AKADEMIKA | JURNAL TEKNOLOGI PENDIDIKAN
P-ISSN 2089-4341 | E-ISSN 2655-9633

UNIVERSITAS ISLAM AS-SYAFI'IYAH
MAGISTER TEKNOLOGI PENDIDIKAN
FAKULTAS KEGURUAN DAN ILMU PENDIDIKAN
UNIVERSITAS ISLAM AS-SYAFI'IYAH

Development of the Sandro Application (Statistics on Android) as a Learning Media in the Educational Statistics

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P-ISSN: 2089-4341 | E-ISSN: 2655-9633
Url Jurnal: https://jurnal.uia.ac.id/akademika/article/4284
DOI: https://doi.org/10.34005/akademika.v13i02.4284

Received: **03-12-2024** Accepted: **04-01-2025** Published: **20-01-2025**

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Abstract: *This study focuses on developing an Android-based application as a learning media for the Educational Statistics course at IAIN Sultan Amai Gorontalo. Using a research and development (R&D) approach, this study applied the Waterfall model, which included the stages of requirement analysis, design, implementation, verification, and maintenance. From the expert validation process, conducted by both content and media experts, the results were 92.86% and 95%, respectively, falling into the "Very Valid" category. The evaluation results from the content expert indicate that the material presented in SANDRO aligns with the learning objectives of Educational Statistics, the depth and breadth of the material are sufficient, the quality of material presentation is good, the accuracy and currency of the material are met, and it conforms to the applicable curriculum and educational standards. The evaluation results from the media expert show that SANDRO overall is highly suitable as a learning medium for Educational Statistics because it meets excellent criteria in terms of interface design, navigation, functionality and interactivity, learning content, as well as creativity and innovation, although improvements related to the application's color scheme to make it more appealing to users are necessary. The application trial with users (students) showed positive responses with an average score of 81.17%, indicating that most users found this application very suitable for use as a learning media in the Educational Statistics course. This score shows that SANDRO offers an attractive appearance as a learning media, the content is comprehensive for Educational Statistics, the language is easy to understand, practical and not confusing, and interactive. The development of this application significantly contributes to creating relevant and engaging learning media, while also providing a solution to the low interest of students in this course.*

Keywords: *waterfall model; learning media; educational statistics*

INTRODUCTION

The interest and engagement of students in particular subjects or courses often play a key role in the success of the learning process. This phenomenon is particularly visible in higher education, where students frequently face challenges in understanding material that is

perceived as complex and challenging. Educational Statistics is one such course that often receives negative evaluations from students, as it combines mathematical rigor with abstract statistical concepts. Many students struggle with interpreting statistical data, applying formulas, or understanding the relevance of statistics to real-world problems (Anuyahong & Pucharoen, 2023).

An initial observation conducted on 30 students within the Faculty of Tarbiyah and Teacher Training at IAIN Sultan Amai Gorontalo revealed that interest in Educational Statistics tends to be low. The indicators such as curiosity, enjoyment, attention, participation, and desire were categorized as low. For instance, students often expressed confusion over technical terms and statistical procedures, which reduced their motivation to engage with the material. Additionally, a lack of active teaching strategies, such as interactive learning or practical applications, exacerbated this issue (Morales Rodríguez et al., 2020). This disengagement is evident in students' passive participation in lectures, delays in completing assignments, and frequent distractions, such as prioritizing smartphone use over classwork. As a result, students struggle to retain concepts and forget the key content of the course (Hashemi et al., 2022).

As it is known, the digital world and technological advancements have become an integral part of people's lives. Many human activities can now be carried out digitally. For example, administrative matters can now be conducted practically, anytime and anywhere, online through smartphones. Many other examples show that the development of the digital world and technology has a significant impact on facilitating human activities. However, many smartphone users still spend most of their time on social media platforms (Singh et al., 2021). In fact, smartphones can be used as a learning media, to support the achievement of learning goals. In the learning process, educators can use various tools to deliver messages or teaching material to spark interest, curiosity, thought, and emotions in students (Latif et al., 2019). Using appropriate learning media can increase the efficiency of achieving learning objectives (Anuyahong & Pucharoen, 2023; Tigor & Simbolon, 2023).

