Development of Android-Based Interactive Multimedia in E-Learning

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Abstract: The utilization of digital media in e-learning has become one of the alternatives to conduct teaching and learning activities more efficiently when faced with challenges such as long distances, a lack of physical learning spaces, shifts in class schedules, and so on. One of the innovations in e-learning is the development of multimedia learning materials that can optimize the learning process and output. The research aims to develop interactive multimedia learning media based on Android for e-learning. The research method used is a development-research, which includes: 1) Research and information collecting; 2) Planning; 3) Developing a preliminary form of product; 4) Preliminary field testing; 5) Main product revision; 6) Main field testing; 7) Operational product revision; 8) Operational field testing; 9) Final product revision; 10) Dissemination and implementation. The product was tested in a class G PGSD (Elementary School Teacher Education) at FKIP University of Lampung with 34 students. Based on the research results, the Android-based interactive multimedia developed was found to enhance students' cognitive skills, with an N-gain score of 0.729, categorized as "High". The implications of this research indicate the importance of utilizing technology in developing instructional media. The positive outcomes of using Android-based interactive multimedia in enhancing students' cognitive skills can serve as a basis for further studies aimed at creating engaging, innovative, and enjoyable learning experiences.

Abstrak: Pemanfaatan media digital dalam e-learning telah menjadi salah satu alternatif untuk melakukan kegiatan belajar mengajar secara lebih efisien ketika dihadapkan dengan tantangan seperti jarak yang jauh, kurangnya ruang belajar fisik, pergeseran jadwal kelas, dan sebagainya. Salah satu inovasi dalam e-learning adalah pengembangan materi pembelajaran multimedia yang dapat mengoptimalkan proses dan output pembelajaran. Tujuan dari penelitian ini adalah untuk mengembangkan media pembelajaran multimedia interaktif berbasis Android untuk e-learning. Metode penelitian yang digunakan adalah penelitian pengembangan, yang mencakup: 1) Penelitian dan pengumpulan informasi; 2) Perencanaan; 3) Mengembangkan bentuk awal produk; 4) Uji coba lapangan awal; 5) Revisi produk utama; 6) Uji coba lapangan utama; 7) Revisi produk operasional; 8) Uji coba lapangan operasional; 9) Revisi produk akhir; 10) Diseminasi dan implementasi. Produk diuji coba di kelas G PGSD (Pendidikan Guru Sekolah Dasar) FKIP Universitas Lampung dengan 34 mahasiswa. Berdasarkan hasil penelitian, multimedia interaktif berbasis Android yang dikembangkan dapat meningkatkan kemampuan kognitif mahasiswa, dengan skor N-gain sebesar 0,729 yang dikategorikan sebagai "Tinggi".Implikasi dari penelitian ini menunjukkan bahwa pemanfaatan teknologi dalam pengembangan media pembelajaran sangatlah penting. Hasil positif penggunaan multimedia interaktif berbasis Android terhadap peningkatan kognitif mahasiswa dapat dijadikan dasar studi lanjutan dalam rangka menciptakan pembelajaran yang menarik, inovatif, dan menyenangkan.

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A. Introduction

The organization of education, research, and community service, known as the tri dharma of higher education, is a fundamental responsibility of academic faculty members. Effective execution of the tridharma within higher education institutions depends on collaboration among all stakeholders, including the faculty members themselves (Lian, 2019). Faculty members are recognized as professional educators and scholars whose primary duty is to transform, advance, and disseminate knowledge, technology, and the arts. Teaching activities are central to the tri dharma in higher education, focusing on knowledge transfer. This responsibility is core to the role of a faculty member as a professional educator.

Faculty members are tasked with transforming knowledge and technology for students in line with their expertise, aiming to help students realize their potential. Instructors often play a critical role in engaging passive students (Mustofa et al., 2019). Given faculty members' significant responsibilities and roles in teaching, they must possess academic qualifications, competence, educational certifications, physical and mental well-being, and meet other qualifications set by their institutions. Faculty members are also expected to contribute to achieving national educational goals through practical learning activities, which are interactive processes between educators and learners.

