Android-Based Mobile Learning Application Using App Inventor on Computer Operating System Material: The Development and Validity Study

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Abstract **–Mobile learning apps are widely acknowledged for their effectiveness in enhancing learning results. This study aims to develop and validate an Android-based mobile learning app for computer operating system principles. Using the user-friendly App Inventor platform known for visual programming, it integrates interactive modules and multimedia for diverse learning styles. The study adopted a Research and Development approach following the ADDIE model (analysis, design, development, implementation, and evaluation). The research was conducted at Universitas Negeri Padang and Universitas Muhammadiyah Muara Bungo and involved 10 participants. The analysis of questionnaire-based data conducted by media and material experts categorized the Android-based learning media as "Appropriate", achieving an over-all average of 82.51% and 82.29%, respectively. Meanwhile, student evaluations rated this media as "Feasible" with a score of 82.72%.**

In conclusion, the development of this Android-based mobile learning application for computer operating system material demonstrates significant potential as an innovative educational tool. The validation process highlighted its potential effectiveness and offered valuable recommendations to enhance its educational value. These findings make a meaningful contribution to the ongoing discourse surrounding the integration of technology-driven learning approaches into traditional education, benefiting educators and developers seeking to create impactful mobile learning experiences.

Keywords **– Android-based mobile learning, app inventor, computer operating system, development, validity study.**

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1. Introduction

In the rapidly evolving landscape of education, technology has emerged as a pivotal driver of transformative learning experiences [1], [2]. Mobile devices and applications have played a substantial role in reshaping how knowledge is accessed and assimilated [3]. The integration of mobile learning applications into educational settings has garnered significant attention due to their potential to enhance engagement, interactivity, and accessibility [4]. These applications hold the promise of providing learners with dynamic and personalized learning experiences, especially in complex subjects like computer operating systems [5], [6].

This study delves into the domain of mobile learning, focusing on the development and validation of an android-based mobile learning application specifically designed to facilitate the understanding of computer operating system concepts.

The ubiquity of smartphones and the adaptability of the android platform make it an ideal medium for delivering educational content in a convenient and interactive manner [7]. This research project centers on the creation of such a mobile learning application, employing the app inventor platform renowned for its user-friendly interface and visual programming approach [8].

The primary objective of this research is to rigorously assess the validity and educational efficacy of the developed android-based mobile learning application. This entails a comprehensive examination of the application's content accuracy, relevance, and overall pedagogical value. By conducting a validity study, this research aims to ascertain the extent to which the mobile learning application aligns with established educational standards and effectively serves as a supplementary tool for comprehending computer operating system material [10]. To ensure the integrity and practicality of the developed mobile learning application, expert educators, and subject matter specialists in the field of computer science are engaged in the validation process. Their insights and feedback play a critical role in refining and optimizing the application's content and structure [11].

The significance of this research lies in the potential contribution to the educational technology domain by providing a validated and effective android-based mobile learning solution for computer operating system concepts. The outcomes of this study hold implications for educators, curriculum developers, and educational technologists seeking innovative ways to enhance learning experiences through technology-driven mediums. Ultimately, this research strives to bridge the gap between traditional pedagogical approaches and contemporary mobile learning solutions, fostering a more engaging and effective learning environment.

2. Literature Review

The integration of technology, particularly mobile devices, and applications, into education has revolutionized the learning landscape, offering unprecedented opportunities for engaging and personalized learning experiences [12]. As mobile devices become ubiquitous, the utilization of mobile learning applications has gained prominence due to their potential to enhance the accessibility and effectiveness of education across various subjects [13]. This literature review explores the existing body of knowledge related to mobile learning applications, particularly their development and validation, within the context of computer operating system material [14].

Mobile learning, often referred to as m-learning, involves the use of mobile devices to facilitate learning and knowledge acquisition [15]. These devices offer learners the flexibility to engage with educational content anytime and anywhere, thereby extending learning beyond traditional classroom settings [16]. The interactive nature of mobile learning applications has been shown to increase learner engagement and motivation, promoting a deeper understanding of complex subjects [17]. App Inventor, a visual programming platform, has garnered attention for its user-friendly interface that allows individuals with limited programming experience to create mobile applications [18]. This platform empowers educators and developers to design apps that cater to specific educational needs, enabling the creation of interactive and engaging learning experiences [19].

