android-Based Digital Learning Media: Improving Interactivity in Analysis and Design of Systems Course. Data and Metadata. 2025; 4:523. https://doi.org/10.56294/dm2025523

Submitted: 15-04-2024 **Revised:** 23-08-2024 **Accepted:** 02-12-2024 **Published:** 01-01-2025

Editor: Adrián Alejandro Vitón-Castillo

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ABSTRACT

This study aims to develop an Android-based digital learning media to enhance student engagement and understanding in the Analysis and System Design course at Universitas Negeri Padang (UNP). The development of this media was carried out using the Multimedia Development Life Cycle (MDLC) method, which includes the stages of concept, design, material collection, assembly, testing, and distribution. Validation was conducted by experts in pedagogy, design, and technology to ensure the quality of the media, with the validation results showing an average Aiken V value of 0,84, categorized as valid. Additionally, Black Box Testing was performed to ensure that the application's features, such as navigation, content delivery, and task submission, functioned properly. The results of the study indicate that this Android-based learning media is effective in supporting learning, providing flexible access, and increasing student interaction and engagement with the material in the Analysis and System Design course. This media has proven to be a useful tool for improving learning outcomes by presenting multimedia content that can be accessed through Android devices. Future research is expected to develop the compatibility of this media on other platforms and assess its impact on student learning performance.

Keywords: Android-Based Learning Media; Multimedia Development Life Cycle (MDLC); Educational Technology; Validation; Interactive Learning.

RESUMEN

El objetivo de este estudio es desarrollar un de aprendizaje basado en Android para mejorar el compromiso y la comprensión de los estudiantes en el curso de Análisis y Diseño de Sistemas de la Universitas Negeri Padang (UNP). y Diseño de Sistemas de la Universitas Negeri Padang (UNP). El desarrollo de multimedia (MDLC), que incluye las fases de concepto, diseño y desarrollo. que incluye las fases de concepción, diseño, recopilación de material, montaje, pruebas y distribución, montaje, pruebas y distribución. La validación corrió a cargo de expertos en pedagogía, diseño y tecnología para garantizar la calidad de los medios. los resultados de la validación arrojaron un valor V de Aiken medio de 0,84, clasificado como válido. Además, se realizaron pruebas de caja negra para garantizar que las de la aplicación, como la navegación, la entrega de contenidos y el envío de tareas. tareas, funcionaban correctamente. Los resultados del estudio indican que este medios de aprendizaje basados en Android es eficaz para apoyar el aprendizaje, proporcionar y aumentar

la interacción y el compromiso de los estudiantes con el material en el curso de Análisis y Diseño de Sistemas. Este medio ha demostrado ser una herramienta útil para mejorar los resultados del aprendizaje mediante la presentación de contenidos multimedia al que se puede acceder a través de dispositivos Android. Se espera que futuras investigaciones desarrollar la compatibilidad de este medio en otras plataformas y evaluar su impacto en el rendimiento de aprendizaje de los estudiantes.

Palabras clave: Medios de Aprendizaje Basados en Android; Desarrollo Multimedia (MDLC); Tecnología Educativa; Validación; Aprendizaje Interactivo.

INTRODUCCIÓN

Education is not merely a tool for improving living standards but also serves as a fundamental foundation for building high-quality human resources with global competitiveness. The quality of education has long been recognized as a key indicator, influencing not only individual lives but also determining social positioning within society.[1] High-quality education provides greater opportunities for individuals to develop their potential, while at a societal level, education acts as a catalyst for significant social and economic changes.[2,3]

In the context of learning, the process is defined as an interaction involving students, educators, teaching materials, delivery methods, strategies, and learning resources available in a learning environment. The success of learning is assessed by the extent to which educational objectives are achieved through this process.[4,5,6] Instructional media, as one of the main elements in the learning process, plays a strategic role in bridging the transfer of knowledge from educators to students.[7,8,9] Instructional media not only enhances communication efficiency but also creates more engaging and interactive learning experiences. These media can range from physical teaching aids and multimedia presentations to digital platforms such as mobile applications and websites.[10]

Research shows that well-designed instructional media tailored to students' cognitive needs and learning preferences positively impact their motivation and learning outcomes.[11,12] In the digital era, adopting technology has become imperative to create instructional media that are adaptive and relevant to the needs of the current generation. The integration of technology in instructional media enables more personalized, interactive, and contextual learning experiences.[13]

