

# Enhancing Digital Literacy and Biology Understanding through Android-Based Learning Media: A Kodular Platform Development and Evaluation

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## ABSTRACT

Traditional biology instruction often neglects digital literacy development, despite its increasing importance in 21st-century education. There is a pressing need for integrated learning tools that enhance both biological understanding and digital competencies. This study aimed to design and evaluate an Android-based biology learning media using the Kodular platform. A Research and Development (R&D) approach was adopted, following the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Sixteen grade XI students from Senior High School 2 Wajo were selected through random sampling. Data collection involved expert validation sheets, practicality and effectiveness questionnaires, and digital literacy tests. The developed media achieved high expert validation scores (82.33%) and was rated highly practical (82.5%). Paired pre-test and post-test results showed significant improvements in both biology comprehension (41.8%) and digital literacy (39.4%). Additionally, 94% of students reported that the media was effective in enhancing their engagement and understanding of the subject matter. The Kodular-based learning media proved to be an effective tool for fostering student motivation, improving conceptual understanding, and developing digital skills. Its interactive features—such as videos, animations, and quizzes—addressed common limitations in traditional instruction. The design's scalability also makes it adaptable to other STEM subjects with minimal content modification. Kodular-based media offers a flexible, user-friendly, and pedagogically sound approach to integrating digital literacy and subject learning, supporting students' preparedness for the digital era.

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## 1. INTRODUCTION

In the current digital era, mastering digital literacy skills has become a fundamental necessity, especially for students who must navigate an increasingly technology-driven learning environment. As digital technology continues to evolve, students are expected not only to consume information but also to analyze, evaluate, and create new content. This shift emphasizes the importance of digital literacy as a core competency, enabling students to engage effectively in both academic and professional contexts. According to the American Library Association (2003), digital literacy is the ability to use information and communication technology (ICT) to search, understand, evaluate, and produce information. These skills are essential for success in the modern educational landscape and beyond, as they empower students to think critically and solve problems using digital tools.

Despite the recognized importance of digital literacy, many students, particularly in Indonesia, face significant challenges in acquiring these competencies. In the Indonesian Senior High School context, a considerable number of students struggle with accessing and utilizing digital technologies for learning purposes (Sudarsana et al., 2019). This difficulty is compounded by unequal access to digital resources and varying levels of exposure to ICT in different regions. The integration of ICT into education is crucial for addressing these gaps, and while the Indonesian Ministry of Education and Culture has implemented several policies to support this integration (Ministry of Education and Culture, 2020), more targeted efforts are needed to ensure students can fully develop their digital literacy skills.

Digital literacy is not only vital for students' academic success but also for preparing them to thrive in the 21st-century workforce. The Partnership for 21st Century Skills (2009) identifies digital literacy as one of the four essential literacies, alongside information literacy, media literacy, and ICT literacy. These literacies are necessary for students to function in a globalized, technology-driven world. However, the specific ways in which digital literacy can be enhanced through innovative educational methods remain an area that requires further exploration. While general digital learning media have been widely studied, there has been less focus on how subject-specific learning, particularly in complex disciplines like biology, can benefit from digital literacy enhancement.

Biology as a subject poses unique challenges in a digital learning environment. It often requires hands-on learning, visualization of complex biological processes, and interactive engagement with content, which can be difficult to replicate through traditional digital media. In the digital age, it is essential to find innovative ways to deliver biology education effectively. This is where the development of interactive and Android-based learning media becomes crucial. These platforms can not only improve students' understanding of biology content but also foster the necessary digital literacy skills they need to succeed in a technology-driven learning environment.

One promising solution to this challenge is the use of Android-based learning media developed on platforms like Kodular. Kodular is an application development platform that allows users to create Android applications without requiring complex programming skills (Majumdar, 2021). Its user-friendly interface and block-based programming approach make it an accessible tool for educators who want to develop interactive learning media. This is particularly useful in the context of biology education, where interactive features can help students better engage with the subject matter and improve their overall learning outcomes.