The global COVID-19 pandemic caused significant disruptions across various sectors, including education. For over two years, education at all levels transitioned to remote learning, resulting in learning loss among students. The Glossary of Education Reform defines learning loss as "the loss or limitation of knowledge and skills related to academic progress, typically occurring due to prolonged gaps or discontinuities in education." Distance learning contributed to this loss due to the suboptimal implementation of teaching activities (Basori, 2017). However, the pandemic also introduced new learning cultures, such as the increased use of digital media in teaching. Tools like Zoom, Google Meet, and various Learning Management Systems (LMS) have become integral to students' learning experiences. Even as in-person teaching resumes, e-learning plays a significant role in education (Syahrul et al., 2022).

Post-pandemic learning is characterized by solid digitization. Technology's role in education is more pronounced, with several key aspects to consider, including synchronous and asynchronous delivery of course materials, the home as a new learning environment, and the importance of blended and flipped learning. These concepts, which existed before COVID-19, have gained greater significance and are guided by technological pedagogical and content knowledge (TPACK). TPACK encompasses content knowledge (CK), pedagogical content knowledge (PCK), and general pedagogical knowledge (GPK). Faculty members must develop digital competencies applicable across various courses, moving towards hybrid learning that combines synchronous and asynchronous content delivery. Consequently, faculty members are expected to create physical and virtual learning environments, utilizing technology effectively (Wahyuningtyas & Rosita, 2019).

Educational Management is a mandatory course for all Faculty of Education and

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Teacher Training (FKIP) students, serving as foundational knowledge for other subjects such as Educational Psychology, Learning and Teaching, and Educational Evaluation. Typically, instructional media for this course include PowerPoint slides, necessitating further explanations from faculty members. Given the theoretical nature of the course, its content needs to adapt to the current digital learning environment. Faculty members are responsible for implementing the curriculum and supporting student learning online. One way to optimize online teaching is by innovating e-learning media.

Information and communication technology significantly impacts education, from management systems to teaching and learning processes. Educators, who now act more as facilitators, must use digital technology creatively and innovatively to engage students and foster critical thinking (Romadiah et al., 2022). Practical media usage is essential for achieving efficient learning processes. Media serve as tools for message distribution, helping educators convey information effectively (Rahmawati & Partana, 2019).

The lack of engaging learning media can hinder knowledge transfer from teachers to students. Learning media that students can use anytime and anywhere is necessary to avoid reliance on classroom-based learning. Effective learning media include teaching aids and means of conveying messages from learning sources to students (Romadiah et al., 2022). Many schools still need engaging learning media, leading to student boredom and decreased motivation to study. This affects their understanding of the material. The rapid technological development changes the educational paradigm, requiring teachers to master and apply technology in learning processes (Suminar, 2019).

One innovation in learning media is the development of interactive multimedia based on the Android platform for e-learning courses. This aims to enhance learning and help students better understand course concepts, aligning with program and learning outcomes. Research indicates that Android-based learning media developed for high school subjects are effective (Kuswanto & Radiansah, 2018; Muyaroah & Fajartia, 2017).

However, interactive multimedia for higher education still needs to be developed. Android smartphones are ideal for mobile learning due to their portability and multimedia capabilities, allowing students to learn independently anywhere and anytime (Eliza et al., 2019).

This research aims to develop interactive multimedia learning media based on Android for e-learning, specifically for higher education students. The specific aim is to analyze the product's feasibility with input from material and media experts and evaluate the effectiveness of its implementation.

B. Method

Research Method and Design

This research is classified as research and development (R&D). The study focuses on creating interactive multimedia-based Android learning materials for the concept of School-Based Management (SBM). The developed learning media aims to help students master educational management concepts, particularly in the SBM subject. This research follows

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the development procedure Borg & Gall (2003) outlined. The development model includes the following steps: 1) Research and information collection; 2) Planning; 3) Developing the preliminary form of the product; 4) Preliminary field testing; 5) Main product revision; 6) Main field testing; 7) Operational product revision; 8) Operational field testing; 9) Final product revision; and 10) Dissemination and implementation.