Universitas Negeri Padang (UNP) is one of the higher education institutions committed to developing quality education. Established on October 23, 1954, UNP envisions becoming an outstanding university with an international reputation. With the motto *"Alam Takambang Jadi Guru"* ("Nature as the Ultimate Teacher"), UNP emphasizes the importance of an education system that adapts to global changes.[14,15] One strategic approach employed is *research-based learning* (RBL). This approach emphasizes the development of students' critical thinking skills through inquiry-based and problem-solving strategies.[16] Previous studies indicate that RBL creates a student-centered learning environment, allowing them to explore, hypothesize, and collaboratively solve problems.[17] These findings align with studies revealing that integrating inquiry-based models in RBL enhances student engagement, learning relevance, and concept mastery in real-world contexts.[18,19]

However, several study programs at UNP still face significant challenges in implementing technology-based learning approaches. One example is the Computer Engineering Education program. Students in this program are required to understand complex engineering concepts while mastering practical skills relevant to industry needs.[20,21,22] Nevertheless, resource limitations, insufficient training for educators, and less relevant pedagogical models often become major barriers to effective learning processes.[23,24] Studies have shown that conventional teaching methods, which focus on one-way instruction, are inadequate to meet the diverse needs of computer engineering students.[25,26]

The development of Android-based instructional media has emerged as a viable solution to address these challenges. Android, as an open-source and flexible operating system, offers a significant opportunity to develop innovative learning applications. Its architecture allows the integration of features such as simulations, project-based tools, and interactive activities that align with students' learning needs.[27] Additionally, research demonstrates that Android-based applications provide flexible access for students, enabling them to learn anytime and anywhere.[28,29]

Observations in the System Analysis and Design course reveal that the learning process in this study program is still dominated by conventional teacher-centered methods. This often hinders active student participation in learning. Moreover, a lack of motivation for independent exploration and limited interactive learning resources makeit challenging to comprehend core concepts. These challenges are further compounded when students are required to integrate theoretical knowledge with practical skills relevant to their field.[30,31]

To address these challenges, innovative approaches such as developing digital instructional media using iSpring software can be implemented. iSpring facilitates the design of interactive and engaging learning materials. These materials can then be converted into Android-based applications using platforms like *Web 2*

APK Builder. This approach not only simplifies access but also enhances student engagement in learning through more adaptive and interactive experiences.[32,33]

The development of instructional media is systematically carried out using the *Multimedia Development Life Cycle* (MDLC) method. This method encompasses stages such as needs analysis, design, development, implementation, and evaluation. Through this approach, the resulting instructional media can be tailored to students' cognitive needs and motivations. The media are designed to enable students to actively participate in every learning session, whether individually or in groups. Furthermore, Android-based media provide flexible access that supports the mastery of practical skills relevant to industry demands.[34,35]

This transformation in learning is expected to address students' needs in understanding complex concepts and mastering practical skills. Through a technology-based approach, instructional media not only enhance learning efficiency but also create more engaging and meaningful learning experiences. This solution represents a strategic step in preparing students to face the increasingly dynamic challenges of the workforce.

METHOD

The research method applied in this study is the Multimedia Development Life Cycle (MDLC). The MDLC method is a systematic approach to developing multimedia systems, consisting of six main stages: concept, design, material collection, assembly, testing, and distribution. Although the sequence of these stages may vary in practice, the **concept** stage must always be the initial step.[36,37]

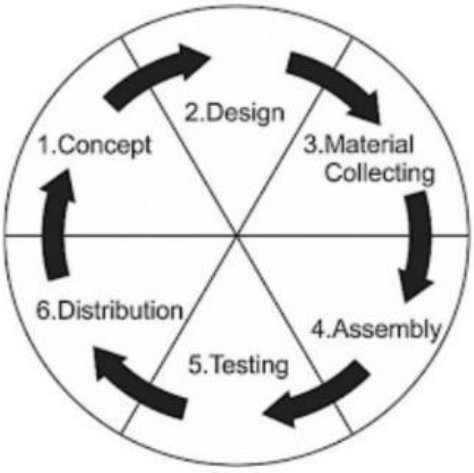

Figure 1. Stages of the Multimedia Development Life Cycle Method [38]

The stages in the Multimedia Development Life Cycle (MDLC) are described as follows:

Concept Stage

The concept stage is a crucial initial step in application development, where in-depth analysis is conducted to formulate the foundational aspects of development. In this stage, key elements are defined, including the application's development objectives, the type of application to be created, and the identification of user needs. This step includes formulating application goals, describing user requirements, and designing the general concept and specifications of the application. In this study, an Android-Based Digital Learning Media was developed by involving four media validators, two subject matter experts, and two media experts to assess the validity of the application. Additionally, to measure practicality, lecturers and students were involved. A total of 18 students enrolled in the System Analysis and Design course were selected as respondents to evaluate the application's practicality.