The efficacy of mobile learning applications is contingent upon their content validity, accuracy, and alignment with educational objectives [20]. Validation studies play a pivotal role in ensuring that these applications meet pedagogical standards [21]. Expert reviews, user evaluations, and empirical studies are common methods used to assess the effectiveness and usability of mobile learning applications [22]. Computer operating system concepts constitute a fundamental part of computer science education. These concepts are often intricate and require interactive engagement for comprehensive understanding. Mobile learning applications offer a unique platform to present these concepts using multimedia elements, catering to diverse learning preferences, and enhancing knowledge retention.

Validation studies employ various research methodologies to assess the effectiveness of mobile learning applications. These methodologies include expert reviews by educators and specialists in the subject domain, user feedback gathered through surveys and usability testing, as well as empirical evaluations of learning outcomes. The utilization of mobile learning applications, such as the Android-based app developed using App Inventor for computer operating system material, holds significant implications for both educators and learners [24]. These applications provide educators with tools to deliver content in innovative ways, fostering active learning and engagement. Learners benefit from interactive and flexible learning experiences that accommodate their individual learning styles [26].

The literature highlights the transformative potential of mobile learning applications in reshaping education [27]. In line with the trend of integrating technology into education, this study focuses on developing an Android-based mobile learning application for computer operating system material using the App Inventor platform [28].

The importance of a validation study cannot be underestimated, as it serves to validate the educational benefits of the application, ensuring its efficacy in improving learning outcomes. Research studies in line with this research contribute to the ongoing discourse around technology-based education and the creation of validated mobile learning solutions that meet the diverse needs of learners in the digital age [29]. This research has high relevance to technological developments and the evolving challenges of education in the digital era. Mobile technology, particularly Android, has great potential to enhance the learning experience. The main objective of this research is to improve the quality of education by developing an innovative Android-based learning platform, capable of supporting conceptual understanding and practical application for master's level students. In addition, this research addresses a long-standing problem by criticizing the use of App Inventor in the creation of Android-based educational applications for desktop operating systems. The research also involved three stages of validation by media experts, academics, and students to ensure the effectiveness and applicability of the research results. By providing more effective teaching methods and encouraging long-term innovation, the findings from this research possess the potential of having a significant positive impact on education in the digital age.

This research has valuable implications and important specific objectives. The implications include improving the quality of education through the development of an innovative Android learning platform, filling a gap in previous research with the use of App Inventor, and validation by experts and students to maintain the quality of the research results. This research also has the potential to have a positive impact on education and encourage innovation in educational technology. Therefore, this research is important to improve students' learning experience in the digital era and meet the growing needs of education.

3. Methodology

The research methodology used in this study is the Research and Development (R&D) method, which is used to create specific products and assess their effectiveness. The development process involves creating a learning design using the ADDIE approach which stands for Analysis, Design, Development, Implementation, and Evaluation. The following development design is presented in Figure 1.

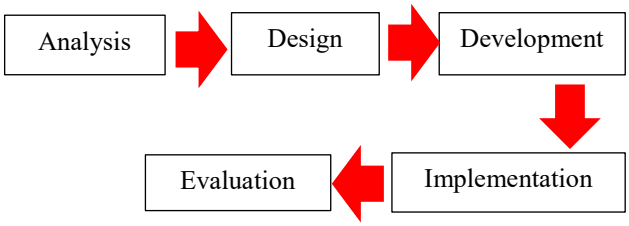

Figure 1. ADDIE development design

3.1. Sample

The sample consisted of 10 students enrolled in the Faculty of Engineering, Universitas Negeri Padang (UNP) and the Faculty of Teacher Training and Education, Universitas Muhammadiyah Muara Bungo (UMMUBA). The students took the operating system course in the third semester of the 2023 academic year.

3.2. Data Collection Technique

Data collection in this research involves two primary methods: participatory observation and questionnaires. Participatory observation entails direct engagement with the data source, encompassing observations of various aspects related to campus life, including classroom dynamics and the effectiveness of teaching and learning tools in promoting independent student learning. On the other hand, questionnaires are utilized to evaluate the effectiveness of android-based learning media. These questionnaires are administered to media experts, subject matter specialists, and students. Media and material expert questionnaires aim to assess the quality of the learning media and its associated materials, while student questionnaires gauge the practicality and usefulness of the android-based learning media in an educational context.