Kodular is not the only platform available for developing Android-based learning media. Other platforms, such as Appypie and MIT App Inventor, also allow users to create applications without needing extensive coding knowledge. However, Kodular offers distinct advantages, particularly in its ability to handle more complex, interactive features that are critical for effective learning in subjects like biology (Rismayanti et al., 2022). The platform's versatility allows educators to design media that caters to specific educational needs, making it a valuable tool for improving both digital literacy and content understanding in students.

Although research has been conducted on digital learning media in Indonesia, the use of Kodular as a platform for developing learning applications is still relatively underexplored. Previous studies, such as those by Arafah et al. (2023), have shown that Android-based learning media, developed using platforms

like Andromo, can significantly enhance students' accessibility to and engagement with biology content. These studies highlight the potential of interactive learning platforms in improving student motivation and learning outcomes. However, few studies have specifically examined how Kodular can be utilized to both enhance digital literacy and support subject-specific learning, particularly in biology.

This research aims to fill that gap by exploring how the Kodular platform can be used to design and develop Android-based learning media that not only improve digital literacy but also enhance students' understanding of biology. The study has two primary objectives: 1) to identify the digital literacy needs of Indonesian Senior High School students, and 2) to develop an Android-based learning media platform using Kodular that is valid, practical, and effective in improving students' digital literacy and their comprehension of biology content. By addressing these goals, the research contributes to both the theoretical understanding of digital literacy in education and the practical development of innovative learning tools for biology education.

## 2. METHODS

This research follows a Research and Development (R&D) approach, which is a systematic process used to develop and validate educational products. The rationale behind utilizing the R&D methodology is to ensure that the product (in this case, an android-based biology learning media) is designed based on user needs, is validated by experts, and tested in real-world conditions to evaluate its practicality and effectiveness. To guide the development process, we used the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation), which is widely recognized for its structured approach in instructional design (Branch, 2009).

### 2.1 Analysis Stage

In the Analysis phase, the focus was on identifying the needs of students and teachers regarding digital literacy in biology education. This phase involved both surveys and interviews with teachers and students. The survey contained both closed and open-ended questions designed to gather insights on current digital literacy skills, challenges faced in digital media usage, and specific requirements for the learning media. Interviews with biology teachers further explored how digital tools were integrated into their teaching practices and what specific functionalities they desired in the media. Through these interactions, we identified key areas of need, such as user-friendliness, ease of access, and effective engagement strategies.

### 2.2 Design Stage

In the Design phase, the development of an interactive and user-friendly application was prioritized. We employed design principles such as user-centered design (UCD) to ensure that both students and teachers could easily navigate the media. To enhance interactivity, we incorporated elements of gamification and multimedia learning (graphics, animations, and quizzes) based on educational technology literature. Wireframing tools like Figma were used to draft the initial interface layout, ensuring the ease of interaction and functionality for the intended users. The design also considered feedback from the analysis stage, integrating their needs into the app's interface and features.

### 2.3 Development Stage

The Development phase involved the creation of the application prototype using the Kodular platform, a tool designed for developing Android-based applications with ease. During this phase, expert validation was conducted by two types of validators: (1) material experts and (2) learning media development experts. These validators assessed the application based on specific criteria such as content accuracy, interactivity, and usability. The feedback provided by the validators was critical to refining the prototype. Based on their suggestions, several iterations of the prototype were made, including

adjustments to the interface design, content presentation, and user interaction elements. Revision processes were documented, ensuring that every improvement was in line with expert feedback.

## 2.4 Implementation Stage

The Implementation phase involved testing the application in a classroom setting, specifically in Senior High School 2 Wajo, involving 16 students from class XI Science 4 as respondents. Before the trial, both teachers and students received training and instructions on how to use the application, ensuring that they were familiar with its functions. The testing involved observing students as they interacted with the media and noting any issues related to usability or engagement. Observational notes were taken to document student reactions and any challenges they faced while using the application. Feedback from this phase was collected through both post-use questionnaires and teacher feedback sessions.