Design Stage

The design stage focuses on developing the technical and visual specifications of the application. In this stage, the application architecture, visual elements, and user interface are meticulously designed. Each scene within the application is created using storyboards that illustrate the navigation flow and relationships between scenes. This design ensures that the application's interface delivers an intuitive and efficient user experience. Additionally, navigation, aesthetics, and interface layout aspects are considered to optimally support the application's functionality.

Material Collection Stage

The material collection stage involves gathering all necessary resources to support application development. These resources include elements such as text, audio, and images relevant to the application's learning

objectives. The primary focus at this stage is ensuring that all collected materials are of appropriate quality to support effective information delivery within the application. These materials are integrated to produce engaging, informative content that aligns with the learning objectives.

Assembly Stage

The multimedia materials and files collected are systematically arranged and assembled according to the planned design.

Testing Stage

Once the visualizations are completed, testing is conducted to ensure their accuracy and validity before the application is deployed on a broader scale. This testing phase involves applying the developed product in a practical setting. The primary objective of this process is to ensure that the Android-Based Digital Learning Media produced is valid and suitable for use in teaching system analysis and design.

Validity Analysis

The validity of the developed learning media is analyzed descriptively. The data is examined in two forms: quantitative data in the form of numerical scores and qualitative data in the form of verbal descriptions. The results of this analysis are used to evaluate the validity of the developed learning media. The evaluation process involves assessing each validation item using a 1–5 rating scale. The total scores from all evaluators across all indicators are calculated using Aiken's V statistics, as determined by the following formula.[39]

Validity Formula

$$V = \frac{\sum S \qquad \sum S}{[n(c-1)][n(c-1)]}$$

Explanation:
n: Number of research panelists
s: *r* - *lo*
lo: The lowest validity rating value (in this case = 1)
c: The highest validity rating value (in this case = 5)
r: he score given by the evaluator

Table 1. Learning Media Validity Categories

No	Achievement Level	Category
1	0 - 0,667	Valid
2	< 0	Not Valid

RESULT

Concept Stage

Formulating the foundational analysis for the development of an Android-based digital learning media application is a critical step, particularly when defining its objectives and type. The primary goal of this application is to enhance students' understanding, foster engagement in learning, and provide independent access to educational materials via Android-based mobile devices. The development process involves careful planning, including setting objectives, identifying target users, designing a user-friendly interface (UI), and specifying technical requirements. With a well-structured approach, such learning media can serve as an innovative, accessible, and effective educational tool.

The development requires both hardware and software resources. A computer or laptop is essential for development, alongside an Android smartphone or tablet for testing the application. Software tools such as Web 2 APK Builder, iSpring, and design platforms like Figma or Adobe XD are employed for UI design. Validation of the media involves four experts—two focusing on content and two on media design—to ensure its quality and functionality. Practicality testing is conducted with lecturers and 18 students as respondents to measure the application's effectiveness in supporting the learning process. This comprehensive approach ensures the creation of robust and impactful digital learning media.

Design Stage

The design phase is a critical initial step in the development of Android-Based Digital Learning Media. During this stage, developers and designers collaborate to outline the application's architectural specifications, visual

appearance, and user interface (UI). This process emphasizes not only aesthetic aspects but also the functional design of the application to ensure an intuitive and comfortable learning experience.

Storyboards are utilized as tools to visualize the flow of user interactions, illustrating transitions from one screen to another. The navigation structure is meticulously designed to enable users to easily access all application features, thus making the learning process more efficient. Special attention is also given to incorporating native Android elements, such as buttons, menus, and icons, to ensure the application feels familiar and user-friendly for its audience.

Figure 2. Android-Based Digital Learning Media Storyboards

Material Collection Stage

The material collection phase is a strategic step to ensure that the Android-Based Digital Learning Media meets users' needs in the learning process. In this stage, the development team gathers relevant materials, such as instructional texts, illustrative images, explanatory videos, interactive animations, and supporting audio. The materials are sourced from credible references, including textbooks, learning modules, and scholarly journal articles.

These resources are then reformatted into digital content that is easily accessible and comprehensible. Additionally, quizzes and interactive exercises are designed to help users evaluate their understanding of the material being studied. All content is optimized to ensure compatibility with Android devices, maintaining lightweight and responsive application performance.