3.3. Research Instruments

The validity instrument comprises media validation and material validation. Media validation employs a questionnaire validated by media experts to assess the suitability of the media for learning purposes. Material validation employs a questionnaire validated by material experts to gauge the depth of the material and its relevance to the expected competencies. The steps involved in creating a validation questionnaire are as follows:

a. Create a questionnaire grid.
b. Define the validation aspects.
c. Analyse the validation aspects into several indicators.
d. Determine the required number of question items for each indicator.

e. Organize the question items based on the predetermined indicators.
f. The validation instruments for media experts and material experts use a Likert scale with the following ratings: 4 = very good, 3 = good, 2 = fair, 1 = poor.

The validation grid for Android-based mobile learning, as assessed by media experts and material experts, is presented in Table 1 and Table 2.

Table 1. Media expert validation questionnaire instrument

Aspect	Indicator
Ease of use navigation	Login page and main page layout
	Menu and icon presentation clarity
	User profile, material, discussion room, and message pages
	Media logo, layout, and multimedia display clarity
Aesthetics	Ease of installation and media navigation
	Ease of use of provided media features
Media integration	Font style and size selection
	Text readability in media and material
Technical quality	Response speed of the media
	User interaction
	Media accessibility ease

Table 2. Material expert validation questionnaire instrument

Aspect	Indicator
Suitability	The extent to which the app's appearance and navigation facilitate users to find and access materials
	Ease of installing and navigating the app
	The application is suitable for use as a computer operating system learning tool
Content Quality and Relevance	Quality of content presented in the app
	The app is in-depth and relevant enough to achieve the competencies
Instructional Quality	Use of multimedia in this app to enhance learning engagement
	The app provides good guidance on how to use the Android-based learning platform

The user trial data analysis instrument is presented in Table 3, using a Likert scale with the following options: 4 = very good, 3 = good, 2 = fair, 1 = poor.

Table 3. Student evaluation validity questionnaire instrument

Aspect	Indicator
Ease of use and navigation	Level of ease in navigating the application
	Navigation function in the app
Clarity of presentation	Ease of understanding the content of the material presented in the application
	The level of clarity of explanation in the material
Aesthetic	Overall visual appearance of the application
	Overall visual appearance of the app
Instructional quality	Quality of learning materials presented
	Interactive level of learning material

3.4. Data Analysis Technique

Learning media validation data is obtained through expert judgment, namely validators consisting of media experts and material experts who provide input. These inputs are then analysed to improve the learning media being developed. The validation analysis of web-based learning media involves the following steps:

a. Determining the answer score criteria as follows: 4 = very good, 3 = good, 2 = fair, 1 = poor.
b. Giving validity value using Aiken's formula:
   $V = (\sum(s)) / [n(c-1)]$
   Where:
   V = validity value
   s = r – lo
   lo = the lowest validity assessment number (in this case = 1)
   c = the highest validity assessment number (in this case = 4)
   r = the number given by the validator.

To determine the level of validity using a range of V numbers that range from 0 to 1.00. If the number in this range is ≥ 0.667, it can be interpreted as a high V coefficient, and the validity category can be categorized as " Feasible".

4. Development and Research Results

The research implementation process is bifurcated into two stages. The first stage involves the development of an innovative Android-based learning application designed to enhance understanding of computer operating system concepts. Subsequently, the second stage focuses on evaluating the validation of the tools developed in the results stage of the research. The following are the stages of developing an android-based mobile learning application using App inventor:

4.1. Development Results

The outcomes derived from this development effort manifest as Android-based learning media designed for Computer Operating System material. This resultant application is encapsulated within a (.apk) file format and can be installed on an Android-operating-system-equipped smartphone. The development process follows the systematic stages of the ADDIE development model: Analysis, Design, Development, Implementation, and Evaluation. The ensuing sections elucidate the outcomes within each of these stages:

Analysis Stage. This stage involves examining and identifying problems within a specific environment, thus generating ideas to guide the development of the desired product. The purpose of this stage is to determine potential reasons for performance gaps. The analysis stage consists of the following steps: (1) Identification of learning challenges related to computer operating system subjects, (2) Formulation of appropriate learning objectives for computer operating system materials, (3) Characterization of student characters, (4) Identification of required resources, (5) Determination of appropriate learning strategies, (6) Creation of a comprehensive learning management plan.