### Evaluation Stage

The Evaluation phase was conducted in two cycles to systematically assess the learning media's effectiveness. Descriptive statistics were used to calculate the average scores and categorize the assessments. For the inferential analysis, paired sample t-tests were used to compare students' pre-test and post-test scores, determining whether there was a significant improvement in digital literacy skills after using the application. The evaluation also included qualitative feedback from students and teachers to complement the statistical results. The evaluation criteria were aligned with standards set by Hague and Payton (2011) to ensure a comprehensive assessment of the learning media's effectiveness in honing digital literacy.

The research instruments used in this study included an Expert Validation Sheet, adapted from Arsyad (2011), which assessed the feasibility of the learning media based on content accuracy, language clarity, and presentation quality. Additionally, the Practicality and Effectiveness Questionnaire, derived from Djuredje and Himawan (2022), measured the media's ease of use, interactivity, and ability to motivate students, with feedback gathered from both students and teachers. To evaluate the improvement in students' digital literacy, a Digital Literacy Test, adapted from Hague and Payton (2011), was utilized, focusing on students' ability to search for and evaluate information, communicate digitally, and solve problems using technology. These instruments provided a comprehensive assessment of the media's effectiveness in enhancing digital literacy.

## 3. FINDINGS AND DISCUSSION

The following results are presented in accordance with the stages of the ADDIE development model.

### 3.1. Analysis stage

In the analysis phase, the biology learning process primarily utilized basic digital media, such as PowerPoint (PPT) presentations, which often led to student disengagement due to their static and monotonous nature. To address this challenge, an Android-based biology learning media was developed to enhance engagement, facilitate interactive learning, and improve digital literacy. Table 1 shows students' responses to the needs analysis questionnaire, indicating their preferences and expectations for digital learning media.

**Table 1.** Results of Needs Analysis for Android-Based Learning Media Development

No.	Question	Average Score
1	I feel comfortable using digital technology to learn.	4.2
2	I needed more interactive learning materials to understand biology.	4.0
3	I often have trouble finding relevant digital learning resources.	3.9
4	An easy-to-navigate learning app is very important to me.	3.8
5	The use of videos and animations in the app helped me understand the concepts of biology better.	4.3
6	I prefer to study with interactive quizzes rather than long texts.	4.1

The data from the needs analysis are shown in Table 1. It shows that students have a high level of interest in the use of technology in learning, with a high average score on questions related to the convenience of using technology and the desire to have more interactive learning materials. This shows that students tend to accept and respond positively to the introduction of digital-based learning media. However, lower scores on questions about the ease of navigation of the app indicate the need to develop an intuitive and easy-to-use interface, which can reduce the potential for frustration and improve learning effectiveness.

Students' preference for interactive quizzes and visual materials such as videos and animations also indicate that these elements should be significantly integrated in the learning medium to maintain engagement and facilitate better comprehension of the material. The addition of interactive features can stimulate the active participation of students and support various learning styles.

**Table 2.** Results of Analysis of Students' Initial Digital Literacy Abilities

No.	Digital Literacy Aspects	Average Score
1	Ability to search for information online	2.8
2	Ability to evaluate information reliability	2.5
3	Ability to use information ethically	3.0
4	Ability to communicate information digitally	3.2
5	Ability to solve problems using digital technology	2.7

Based on the data presented in Table 2, students demonstrate an initial level of digital literacy characterized by proficiency in using digital devices for academic tasks and basic skills in information retrieval. However, significant deficiencies remain in critical areas such as online safety, digital ethics, and the evaluation of information credibility. Low scores in online security awareness, privacy, and ethical digital behavior highlight the urgent need for educational programs that explicitly integrate these components into the curriculum. These gaps suggest that greater emphasis must be placed on the development of learning media that robustly address online safety, ethical digital practices, and critical thinking in information assessment. Engaging students in activities that foster critical evaluation and responsible use of digital tools is essential for cultivating comprehensive and contextually relevant digital literacy. The preliminary findings indicate that students' current digital competencies are insufficient to meet the demands of evolving educational technologies, reinforcing the necessity for innovative learning media to enhance their digital skill sets.