Ezza, etc. (2022) developed an Android-based learning media for 3D animation, rated as highly feasible with a score of 4.42. The material in this application was successfully verified with a score of 4.19, and the user validation score reached 4.40. The effectiveness test showed that this learning media could improve student achievement with an effectiveness level of 0.73, considered adequate (Ezza et al., 2022).

Syahruni, etc. (2018) developed a practical and easy-to-use Android-based learning media, as evidenced by the positive response from students towards this application. Two validators validated the application and showed that it could be accepted with minor revisions. Test results also showed that this learning media effectively improved

student’s test scores, as seen from the comparison of pre-test and post-test scores, making it a significant contribution to student’s academic achievement in high school (Syahruni, 2018).

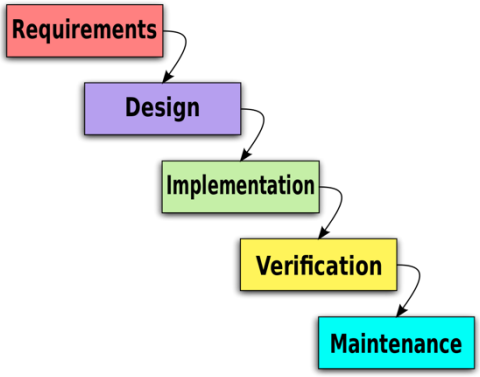
Yahya's research in 2016 produced an interactive Android-based learning media application for basic electronics engineering material. The evaluation showed that this application was highly suitable for use, with high scores in function evaluation, media feasibility, and operational ease. Testing on various Android devices also showed that the application functioned well without technical issues, making it an effective tool for electronics engineering learning (Yahya, 2016).

Noviana, et al. (2018) developed a website-based thesis guidance application for students in the Elementary School Teacher Education program at the University of Riau. This application was rated as valid with a highly effective category in four aspects: correctness, reliability, integration, and usability. The effectiveness test results showed an average percentage of 84.89%, indicating that this application could be widely adopted to support the thesis guidance process for students (Noviana et al., 2018).

Based on these phenomena, the researcher sees that smartphones can be utilized as a learning media to stimulate attention and interest and provide ease for students to follow the educational statistics learning process. The current technological advancement makes it possible to design a learning media in the form of an Android-based mobile learning application that contains material, exercises, and assignments. With this application, it is hoped that students will be more interested in material literacy inside and outside the classroom, be more active in attending lectures, and reduce negligence in completing exercises, assignments, and evaluations, particularly in Educational Statistics learning.

METHOD

This research is classified as a type of Research and Development (R&D), which involves a systematic series of steps to create new products or improve existing products while maintaining accountability. In developing an Android-based learning application, the researcher uses the Waterfall approach as the development methodology. The selection of the Waterfall model is considered appropriate for this process due to its structured stages, as described by Nugroho, which include requirement analysis, design, implementation, verification, and maintenance (Nugroho, 2019). The Waterfall model is one of the most popular classical methods in software development and has proven effective in various fields, including the development of information systems, web-based applications, and Android applications (Ratumbuisang et al., 2022; Syahruni, 2018; Triansyah et al., 2022).



Picture 1. Waterfall Development Model Design

By following the Waterfall model, the application development in this study includes several stages as follows:

Requirement Analysis

Based on the requirement analysis conducted by the researcher, the course on Educational Statistics is still considered a complex and difficult subject to understand. As a result, student interest and engagement in this course tend to be low. On the other hand, technological advancements have made it impossible for students to avoid using smartphones in various daily activities. Therefore, utilizing technology, particularly smartphones, as a learning media can serve as a solution to optimize the learning process and achievement of learning objectives, especially in the Educational Statistics course within the Islamic Education Study Program (PAI) at IAIN Sultan Amai Gorontalo.

Design

In the design phase, the SANDRO application is created in alignment with the user needs identified during the requirement analysis process. It is designed and developed using Android Studio as the platform. The process begins with creating the application's logo design and the initial interface that appears when users access the SANDRO application.