Design Stage. In this stage, a flowchart is created to detail the sequence and architecture of the learning media. In addition, storyboards are used to outline the template design scheme and interface design. The flowchart serves as the basis for the storyboard, which allows the creation of a design plan that aligns with the structure of the media. Storyboards provide an initial outline of the envisioned appearance of the learning media, which includes content, layout, and incorporated elements. This storyboard, in turn, serves as a blueprint for creating the interface design, which translates the storyboard into a tangible representation. This phase carefully addresses attributes that are specific to the learning media.

The initial step in the design phase is to create a learning media flow chart, as visualized in Figure 2 below:

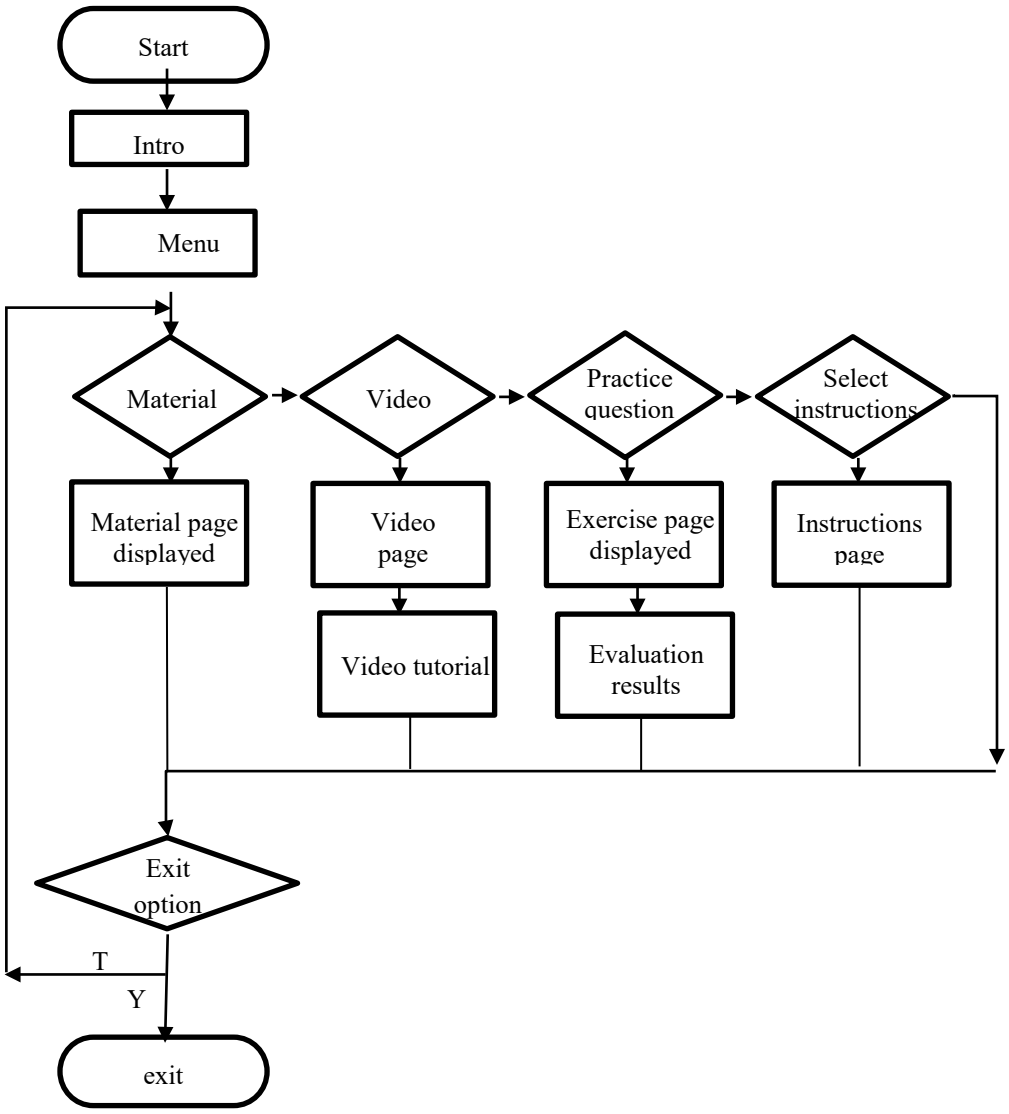

Figure 2. Flowchart of android-based mobile learning

Development. The development stage is an important phase in the creation and testing of the product, where the results of analysis and design are transformed into the final product. The initial design, created using CorelDRAW X7 software, was then translated into a tangible product through application development using the Thunkable platform. The resulting file took the form of a (.aia) file, accompanied by a plugin extension (.aix). This plugin includes Java programming language code (.java), which is converted into a plugin file (.aix) for use in the extension section. Next, we will explain the development process of the Android-based mobile learning application. This information is presented through the login page interface image in Figure 3.

Figure 3. Login page interface

This login page has three components, consisting of two images and one label. The first image serves as the logo for the mobile learning operating system screen, with an iconic image of Windows. The second image serves as the login display to improve the aesthetics of the interface before switching to the next screen. In addition, there is a windows label that is used to display the name of the computer operating system learning media (.apk). next, the menu page interface, presented in Figure 4.

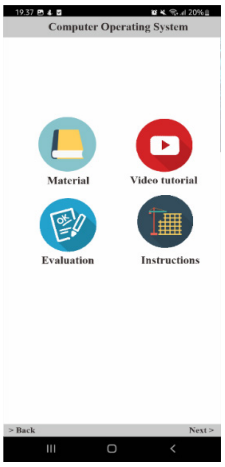

Figure 4. Menu page interface