### 3.2. Design stage

The design of the Android-based learning media, developed using Kodular, incorporates several key elements aimed at enhancing student comprehension and engagement. The user interface is intentionally designed to be clear and intuitive, facilitating ease of use for students. Learning materials are presented in a concise manner using simple, accessible language to support understanding. Animations are integrated to reinforce the content, while visually appealing templates are selected to boost student motivation and reduce learning fatigue. Additionally, engaging educational videos on the human reproductive system are included to enrich the content and deepen students' understanding of the topic.

The design stage in the development of Android-based biology learning media using the Kodular platform shows very positive results, in accordance with the needs and preferences of users identified at the analysis stage. In this phase, the design of the media display is clearly designed so that it is easy for students to understand, the preparation of learning materials that are concise in simple words so that they are easy to understand by students, coupled with the use of animation as a support for the material presented in the learning media, the selection of attractive templates so that it is able to increase student learning motivation and reduce student boredom in learning. Finally, the addition of learning videos about the reproductive system in humans is interesting to complement and sharpen students'

understanding of reproductive system material. In addition, the integration of interactive features such as quizzes, educational videos, and animations.

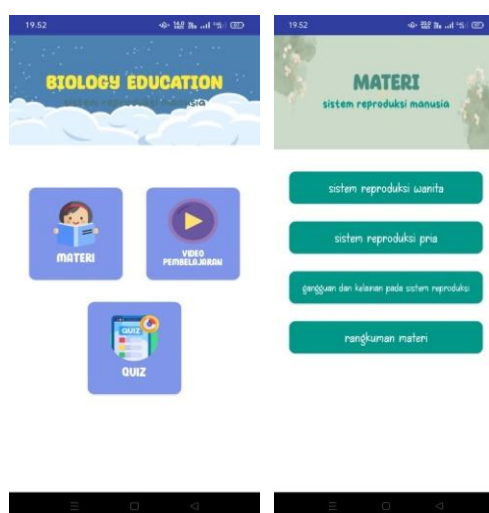
An Android-based biology learning media prototype developed using Kodular is designed to provide an interactive and user-friendly learning experience to students. This prototype includes a variety of features designed to improve students' understanding of biology material, particularly on the topic of reproductive systems. The app has an intuitive interface, making it easy for students to navigate through a variety of learning modules, which include text, images, videos, animations, and interactive quizzes. The prototype is presented in Table 3.

**Table 3.** Description of Learning Media Development Prototype

Feature	Description	Purpose
User Interface	Intuitive design with clear navigation menus	Make it easier for students to access and navigate the material
Learning Content	Text, images, videos, and animations	Helps visualize and understand biological concepts
Interactive Quiz	Multiple choice, true/false, and short fill questions	Tests students' understanding of the material
Search Feature	Search for specific topics in the app	Make it easier for students to find the information they need

### 3.3. Development stage

In the development stage, Android-based biology learning media using the Kodular platform goes through several critical stages that include prototype development, validation, and revision based on feedback from experts. The development process begins with the development of an interactive and user-friendly application prototype. This prototype was then validated by two groups of experts, namely material experts and learning media experts. The results of the development of android-based learning media designed using Kodular are presented in Figure 1.



**Figure 1.** Display of learning media using Kodular

After the media is successfully developed, the next step is to test the media validation by 2 experts, namely the media expert validator and the material expert validator. The results of the validation of media experts are presented in Table 4.

**Table 4.** Material Expert Validation Results

No.	Assessment Aspects	Value (%)	Category
1.	Content eligibility	82	Highly Valid
2.	Presentation quality	83	Highly Valid
3.	Language clarity	82	Highly Valid
<b>Average</b>		<b>82.33</b>	<b>Highly Valid</b>

Based on the data in Table 4. The average result of the percentage of validation of material experts is 82.33%, showing that the material in the learning media is included in the "Very Valid" criteria. The results of the validation of learning media experts are presented in Table 5.