Assembly Stage

The assembly phase involves integrating all technical elements and learning content into the Android-Based Digital Learning Media. This process includes compiling interactive modules that combine text, images, videos, and simulations to deliver a comprehensive and engaging learning experience. The user interface is carefully designed to be visually appealing and user-friendly, while additional features, such as reminder notifications, interactive quizzes, and progress tracking tools, are incorporated to enhance user engagement. To ensure optimal performance, compatibility, and stability, the application undergoes rigorous testing across various Android devices before its launch.

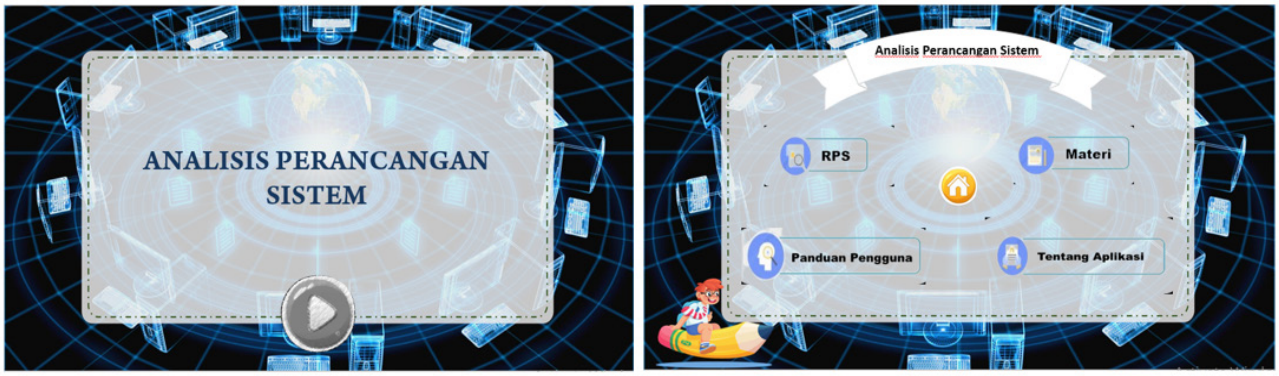

Figure 3. Splash Screen and Main Menu Display

https://doi.org/10.56294/dm2025523

Figure 4. User Guide and About App Display

Figure 5. Material and Quiz Display

Testing Stage

The testing stage is carried out after all development processes are completed, focusing on identifying errors in the application through black box testing. This method evaluates the program based on its functional specifications, aiming to detect functional errors and ensure that the software meets its functional requirements. Black box testing emphasizes the analysis of input conditions to verify whether the system fulfills all functional demands. By running the developed application or media, this type of testing facilitates the identification of errors in the design or code, ensuring that the system operates as intended.

Table 2. Black box testing

No	Testing	Expected Result	Test Result
Splash Screen Testing			
1	Opening the application	Displays the course name and play button	Success
Main Page Testing			
1	Main page	Displays buttons: home, material, main menu, about the application, user guide	Success
2	About APK Button	The button directly leads to the About Application page	Success
3	Material Button	The button directly leads to the meeting list page	Success
4	Meeting Button 1-16	The button leads to the selected meeting material page	Success
5	User Guide Button	The button leads to the user guide page	Success
6	Task Upload Button	The button leads to the Google Form for task upload	Success
7	Back Button	The button leads to the previous page	Success
8	Next Button	The button leads to the next page	Success
9	Home Button	The button leads to the main menu page	Success

https://doi.org/10.56294/dm2025523

In addition to testing the software from a technical perspective, the developers also conducted a validity test on the Android-Based Digital Learning Media. The data collection process for validity was carried out using a questionnaire instrument designed to evaluate various aspects of the media, including the quality of the content and the user interface design. In this test, the questionnaire was distributed to four expert validators tasked with validating the application based on predetermined criteria. The validators included experts in education, design, and information technology, ensuring that the validation results encompassed diverse perspectives.

The validity test focused on two main aspects: the validity of the learning material and the application design. Material validity included the feasibility of the content, its alignment with learning objectives, and its relevance to user needs. Meanwhile, design validity emphasized navigation clarity, interface aesthetics, and ease of use. Data obtained from the questionnaire were analyzed to produce an overall validity score, which is summarized in the following table to provide a clearer picture of the evaluation results for each aspect.