The main menu comprises four images, four buttons, and two additional buttons (back and next). The "Material" button provides access to computer operating system course materials, while the "Video" button offers a tutorial on operating system installation. The "Evaluation" button facilitates practice exercises and assessments, and the "Instructions" button offers guidance on using the Android-based mobile learning platform application. Next, the video tutorial page is depicted in Figure 5.

Figure 5. Video tutorial

This video tutorial selection page includes a video tutorial on computer operating system installation, with a summary of the material presented below the video. There is a "Back" button to return to the previous page and a "Next" button to navigate to the next page. This video tutorial focuses on guiding the installation of the Windows 10 operating system using a flash disk. Furthermore, the interface page for evaluation can be seen in Figure 6.

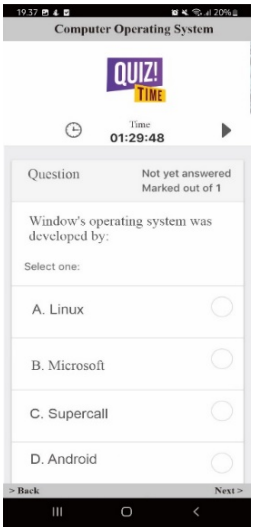

Figure 6. Evaluation

On the evaluation exercise page, there are 4 components, namely the quiz time logo, 1 time button, questions, and test questions. In the question section, there are evaluation questions that students must answer by pressing the answer button, and there are also back and next buttons. The evaluation page presents a total of 20 questions randomly and will display the score after answering all questions.

Implementation. In this stage, the Android-based mobile learning application that has passed validation through small group trials and peer review has been implemented to students who already have a basic understanding of computer operating systems. This Android-based mobile learning platform consists of several applications distributed to students, so that each student can download and use it on their respective smartphones.

Evaluation. this stage is a process to examine or determine how valuable something is in a certain context, with a certain purpose. In education, evaluation serves as a measuring tool to achieve educational goals. One type of evaluation that is commonly used is formative evaluation, which is applied to all the stages previously described. Formative evaluation is used before the final product is used, with the main purpose being to improve the product being developed. After going through trials by media experts, material experts, and small groups, the learning media developed at the development stage will be refined at this evaluation stage. The changes applied to the Android-based mobile learning at this review stage are based on the feedback and ideas received, aiming to create a high-quality final product.