**Table 5.** Media Expert Validation Results

No.	Assessment Aspects	Value (%)	Category
1.	Visual	82	Highly Valid
2.	Fill	83	Highly Valid
3.	Quality	82	Highly Valid
<b>Average</b>		<b>82.33</b>	<b>Highly Valid</b>

Based on the data in Table 5. The average result of the overall validation percentage above shows the "Very Valid" criterion with an average of 82.33%. The comments and suggestions from media experts are to improve the content of the material and the animation. However, beyond these scores, it is essential to highlight how the feedback from validators was implemented to improve the learning media. Material experts provided suggestions to enhance the depth of the content, ensuring that the information presented is comprehensive and aligns with the learning objectives. Based on this feedback, additional explanations were added to certain sections of the media, particularly in areas where students may require more detailed context to understand complex biological concepts (Susanti & Watrianthos, 2020).

From the media expert perspective, suggestions were made to enhance the animations used in the learning media, particularly to improve visual clarity and engagement. This feedback led to revisions in the design of the animations, making them more interactive and visually appealing to better capture students' attention and aid in the comprehension of difficult concepts (Husna et al., 2022). Throughout the validation process, some challenges were encountered. One of the primary difficulties was balancing the depth of content with the need for simplicity in the design. It was critical to ensure that the material remained engaging without overwhelming students with too much information. Additionally, technical limitations in the Kodular platform posed constraints on some of the suggested animation improvements, requiring compromises in the final design (Firdaus, 2020). The validation process not only confirmed the high validity of the learning media but also provided valuable feedback that was instrumental in refining the content and design. While the learning media was positively received by both material and media experts, future iterations may explore alternative platforms to address the technical limitations encountered in the animation features (Gunawan et al., 2017; Siboro & Purba, 2022).

### 3.4. Implementation stage

At this stage, the researcher implemented Android-based biology learning media (Kodular) in the biology learning process in schools to measure students' digital literacy ability. To evaluate the media's effectiveness, a pre-test and post-test were administered, focusing on conceptual understanding and digital literacy. The results are shown in Table 6.

**Table 6.** Pre-Test and Post-Test Results

Measured Aspects	Pre-test Mean ( $\pm$ SD)	Post-test Mean ( $\pm$ SD)	Improvement (%)
Biology Concept Understanding	58.3 $\pm$ 12.4	82.7 $\pm$ 9.8	41.8%
Digital Literacy	62.5 $\pm$ 14.2	87.1 $\pm$ 10.3	39.4%

The results in Table 6 demonstrate that the implementation of Android-based learning media developed through Kodular significantly enhanced students' understanding of biological concepts and their digital literacy. Prior to the intervention, the mean pre-test score for biology conceptual understanding was 58.3 ( $\pm$  12.4), which increased to 82.7 ( $\pm$  9.8) after the use of the media. This represents an improvement of 41.8%, indicating a substantial gain in students' comprehension. Similarly, digital literacy scores improved from a pre-test mean of 62.5 ( $\pm$  14.2) to a post-test mean of 87.1 ( $\pm$  10.3), showing a 39.4% increase. This reflects that the integration of digital tools within the learning process contributed effectively to students' skills in navigating, evaluating, and utilizing digital information. These improvements were further supported by statistical analysis using a paired t-test, which confirmed that the gains were significant at  $p < 0.05$ . The effectiveness of the media aligns with previous studies suggesting that multimedia-based and mobile-assisted learning environments enhance both cognitive and technological competencies (Putra et al., 2022; Herlina et al., 2021). In addition to measuring conceptual understanding, this study also assessed specific components of students' digital literacy to gain deeper insights into their strengths and weaknesses. The breakdown of these digital skills is illustrated in Figure 2.