Implementation

In the implementation phase, the Educational Statistics material is prepared, which includes an introduction to basic statistics, covering both descriptive and inferential statistics. The prepared material will then undergo validation by subject matter experts before it is integrated into the developed application system. Below is the outline of the content expert validation instrument used in this study.

Table 1. Content Expert Validation Questionnaire Outline

No.	Assessment Aspects	Indicators
1.	Alignment of Content with Learning Objectives	The alignment of the content displayed in the application with the learning objectives to be achieved, as well as the needs and characteristics of the users
2.	Depth and Breadth of Content	The completeness and clarity of the content displayed in the application
3.	Quality of Content Presentation	The systematics and innovation in the presentation of the content displayed in the application
4.	Accuracy and Currency of Content	The up-to-date and current nature of the content displayed in the application
5.	Alignment with Curriculum and Educational Standards	The alignment of the content displayed in the application with the applicable curriculum to support the achievement of competencies

At the same time during the implementation phase, the development of the SANDRO application system is carried out comprehensively by conducting functional testing of the menus within the application to determine whether the menus in the application are operational and meet the criteria based on the requirement analysis.

After the Educational Statistics material has passed the content expert validation and the system development has been functionally tested, the learning material will be integrated into the application system. Once the integration process is complete, the application is thoroughly checked and tested to identify potential errors when it is run. If errors or bugs are found at this stage, the application will be revised before being tested by media experts and then forwarded to the users.

Verification

In this stage, a media expert validation is conducted. This media expert validation aims to assess whether the developed application can be used as an educational media. Below is the outline of the media expert validation instrument used in this study:

Table 2. Media Expert Validation Questionnaire Outline

No.	Assessment Aspects	Indicators
1.	Interface Design	The alignment of the application design, layout of application elements, and color selection with the characteristics of the users
2.	Navigation	The ease of understanding and using the functions of the menus or buttons within the application
3.	Functionality and Interactivity	The smoothness and ease of using the application according to its intended functions

No.	Assessment Aspects	Indicators
4.	Learning Content Structure	The ease of accessing learning materials through the application
5.	Creativity and Innovation	The ability of the application to support and optimize the learning process

After being validated by media experts, the SANDRO application was improved based on the feedback received regarding the adjustment of the display colors and fonts to create a better user interface. Based on the results of the validation tests by content and media experts, as well as the revisions made in the first stage, it was concluded that the SANDRO application is deemed suitable for use as a learning media for the Educational Statistics course and is ready to be handed over to the users, namely the PAI students at IAIN Sultan Amai Gorontalo.

Maintenance

This phase allows for further improvements in the future for any errors that were not detected in the previous stages. Additionally, this maintenance phase also includes system unit implementation fixes, enhancements, and adjustments to the application system based on future user needs.

Through these stages, this study has produced an Android-based learning media application. The main objective of developing this media is to increase students' learning interest in the Islamic Religious Education (PAI) program at IAIN Sultan Amai Gorontalo, specifically in the Educational Statistics course. The use of this application is expected not only to enhance student engagement in the learning process but also to help them better understand statistical concepts through a practical, technology-based approach. This application is designed with user needs and material relevance, aiming to provide an innovative solution to the challenges of conventional learning.

The research was conducted for 6 months, from June to November 2024. A total of 50 PAI students who had already taken the Educational Statistics course were involved as trial users of the application. Before the trial, the application was reviewed by media and subject matter experts. Once the application is considered valid, it will be tested by users to determine its effectiveness using a Likert scale questionnaire that will be analyzed as follows:

1 = Strongly Agree
2 = Agree
3 = Disagree
4 = Strongly Disagree

Table 3. Expert Assessment Validation Categories

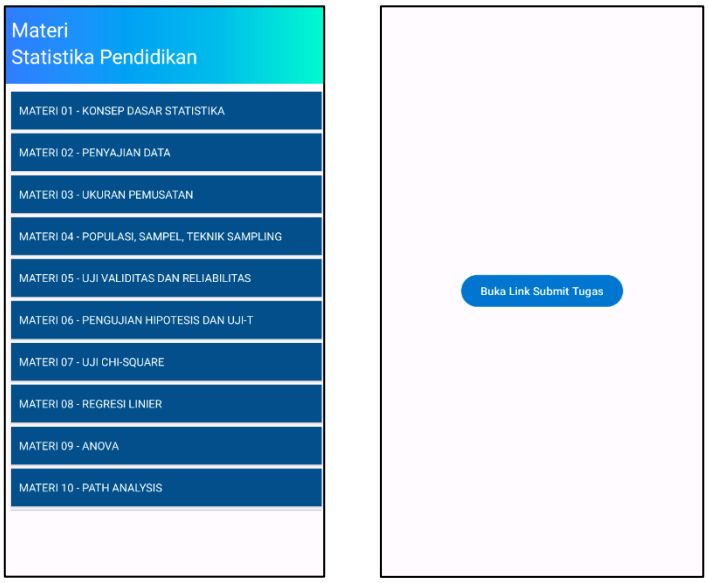
Expert Statement	Score Validation Category
Very Valid	$81 - 100\%$
Valid	$61 - 80\%$
Fairly Valid	$41 - 60\%$
Invalid	$21 - 40\%$

$$Percentage = \frac{number\ of\ assessment\ scores}{number\ of\ ideal\ scores} \times 100\%$$

RESULT

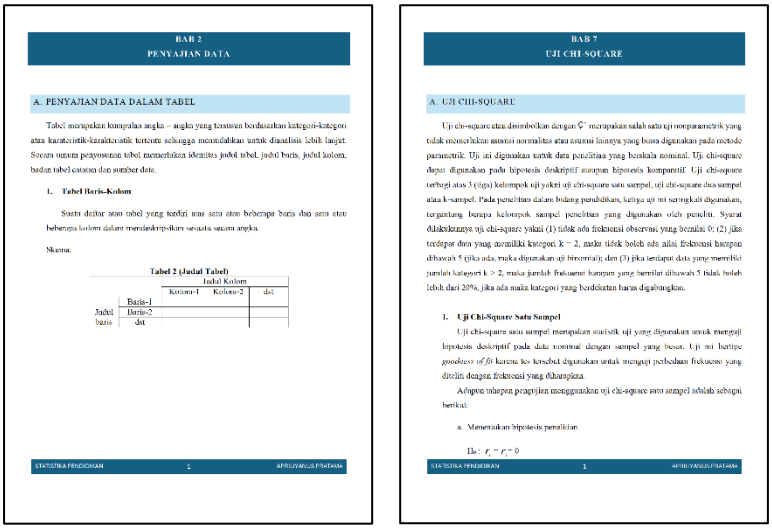
In the initial phase of the research, the author prepared learning materials in PDF format, which were designed to be integrated into the Android-based application. The initial design or mock-up of the application was created using Microsoft PowerPoint and then converted into an APK file as the final form. After the preparation of materials and conversion is completed, the application is assessed by experts, material experts, and learning media experts. From the evaluation process, the media expert suggested that the application's color scheme should be improved to make it more appealing to users. After the revision was made according to the media expert's recommendations, the next phase was to conduct a trial of the application to evaluate user responses regarding the functionality and effectiveness of the educational media.

Initial Design of Applications and Learning Materials



Picture 2. Initial Design Using Microsoft PowerPoint

Picture 2 shows the initial design of the SANDRO application created in Microsoft PowerPoint. This initial design includes a series of menus for the Educational Statistics course materials and a menu for submitting assignments.



Picture 3. Learning Materials

Picture 3 shows the display of the Educational Statistics learning material that will appear when the "Materi" menu is opened in the SANDRO application.

The recap of the expert evaluation results is as follows:

Table 4. Assessment Results from Experts

No	Validator	Score Percentage
1	Media Expert	92.86%
2	Materials Expert	95.00%
Average		93.93%
Information		**Very Valid**

Assessment Conclusion

The results of the expert review obtained a score percentage of 93.93%, which places it in the very valid category.