4.2. Research Results

The second stage is testing the research results, where this stage focuses on evaluating the validation of the android-based mobile learning platform that has been developed to improve the effectiveness of student learning outcomes on computer operating system material. The following is the research result data:

4.2.1. Media Expert Assessment

The evaluation conducted by media experts involved a questionnaire comprising 20 questions, each rated on a Likert scale ranging from 1 to 4. With input from two media experts, the highest possible score for all questions related to ease of use and navigation amounted to 24. In terms of the aesthetic aspect, the maximum score attainable was 28, while media integration carried a maximum score of 16, and technical quality held a maximum score of 12.

By comparing the actual score obtained with the maximum possible score as determined by these two media experts, the feasibility percentage can be accurately calculated. For a more comprehensive breakdown of the media expert assessment data, please refer to Figure 7.

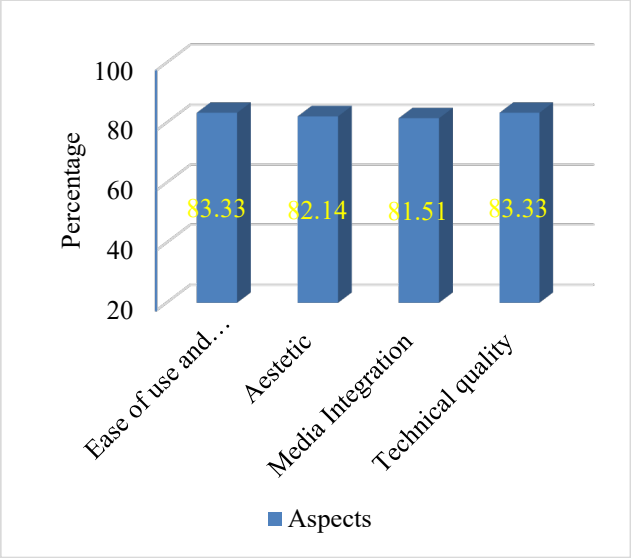

Figure 7. Analysis of the data from the media expert assessment

Utilizing the data presented in Figure 7, the outcomes pertaining to media feasibility percentage scores are as follows: The aspect of ease of use and navigation attains a feasibility percentage of 83.33%, affirming its feasibility. The aesthetic aspect achieves a feasibility percentage of 82.14%, similarly obtaining the feasibility status. The media integration facet secures a feasibility percentage of 81.25%, while the technical quality aspect garners a feasibility percentage of 83.33%. With a cumulative score of 82.51%, the Android-based computer operating system learning media is conclusively categorized as "Worthy" for application.

4.2.2. Material expert assessment

Material expert testing is designed to assess the feasibility of learning media content. This assessment was conducted by lecturers who are experts in teaching Operating System courses. The material expert assessment uses a questionnaire consisting of 20 questions, each of which is rated on a Likert scale ranging from 1 to 4. It should be noted that the maximum score for the suitability aspect, the maximum score that can be achieved is 16 while the quality of media content and objectives has a maximum score of 32, and instructional quality has a maximum score of 32. The results of the material expert testing are illustrated in Figure 8.