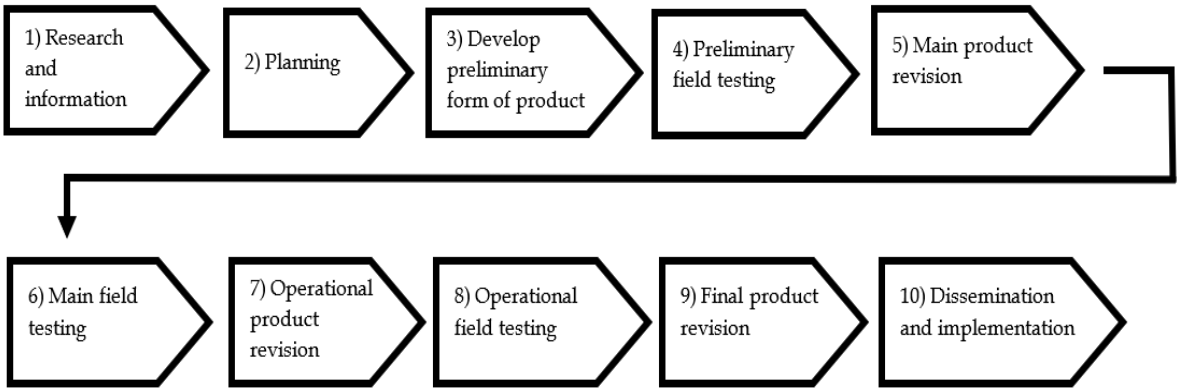

Figure 1. Stages of the development procedure by Borg & Gall

Research Subject

The subjects of this research comprise all 34 third-semester students from the Elementary School Teacher Education program in class G. A census sample is used, meaning the entire population of 34 students, including 5 males and 29 females, is included in the study. The research will be conducted at the Faculty of Teacher Training and Education (FKIP), Campus B, on Jl. Soekarno Hatta 16C, Mulyojati Village, Metro Barat Sub-district, Metro City, Lampung Province.

Research Instrument

Data collection techniques in this research involve two instruments:

- Questionnaire
  The instruments include two phases: an expert validation questionnaire and a user response questionnaire. The expert validation questionnaire assesses and collects data on the developed product's suitability as a learning medium. Meanwhile, the user response questionnaire gathers data on the product's attractiveness, ease of use, and utility.
- Tests (pretest and posttest)
  Data from pretests and post-tests are used to measure the product's effectiveness in improving students' understanding of the learning material.

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Data analysis techniques

This research employed quantitative-descriptive approaches. Quantitative descriptive data analysis involves expert validation and student response data regarding the interactive multimedia product based on Android. The data is converted into interval data, and the rating scale used results in scores that are then converted into data on a five-point Likert scale. The data analysis technique also assesses the product's effectiveness in improving students' understanding of the learning material by calculating the N-Gain from the pretest and post-test results. The equation formulated by R. R. Hake (Ismail et al., 2019) is applied to calculate the normalized gain and its classification as follows:

$$\text{N-Gain}=\frac{\text{Postest Score}-\text{Pretest Score}}{\text{Max Score}-\text{Pretest Scor}}$$

The categorization of the normalized gain as high or low is described in Table 1 (Sugiyono et al., 2007).

Table 1. Gain Values and Its Classification

Gain	Classification
$\langle g\rangle \geq 0{,}7$	High
$0{,}7 > \langle g\rangle \geq 0{,}3$	Moderate
$\langle g\rangle < 0{,}3$	Low

C. Result and Discussion

Result

This section is the central part, where we present the results and discuss the research and development conducted using the Borg & Gall (2003) development model. Below is a detailed explanation of each stage in the product development process:

1) Research and Information Collecting (Preliminary Study)

In this stage, both field studies and literature reviews were conducted. The field studies aimed to gather information about the fundamental issues determining the necessity of developing interactive multimedia (needs analysis). A needs analysis systematically determines and evaluates individuals, organisations, and communities' requirements, gaps, and objectives. It involves gathering and analyzing information (Sofyan & Nasution, 2022). These field studies were carried out through observations, and the findings were as follows:

- A new learning culture has emerged, characterized by the increased use of digital media for teaching and learning. Students can access tools like Zoom Meeting, Google Meet, and various digital learning management systems (LMS) on their smartphones.
- Digital media is an alternative for more efficient teaching and learning when faced with challenges such as long distances, a lack of physical classroom space, or shifts in class schedules.