Table 5. SANDRO User Response Questionnaire Results

Observed Aspects	Answer Percentage			
	1	**2**	**3**	**4**
Appearance	0.50%	2.00%	14.00%	83.50%
Contents	1.00%	1.00%	18.50%	79.50%
Language	0.17%	0.83%	19.33%	79.67%
Practicality	2.00%	3.33%	15.83%	78.83%
Efficiency and Effectiveness	2.17%	3.00%	10.50%	84.33%
Average	1.17%	2.03%	15.63%	81.17%

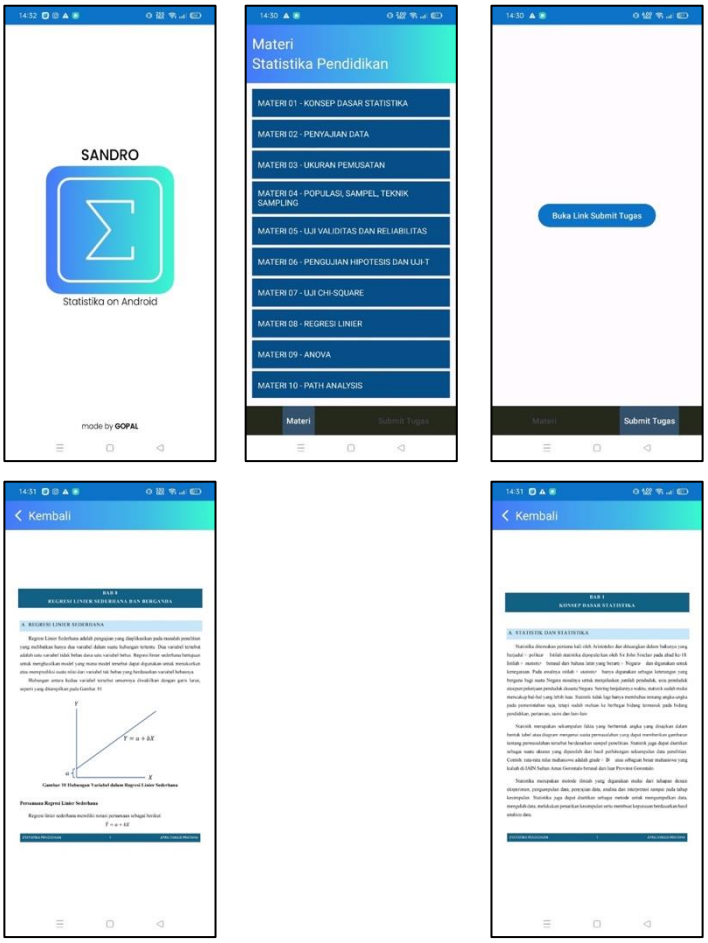
Based on the user response questionnaire regarding the SANDRO application as a learning media for the Educational Statistics course, the results indicate that the SANDRO application has an attractive interface as an Android-based learning media. The content in the SANDRO application covers all the material for the Educational Statistics course, the language used in both the navigation menus and the content is easy to understand, the operation of the application is efficient and not confusing, and it is interactive, especially for the assignment submission menu. It allows students to upload the assignments given in the Educational Statistics course easily. The application received a very positive evaluation. Most users responded with "Strongly Agree" (category 4) on the Likert scale, with an average percentage of 81.17%, indicating that the application met users' expectations across various aspects.

Specifically, the Appearance aspect received the highest percentage of "Strongly Agree" responses at 83.50%, suggesting that the application's visual design is considered attractive and supports the learning process. The Content aspect received 79.50% for "Strongly Agree", indicating that the materials and content presented are relevant and beneficial. In the Language aspect, 79.67% of users strongly agreed that the language used was simple and easy to understand. Furthermore, the Practicality aspect also received positive

responses, with 78.83% of users strongly agreeing that the application is easy to use and supports learning activities. Lastly, the Efficiency and Effectiveness aspect received the highest percentage of "Strongly Agree" responses, at 84.33%, indicating that the application's features significantly help users in the teaching and learning process.

Thus, SANDRO can be considered to have successfully met the criteria for a good learning media and can be recommended for use in Educational Statistics courses. However, further evaluation and development are still necessary, particularly in aspects that received lower evaluations, such as content (learning material), to continuously improve the quality of the application.