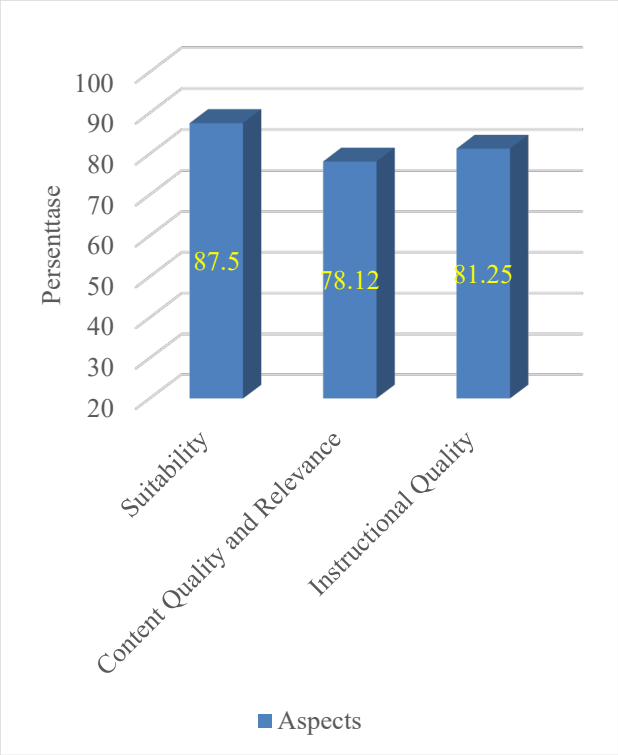

Figure 8. Results of the data analysis by material experts

Based on the data presented in Figure 8, it is evident that the material's feasibility level, assessed based on the suitability aspect, achieved a percentage of 87.5%, categorizing it as "Feasible". Likewise, the quality of content and objectives attained a feasibility percentage of 78.12%, also falling under the "Feasible" category. Similarly, the instructional quality aspect reached a feasibility percentage of 81.25%, which is also classified as "Feasible". With a final score of 82.29%, the Android-based computer operating system learning media can be confidently categorized as "Appropriate" for utilization.

4.2.3. Results of User Trial Data Analysis

User trials involving 10 students were carried out to assess the feasibility of Android-based learning media products. Data collection employed a questionnaire instrument, previously prepared, and validated. Among the 10 students, the maximum score for the ease of use and navigation aspect was 200, for the clarity of presentation aspect, it was 360, for the aesthetic or beauty aspect, it was 200, and the instructional quality aspect had a maximum score of 160. Data analysis from the acquisition of scores by users can be seen in Figure 9.

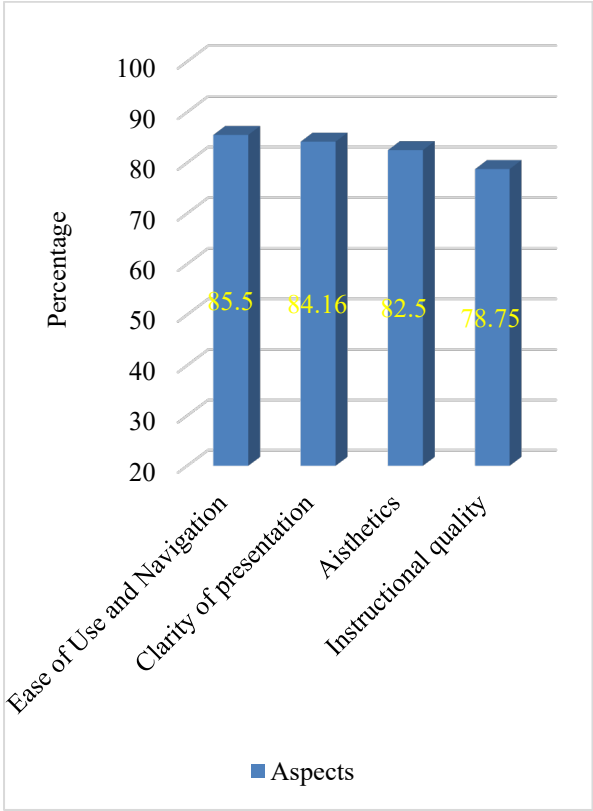

Figure 9. Graph of Android-based mobile learning feasibility test results

Analysing the results depicted in Figure 9, the percentage of feasibility was determined for various aspects. The media feasibility percentage score is then converted into a sentence based on the media feasibility criteria table. The assessment by students gave the following results: 85.5% for ease of use and navigation, categorized as "Feasible"; 84.16% for clarity of presentation, also categorized as "Feasible"; 82.5% for aesthetic or beauty aspects, categorized as "Feasible"; and 78.75%. The average score of overall feasibility reached 82.72%, so this Android-based computer operating system introduction learning media is categorized as "Feasible" to use.

5. Discussion

The success of this research in identifying and overcoming challenges in the development of Android-based mobile learning can be attributed to its comprehensive development approach. The findings of this new study are consistent with the results of previous studies [30], [29], [25]. This approach allowed the researcher to effectively address issues related to limited accessibility, complex user interfaces, and logistical considerations, all with the goal of creating a more practical and efficient learning experience in an Android-based educational context.