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- Many instructors still primarily use simple learning materials like PowerPoint presentations, documents, PDFs, etc., with limited exploration of technology-based learning materials, especially Android-based multimedia.
- There is a high demand for engaging learning materials to enhance the effectiveness and efficiency of course content delivery.
- Students' mastery of course material, particularly in e-learning, could be more optimal.

2) Planning

The data gathered from the initial study were employed to strategize the development of Android-based interactive multimedia. Planning is crucial in optimizing resource utilization and transforming it into a viable product. Moreover, planning provides guidance and impetus for effective administrative decision-making (Huda & Marsono, 2021). The planning process encompassed:

a. Defining the research objectives, specifically to create Android-based interactive multimedia for integration into e-learning courses.
b. Identifying student characteristics relevant to the context.
c. Establishing indicators for Course Program Learning Outcomes (CPMK) about the Educational Management course, mainly focusing on School-Based Management (MBS) content.
d. Drafting a preliminary design for Android-based interactive multimedia.
e. Strategizing the product testing phase.
f. Developing the preliminary form of the product (product draft).

3) Develop a Preliminary Form of the Product (Product Draft)

Findings from the preliminary study and research planning guided the product draft development. During this phase, the researcher crafted an initial version of Android-based interactive multimedia, focusing on analyzing tools/app inventors, typography, colour schemes, and imagery tailored to student characteristics. The development process adhered closely to the educational content elements specified in the Course Program Learning Outcomes (CPMK), particularly emphasizing the School-Based Management (MBS) sub-topic.

Subsequently, a flowchart and storyboard were generated. The flowchart delineated the narrative progression of the interactive multimedia, mapping out the user's journey from start to finish. This was followed by the design of the storyboard, which provided a visual representation and a comprehensive overview of the application. The storyboard was a visual blueprint for the project (Hamdani et al., 2022).

Once the flowchart and storyboard were finalized, the Android-based interactive multimedia development commenced. The application was constructed using www.kodular.io, an online platform for creating applications that offer free access without usage limits. Like MIT App Inventor, Kodular employs block programming (Al-Khalifa et

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al., 2019), allowing for flexible block customization (Alda, 2020). Various assets, such as images (icons), sound, and logos, were integrated throughout development. Tasks included inserting objects, implementing actions, applying button effects, establishing navigation, incorporating games, integrating audio and video, creating animations, and implementing pop-ups. The interactive multimedia featured text, images, videos, animations, simulations, quizzes, and games.

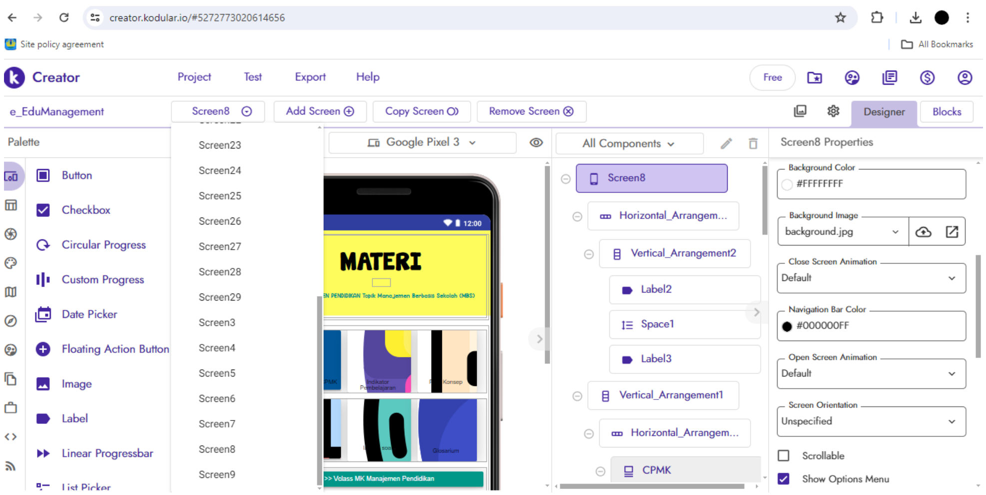

Figure 2. Create Android-Based Interactive Multimedia Design

4) Preliminary Field Testing (Expert Judgment)