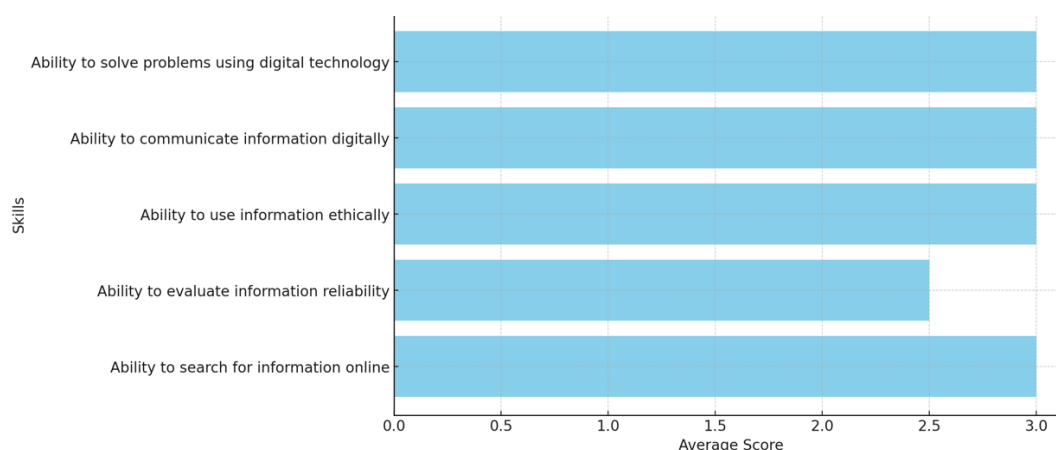
**Figure 2.** Digital Literacy Score of Students Using Kodular Learning Media

Figure 2 presents the average digital literacy scores of students using the Kodular-based media, highlighting several key findings. The highest proficiency among students was in digital communication, with an average score of 3.2, indicating that students are adept at using digital tools to share information effectively. However, the lowest score, 2.5, was in evaluating the reliability of online information, revealing a significant gap in their ability to assess the credibility of digital sources. This is particularly concerning in the current digital age, where access to vast amounts of information makes it critical for students to distinguish reliable sources from misinformation.

This finding suggests that while students may be proficient in digital communication, there is a pressing need for targeted instruction that focuses on critical digital literacy skills, such as information evaluation and verification. The relatively low score of 2.8 in information search skills further highlights the need for enhanced training in using search engines effectively and identifying relevant information. Additionally, students demonstrated only moderate skills in ethical information use (average score of 3.0) and problem-solving using digital tools (2.7), which underscores the importance of incorporating these aspects into future digital literacy instruction.

The broader implication of these findings is that while Kodular-based learning media facilitates improvements in some areas of digital literacy, it also reveals specific areas where students struggle, particularly in critical evaluation and problem-solving. These results align with existing research (Afriana et al., 2023; Gunawan et al., 2017) which suggests that digital media can improve cognitive skills but also highlights the need for more focused digital literacy instruction.

In terms of student responses, the feedback was overwhelmingly positive, with 94% of students rating the media as "quite effective" and 6% as "very effective" in helping them understand biological concepts, particularly on the topic of the reproductive system (Table 6).

**Table 6.** Results of student responses to Android-Based Learning media

No	Score	Category	Frequency	Percentage (%)
1.	85,01-100	Very effective	1	6%
2.	70,01-85,00	Quite effective	15	94%
3.	50,01-70,00	Less effective	0	0%
4.	01,00-50,00	Not effective	0	0%
<b>Total</b>			<b>16</b>	<b>100%</b>

While the media was well-received, the fact that only 6% rated it as "very effective" suggests room for improvement. Some students recommended expanding the media's features and covering a broader range of topics to further enhance its effectiveness. While 94% of students rated the media as 'quite effective,' only 6% rated it as 'very effective,' which suggests that while the media was well-received, there may still be areas for improvement. For example, some students suggested the addition of more advanced features or a broader range of topics beyond the reproductive system, which could enhance the overall effectiveness of the media in future iterations.

The interactive elements, such as animations, videos, and quizzes, were particularly valued by students for making complex concepts more understandable and engaging. The ease of use and intuitive design also contributed to a positive learning experience, increasing student motivation and engagement compared to traditional methods. These findings are consistent with previous studies (Susanti et al., 2020; Watrionthos et al., 2022), which emphasize the role of interactivity and visualization in enhancing student understanding.

Students report that Kodular-based learning media helps them feel more comfortable and motivated in learning. Interactive features such as animations, learning videos, and quizzes are very helpful in understanding complex concepts in a more engaging and fun way. Additionally, the app's intuitive and user-friendly interface makes it easy for students to access and navigate the learning materials without experiencing confusion or difficulty.