A distinctive feature that distinguishes this research from similar studies is that it includes three different types of validation data: validity studies conducted by media professionals, academics, and laypersons, all of whom provided favourable results related to the media under consideration. This study contributes to the dearth of in-depth studies on the creation of mobile learning applications based on Android that use App Inventor to store computer operating system content. Another benefit of this study is the high level of validation provided by media professionals and subject matter experts, with an overall average score of roughly 82.51% and 82.29%, respectively, and the overall classification of "Feasible." Additionally, the validity assessment of the use of Android-based mobile learning by students yielded a final average score of roughly 82.72%, which is also included in the "Appropriate" classification.

Another parallel study by Huda *et al*. [23] adopted the 4D development method, and the validation test results showed the validity of their augmented reality application technology with an average V value of 0.933. The focus of their research lies on the integration of real-world work experience into the learning process through the creation of an interactive Android-based lean manufacturing application. By utilizing the results of validation by experts, the research successfully proved the validity of the app, making it a valuable tool for improving the skills and employability of vocational students. Meanwhile, the research conducted by Hartanto *et al.,* [9] emphasized the significance of integrating real work experience into the learning process through the development of an interactive lean manufacturing application for Android. This study was further reinforced by expert validation results that confirmed the application's validity, solidifying its standing as an interactive lean manufacturing application. However, both studies in line with this research have a singular emphasis on the learning aspect. Whereas this research focuses on the development of Android-based Mobile Learning applications using App Inventor within the framework of computer operating system courses. Novelty in this research uses subjects that we carefully analyse by combining insights from media experts, material experts, and students in the context of computer operating system courses. For that, we used a comprehensive set of research instruments, which include media expert validation questionnaire, material expert validation questionnaire, and student evaluation validity questionnaire. The synergy between previous research and our research arises from a shared dedication to improving students' abilities in the learning process.

The limitations of this study involve the limited sample size of university students, the specific context of the institution, and the focus on the Android platform, as well as the research method being limited to the use of questionnaires. In addition, there are limitations in keeping up with future developments of the Android version range, time constraints, and the influence of variables that cannot be controlled during testing. Despite these limitations, this study makes a valuable contribution to the development of Android-based learning media and educational technology, with the hope of serving as a foundation for further research.

In conclusion, the development of the Android-based Mobile Learning Application Using App Inventor for Computer Operating System Material demonstrates several strengths, such as a systematic and comprehensive development approach, validation by media and material experts, positive student evaluations, and high validity scores. This study not only holds the potential to enhance education with versatile and efficient learning tools but also serves as an inspiration for further innovations in educational technology. Its broader applicability across various educational levels, coupled with practical recommendations, establishes it as a valuable resource for educators and developers, underscoring its significant impact on the field of educational technology.

Hopefully, the research has the potential to have a positive impact in education by improving the quality of learning, sparking innovation in educational technology, and providing practical guidance for educators and developers. It can also inspire further research in the development of Android-based learning applications, have wide application across different levels of education, and generate a better learning experience for students, ultimately improving their understanding of computer materials and technology.

6. Conclusion

The development of Android-based mobile learning has been systematically executed through the utilization of the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) framework. The analysis phase is dedicated to identifying and addressing issues, while the subsequent design phase generates vital components such as data flowcharts and storyboards, serving as the foundation for constructing the Android-based mobile learning. Progressing into the development phase, the initial version of Android-based mobile learning tailored for computer operating system material is successfully created.

Subsequently, during the evaluation stage, a comprehensive review and revision process ensures its feasibility before implementation. The feasibility assessment of Android-based mobile learning, specifically designed for computer operating system materials, meticulously evaluates the dimensions of efficiency, functionality, and usability. The validation results provided by media experts and material experts yielded an overall average score of 82.51% and 82.29%, confirming its comprehensive classification as "Feasible". Furthermore, the student validity evaluation of the Android-based mobile learning, focusing on computer operating system installation and involving 10 student participants, achieved an overall average score of 82.72%, also corresponding to a "Feasible" classification. This research aims to pave the way for the development of more sophisticated and effective Android-based learning media in education. It is anticipated that the outcomes of this study will serve as inspiration for further research, find widespread application across various educational levels, enhance the quality of education, be adaptable to diverse platforms, offer practical guidance for developers and educators, contribute to educational literature, and positively impact students' learning experiences.

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