The initial field testing engaged media experts to evaluate and collect data on the usability of the learning product. Insights gathered from this preliminary trial will inform enhancements during the Main Product Revision phase. Critical expert assessments include:

- The interactive multimedia content is comprehensive and well-developed.
- Custom instructional videos are effectively incorporated.
- The user interface of the learning media is engaging.
- It functions effectively across different devices.
- Recommendations for improvement in the Main Product Revision phase include refining language usage in videos within the Android-based learning media and enhancing developer identification accuracy.

5) Main Product Revision

Based on the preliminary field testing findings, the development team undertakes several revisions to enhance the product. Utilizing data from the initial testing phase, they reconfigure the product development process and make necessary adjustments. Insights from media experts suggest improvements aimed at enhancing feasibility. Additionally, expert feedback emphasizes the need for more varied and formal designs to increase student engagement during learning sessions.

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Table 2. Comparison of Product Revisions

No	Before	After
1.	Initial Interface Display of the Application	 The application's front page has been updated to include a logo
2.	 The initial content page without a references section	 The Content page with a references section
3.	 The initial user guide page without audio guidance	 The user guide page with audio guidance

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6) Main Field Testing (Expanded Testing)

The extended field testing aimed to evaluate the initial product with students to gather data on its suitability as a learning tool, specifically focusing on its format, content, and language aspects. Findings from this extended testing phase will guide enhancements in the Operational Product Revision stage.

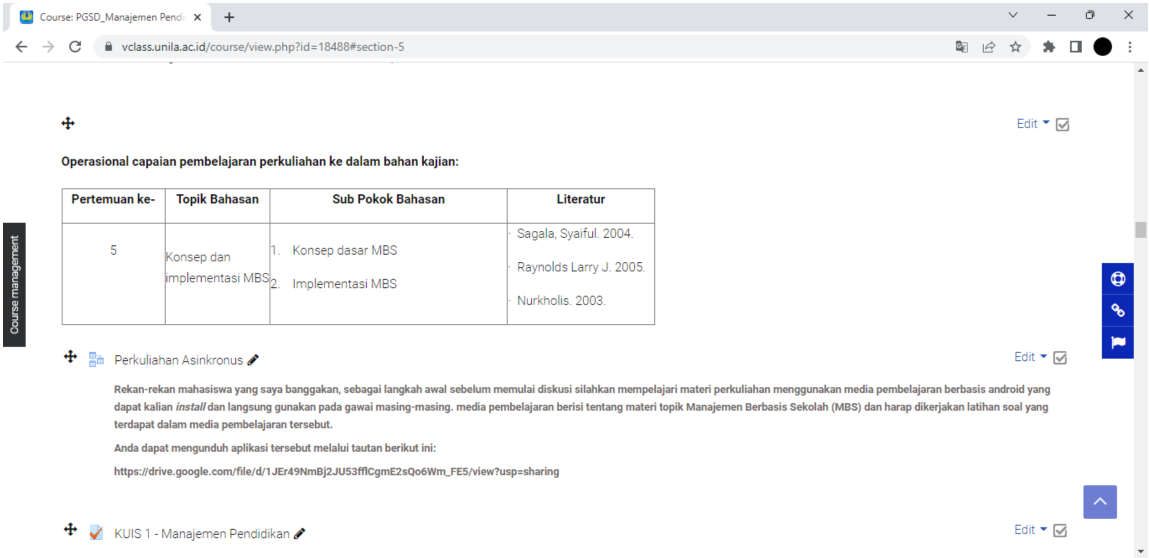

Figure 3. Students can download the application through the Learning Management System (LMS) called https://vclass.unila.ac.id/

The data gathered regarding student responses to the feasibility of the interactive multimedia product encompassed categories such as strongly agree (SA), agree (A), neutral (N), disagree (D), and strongly disagree (SD). Below is the table illustrating the percentage of student responses:

Table 3. Percentage of Student Responses Regarding the Feasibility of Android-Based Interactive Multimedia Product

Aspect	Feasibility				
	SD	D	N	A	SA
Format	-	-	-	73%	27%
Content	-	-	-	65%	35%
Language	-	-	-	61%	39%
Average Score	**-**	**-**	**-**	**66,33%**	**33,67%**

Based on the data presented in Table 3, an average of 66.33% of the students agreed on the product's feasibility in terms of format, content, and language. Furthermore, 33.67% of students strongly agreed with its suitability. These findings indicate that the product is well-suited for use as a learning medium.