Application Appearance After Revision



Picture 4. The SANDRO Application After Revision

The improvements include adding of a navigation menu located at the bottom of the application, and adjusting to the font and colors used. All these improvements were made based on feedback from the experts.

DISCUSSION

The development results in this research were conducted based on the Waterfall development model, consisting of the following stages: (1) Requirement Analysis, (2) Design, (3) Implementation, (4) Verification, and (5) Maintenance (Nugroho, 2019). Based on the requirement analysis, Educational Statistics was still considered a complex and challenging course to understand, leading to relatively low student interest in the subject. To address this issue, using technology, particularly smartphones as a learning media, was considered an effective solution. In line with similar studies previously conducted by Ezza et al. (2022), who developed an Android-based learning media for 3D animation (Ezza et al., 2022), and Syahruni et al. (2018), who developed practical and user-friendly Android-based learning media, the results of these studies indicate a significant positive impact on the learning process and the achievement of learning objectives (Syahruni, 2018). Therefore, the Android-based learning application, SANDRO, was designed to help optimize the learning process and increase student interest in the Educational Statistics course in the PAI (Islamic Religious Education) program at IAIN Sultan Amai Gorontalo.

The development of the SANDRO application began with the design phase, which included the creation of the logo, the initial user interface, and key features such as the “Materi” (Material) and “Submit Tugas” (Submit Assignments) menus. The initial mock-up of the application's interface was created using Microsoft PowerPoint, while Android Studio was used for the development to ensure that both the design and functionality aligned with the user needs that were previously analyzed. The “Materi” menu contains the learning content thoroughly prepared and validated by subject matter experts. Meanwhile, the “Submit Tugas” menu uses Google Forms as a platform for students to submit daily assignments, mid-term exams (UTS), and final exams (UAS) in a structured manner.

The implementation phase of the application involved integrating the validated Educational Statistics material into the application system. Before this integration, a comprehensive functional test of all application features was conducted to ensure that each menu operated effectively according to user needs. This step is crucial as it aligns with best practices in software development, where thorough testing is essential to identify and rectify potential issues before deployment (Astuti et al., 2022). Once the Educational Statistics material was successfully integrated, the application system underwent rigorous testing to identify and fix any errors or bugs. This iterative testing process is fundamental in software development, ensuring the final product is reliable and meets user expectations. If any deficiencies were identified during testing, the application was revised accordingly before being re-evaluated by media experts. This validation process is vital as it assesses the feasibility of the application as a learning medium, focusing on aspects such as its

appearance, ease of use, and effectiveness in supporting the learning process. According to Sutrisno, the validity indicators for media include content, media illustrations, and language (Hastuti et al., 2022). Similarly, Andrizal and Arif proposed additional validation indicators encompassing content, material presentation, media display, programming, language, and usefulness (Alie et al., 2021). These frameworks provide a comprehensive approach to evaluating educational media, ensuring that all critical aspects are considered. By meticulously following these stages, the application, SANDRO, is expected to emerge as a reliable and practical learning medium that effectively meets students' needs in understanding Educational Statistics. Research indicates that well-developed educational media can significantly enhance learning outcomes by facilitating better engagement and comprehension among students (Al-Qoyyim et al., 2022). Integrating of validated content and expert feedback further strengthens the application's potential as an effective educational tool (Almaiah et al., 2020).

The testing of the SANDRO application involved a cohort of 30 users, specifically 5th-semester PAI students who had previously completed an Educational Statistics course. This selection was strategic, as these students possessed foundational knowledge that would allow them to engage with the application’s features effectively. The trial was conducted over a period from October 7 to October 11, 2024, with the expectation that the participants would explore all functionalities and review the provided materials thoroughly. Initial instructions for installation were given, followed by a comprehensive explanation of the application's features and potential uses. To ensure a seamless experience, students using iOS devices were substituted with peers who utilized compatible devices. A questionnaire collected feedback, enabling the researcher to gauge user experiences and satisfaction levels. The importance of user engagement in educational applications is well-documented in the literature. Research indicates that student engagement is significantly influenced by perceived autonomy and choice in learning activities, which can enhance motivation and cognitive involvement (Daniels et al., 2021). Furthermore, designing educational tools that foster engagement can lead to improved learning outcomes, as evidenced by studies that highlight the relationship between effective engagement strategies and academic performance (Kassab et al., 2022). It aligns with findings that suggest a strong correlation between user satisfaction and the usability of educational software, emphasizing the need for applications to incorporate user feedback mechanisms to refine their functionalities (Abubakar et al., 2022).