Table 3. Android-Based Digital Learning Media Validation Results

No	Indicator	ΣV	Category
1	Pedagogical Assessment	0,86	Valid
2	Technical Assessment	0,84	Valid
3	Interactivity and Engagement	0,8	Valid
4	Aesthetic Assessment	0,85	Valid
5	Design assessment	0,85	Valid
Average		0,84	Valid

The assessment results conducted by two validators showed that all the tested indicators: Pedagogical Assessment, Technical Assessment, Interactivity and Engagement, Aesthetic Assessment, and Design Assessment, were classified as "Valid," with validity scores ranging from 0,8 to 0,86. The average overall validity score of 0,84 indicates that the evaluated object meets the established standards in these aspects, although there is slight room for improvement in the interactivity and engagement aspect. Overall, these results reflect that the evaluated object possesses good quality and aligns with the expected criteria across the various assessed dimensions.

DISCUSSION

The course Analysis and Design of Systems is highly complex, as it encompasses topics such as system requirements analysis, data modeling, and system design using diagrams like DFD, ERD, and UML. To help students better understand this material, an Android-Based Digital Learning Media was developed to support more interactive and flexible learning. Based on black box testing results, the application functions well without technical issues, including key features such as material navigation, user guides, and task submissions via Google Forms. The successful functionality demonstrates that the application is well-designed to enhance the learning experience, aligning with Nielsen[40] perspective on the importance of intuitive interfaces in ensuring the success of educational technology.

Validation results indicate that this media achieved an average score of 0,84, categorized as valid. Validation was conducted based on five main aspects: pedagogical, technical, interactivity, aesthetics, and design. The pedagogical assessment, scoring 0,86, shows that the media is designed to meet students' learning needs, supporting Mayer[41] theory emphasizing the importance of pedagogical alignment in learning media. Technical and aesthetic assessments scored 0,84 and 0,85, respectively, reflecting a well-designed application in terms of usability and visual appeal.[42] Additionally, A score of 0,8 on the interactivity aspect indicates that this application is able to create an active learning experience and engage students. This proves that interactivity in digital learning can significantly increase motivation and learning outcomes.[43,44]

Android-based digital learning media holds potential for improving students' cognitive skills and engagement. Research by Azizah[45] suggests that interactive multimedia on Android significantly enhances students' cognitive abilities. Moreover, other studies support that Android-based media effectively aids learning for children with learning disabilities, improving their understanding and engagement in the learning process.[46] In other contexts, this media provides interactive learning materials, such as pronunciation guides and animated visuals in English learning, making the learning process more engaging and enjoyable through the use of familiar smartphone technology.[47,48] By offering appealing multimedia content, interactive practices, and flexible access to information, this media has been proven to enhance student understanding, achieving a satisfaction index of 94 %.[49] These findings highlight that technology-supported multimedia approaches can significantly improve the learning experience.

With high validity and supporting empirical evidence, the Android-Based Digital Learning Media proves to be an effective educational tool to support the teaching and learning process in the APS course. This media not only provides flexible access and interactive features but also enhances student engagement and understanding through innovative approaches. This aligns with the research of Ibáñez and Delgado-Kloos[50], which states that technology-based digital media can help students comprehend complex concepts through visual and interactive approaches. With adequate technical and pedagogical design, this media is expected to positively impact the quality of technology-based learning in higher education, supporting a modern and relevant transformation in the digital era.

CONCLUSION

The Android-Based Digital Learning Media application was developed to support learning in the Analysis and System Design course, with materials structured interactively and tailored to student needs. Testing of the application was carried out using two main methods: validation and Black Box Testing. Validation was conducted by experts using five key indicators: Pedagogical Assessment, Technical Assessment, Interactivity and Engagement, Aesthetic Assessment, and Design Assessment. Based on the validation results, the application was declared valid for use as a learning medium. In addition to validation, technical testing was conducted using the Black Box Testing method to ensure that all application features function as expected according to the design.

This application is beneficial for both lecturers and students, providing access to interactive and flexible learning materials through Android devices. Features such as step-by-step design guides, evaluation quizzes, and case studies help students understand concepts more deeply and applicatively. However, the application has limitations as it only supports devices with the Android operating system. Researchers recommend that future studies develop this application to be compatible with various operating systems and further examine its impact on improving student learning outcomes. With further development, this Android-Based Digital Learning Media application can become a more inclusive and effective solution to support learning in the Analysis and System Design course.

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FINANCING

None.

CONFLICT OF INTEREST

None.

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