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In the space provided by the researcher, students also shared their impressions and suggestions about the application. Overall, students responded positively to the application. The majority found it easy to use, appreciated its colourful appearance, found the learning content easy to understand, and expressed happiness with the abundance of learning materials provided by the application.

7) Operational Product Revision

The development team will use the data to re-plan and revise the product based on the main field testing results. Students have provided valuable suggestions to enhance the application's quality. For instance, they recommended ensuring compatibility across all mobile operating systems, addressing existing bugs, and expanding the range of learning materials. Overall, these suggestions from students are constructive and will be carefully considered when finalizing the application.

8) Operational Field Testing (Operational Test Results)

We proceeded with operational testing after making revisions based on preliminary and expanded testing results. This operational test aimed to evaluate the effectiveness of the Android-based interactive multimedia in enhancing students' comprehension of the course material in line with CPL-prodi and CPMK standards. The outcomes from this operational test will inform further improvements during the Final Product Revision phase.

The operational test was conducted online, with each student using their device. It involved three stages: 1) Pretest, Administered to gauge students' initial understanding of the course material; 2) Application: The research sample used the Android-based interactive multimedia for the School-Based Management (MBS) course; 3) Post-test, Administered to assess students' understanding after using the product.

Pretest and post-test data were scored using the Rights Only method, where correct answers received a score of one and incorrect answers received a score of zero. The number of correct answers calculated each student's score. The product's effectiveness in enhancing conceptual mastery was evaluated using the normalized gain score, calculated using R. R. Hake's formula (Ismail et al., 2019). A summary of the N-Gain scores from the pretest-posttest results using the Android-based interactive multimedia is presented in the following table.

Table 4. N-Gain Results from Pretest-Posttest

Average (*Pretest*)	Average (*Post-test*)	Gain	N-Gain
48	86,3	38,3	0,729

Based on Table 4, the N-Gain value is 0.729, classified as a high improvement. According to Hake's Rule, a score of g≤0.70 indicates significant improvement.

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Consequently, it can be concluded that using Android-based interactive multimedia effectively enhances students' conceptual understanding.

9) Final Product Revision

This stage ensures that the developed product accurately meets the desired specifications and has been tested for effectiveness. The final product of the development process is presented below.

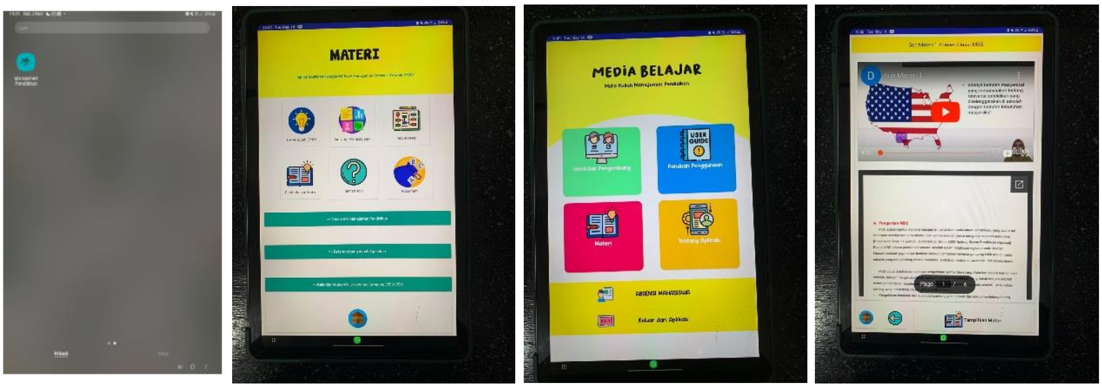

Figure 4. Interactive Multimedia Display Based on Android Accessible via Smartphone

10) Dissemination and Implementation

The next phase involves dissemination and implementation based on the product testing results and subsequent revisions. In this phase, dissemination will be achieved by presenting at international conferences such as [ICOPE](http://icope.fkip.unila.ac.id/) and publishing in academic journals. Implementation will involve incorporating the Android-based interactive multimedia into the entire curriculum of the Educational Management course.