This research is also focused and limited to the development of the application itself, indicating that the development and innovation of learning media in the form of Android-based applications are possible to utilize the technological advances available in society. The implementation of the developed SANDRO application will be carried

out in future research. However, based on student responses during the trial of the SANDRO application, it was found that the SANDRO application significantly met the users' expectations in various aspects, making it highly suitable for use as a media for educational statistics. It is aligned with the research conducted by Yahya (2016), which resulted in an interactive Android-based learning application for basic electronics engineering materials. The evaluation results from that study showed that the developed application was very suitable for use, with high scores on functionality, media suitability, and ease of operation. Testing across various Android devices also showed that the application functioned well without technical issues, making it an effective tool for learning (Yahya, 2016).

SANDRO is deemed suitable as a learning medium because it meets the interactive learning medium criteria. This aligns with Thorn's assertion that there are six criteria for assessing interactive multimedia, which include ease of navigation, cognitive content, the inclusion of knowledge and information presentation, media integration, the ability to engage learning interest, and overall functionality that meets the learning needs and objectives (Riaddin & Umasugi, 2021). The importance of these criteria lies in their ability to enhance user experience and facilitate effective learning outcomes, as interactive multimedia can significantly increase students' motivation and engagement in the learning process (Alam et al., 2022). Moreover, the use of Android-based learning media such as SANDRO supports implementing mobile learning as an alternative, emphasizing that learning can take place anytime and anywhere. Dhanil and Mufit highlight that mobile learning provides flexibility and accessibility, allowing students to access educational materials from any location and at any time (Dhanil & Mufit, 2021). This is particularly relevant in today's educational landscape, where technology integration into learning environments is increasingly recognized to enhance educational experiences and outcomes (Alam et al., 2022). Through SANDRO as the learning media, students can access learning materials and information conveniently, aligning with contemporary educational practices that prioritize learner-centered approaches and technology to facilitate learning.

The potential limitations in the research and development of Android-based learning media applications may affect the results obtained, especially concerning technical factors and variables that are difficult to control, such as the limitations of the hardware used by users or differences in users' understanding of technology. As in this research, the Android-based learning media application created can only be used by Android users. Therefore, the results of this study cannot be generalized to all smartphone users, particularly iPhone users who have the iOS operating system. Additionally, differences in teaching methods or features tested in the application may lead to different results than previous studies, which may have used different approaches or tools.

Several factors can influence the efficiency and effectiveness of the application as a media tool used in the learning process, such as the application's ability to adapt to different types of Android devices used by students and its alignment with students' learning styles. However, these aspects will become clearer in future research related to the implementation of SANDRO as a learning media.

CONCLUSION

The development of SANDRO as a learning media for the Educational Statistics course used the Waterfall model, which consists of five stages: Requirement Analysis, Design, Implementation, Verification, and Maintenance. From the expert validation process, involving both subject matter experts and media experts, the results were 92.86% and 95%, respectively, falling within the "Highly Valid" category. According to the subject matter expert, SANDRO contains content that aligns with the learning objectives of Educational Statistics, the depth and breadth of the material are sufficient, the quality of content presentation is good, the accuracy and currency of the material have been met, and it conforms to the relevant curriculum and educational standards. Meanwhile, according to the media expert, SANDRO is highly suitable for use as a learning media for Educational Statistics, as it meets excellent criteria in interface design, navigation, functionality and interactivity, learning content, creativity, and innovation. At the application launch stage, the student user feedback questionnaire indicated a score of 91.16%, categorized as "Highly Practical." Based on these results, SANDRO can be considered to have successfully met the criteria for good learning media and can be recommended for use in Educational Statistics courses. However, further evaluation and development are still needed to continue improving the quality of the application, particularly in areas that received lower evaluations, such as content (learning material).

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