Discussion

The creation of Android-Based Interactive Multimedia stemmed from the needs analysis conducted in the first stage of this research, which revealed a high demand for engaging learning materials to enhance the effectiveness and efficiency of course content delivery. This finding aligns with prior research, demonstrating that teachers can improve online learning by combining synchronous learning with video recordings, interactive quizzes, and learning management systems (Safitri et al., 2022).

A literature review was conducted following the preliminary study to gather relevant information supporting the product's development. According to the literature, learning media is crucial in achieving educational objectives by effectively conveying learning content. Martono (2014) asserts that learning media can overcome limitations of space, time, energy, and senses while fostering a passion for learning. The development of learning media, including android-based technology, is essential to addressing issues in the

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learning process (Wijaya et al., 2021). Given the rapid development and widespread use of smartphones, android-based learning media is a promising area (Sunaryo et al., 2021). Research by Malik & Asnur (2019) found that higher education students use smartphones and social media daily.

Adding digital content to a course requires careful planning to create engaging materials that add value and emphasize key concepts. Whether implementing lecture capture technology or redesigning a course in an inverted format, careful consideration is necessary to prioritize important content. The research results indicate that the produced Android-based interactive multimedia is suitable for use as a learning medium and is feasible regarding format, content, and language. This conclusion is supported by the application's ease of use, colourful appearance, comprehensible learning content, and ability to provide a wealth of learning materials, making students happy. Brečka & Červeňanská (2015) also state that interactive multimedia learning positively influences students' learning motivation. Effective interactive learning multimedia should have clear competencies and objectives, user instructions, material delivery clarified with images and animations, engaging activities like games and quizzes, and interactivity through feedback responses to enhance learning enjoyment (Syuhendri et al., 2021).

Moreover, the Operational Field Testing stage demonstrated significant improvement based on pretest and post-test results, confirming that Android-based interactive multimedia effectively enhances students' conceptual understanding. These findings are consistent with previous research by Putri (2019), which indicated that multimedia learning positively impacts student achievement, as evidenced by higher post-test scores compared to pretest scores without multimedia learning. Hamimi & Sari (2018) also found that Android-based interactive multimedia can improve learning outcomes in chemistry. Android-based learning multimedia supports personalized learning with independent access, centring the learning process on the student. This aligns with the Constructivist Approach philosophy, which encourages students to construct their knowledge. Additionally, the success of Android-based learning multimedia depends on providing learners with diverse opportunities to access and utilize the information available within the application.

D. Conclusion

The findings and discussions show that using Android-based interactive multimedia learning materials effectively enhances students' cognitive skills. Improved learning outcomes are demonstrated through pretest and post-test responses, with an N-gain score of 0.729, categorized as "High." Additionally, 66.33% of the students agreed on the product's feasibility in format, content, and language, while 33.67% responded 'Strongly Agree,' indicating the product's suitability as a learning medium.

Developing android-based interactive multimedia using www.kodular.io demonstrates that creative approaches to using interactive multimedia can effectively improve conceptual understanding and students' cognitive skills, enriching the learning

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experience for teachers. The use of Android-based interactive multimedia as a learning tool also has the potential to enhance learners' understanding and motivation. Furthermore, this research provides valuable guidance for teachers in developing innovative learning methods, including using digital technology to create learning media. The positive outcomes of using Android-based interactive multimedia in enhancing students' cognitive skills can serve as a basis for further studies aimed at creating engaging, innovative, and enjoyable learning experiences.

Educators are recommended to apply creative, even if simple, learning media to support the effectiveness of the teaching and learning process. Future researchers are encouraged to develop innovative learning multimedia with better designs and more comprehensive materials to continue improving learning outcomes.

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