The positive response was also seen from the increase in student participation and involvement during the learning process. Students feel that this media provides a more dynamic and interactive learning experience compared to traditional learning methods such as the use of simple PPTs. The existence of visual and interactive elements in this learning media can reduce boredom and boredom, thereby increasing students' focus and attention to the material being taught. The use of android-based learning media can increase students' understanding of biology material (Susanti et al., 2020, Watrionthos et al., 2022). The interactivity and visualization offered by the media can help students better understand biological concepts (Watrionthos et al., 2022). In addition, other research suggests that the use of technology-based learning media, including androids, can motivate students to be enthusiastic about learning (Siboro & Purba, 2022). Thus, based on the results of the study, it can be concluded that android-based learning media is indeed effective in increasing students' understanding of concepts and literacy in learning biology material.

In conclusion, the implementation of Kodular-based learning media demonstrates its effectiveness in improving student engagement, motivation, and certain aspects of digital literacy. However, the data suggests that more focused efforts are needed to improve students' ability to critically evaluate digital

information and solve complex problems using technology. Future research should explore how this media can be adapted to address these specific challenges and provide more comprehensive digital literacy instruction in various educational contexts.

### 3.5. Evaluation stage

At the evaluation stage, the Kodular-based learning media developed showed highly satisfactory results, demonstrating both practicality and feasibility for use in the classroom. The evaluation involved gathering data from trials and student feedback, which indicated an average practicality score of 82.5%, reflecting the ease of use and positive reception among students. Furthermore, the media achieved a high feasibility score of 87.6%, indicating its strong potential for integration into both classroom and extracurricular biology learning.

However, beyond these percentages, the significance of these results lies in their implications for educators and future applications. The high practicality score suggests that this media not only fits well within existing teaching frameworks but also offers flexibility, making it accessible for students with varying levels of digital literacy. For educators, this indicates that Kodular-based media could be easily implemented without extensive training or infrastructure changes, providing an immediate and effective tool to enhance student engagement and comprehension. Moreover, the high feasibility score underscores the media's relevance in supporting diverse learning contexts, suggesting that it can be applied not just in biology but potentially adapted across multiple subjects and educational settings.

These results are supported by findings from Afriana et al. (2023) and Gunawan et al. (2017), who demonstrated that interactive, digital-based learning media enhance students' scientific attitudes and problem-solving skills. The success of Kodular-based media in this study similarly indicates that technology-enhanced learning environments can deepen student engagement and improve conceptual understanding, as noted in previous research by Chuang (2014).

In addition, student feedback from the evaluation provides insight into areas for further refinement, such as the suggestion to extend accessibility to iOS devices, highlighting the importance of inclusivity and flexibility in learning tools. This aligns with Firdaus' (2020) emphasis on developing media that is accessible across diverse devices. The feedback emphasizes the need for continual improvement to meet the broader needs of students in the digital age.

Overall, the evaluation results suggest that Kodular-based learning media not only meets pedagogical standards but also offers a scalable solution that could be adapted for wider use in various educational settings. Future research could explore its application across different disciplines and its long-term impact on learning outcomes, particularly in enhancing digital literacy and independent learning skills.

## 4. CONCLUSION

This study concludes that the development of Android-based biology learning media using the Kodular platform was highly effective in improving students' digital literacy and understanding of biology, particularly on the topic of reproductive systems. Students demonstrated enhanced abilities to find, evaluate, and use digital information, with the highest performance in communicating information digitally. The high validity (82.33%) and practicality (82.5%) scores highlight the media's strong potential for educational applications, ensuring that it meets pedagogical standards and can be successfully implemented in classroom settings. However, this study is limited by its small sample size, and further research is needed to explore its effectiveness in different educational contexts and larger populations. The broader significance of this study lies in its alignment with ongoing digital learning trends, offering a flexible, scalable solution that not only enhances subject-specific knowledge but also equips students with essential digital competencies. This research contributes to the field by demonstrating how Kodular-based media can be adapted across various disciplines, supporting the future development of innovative educational tools.

**Conflicts of Interest:** Declare conflicts of interest or state “The authors declare no conflict of interest.” Authors must identify and declare any personal circumstances or interests that may be perceived as inappropriately influencing the representation or interpretation of reported research results.

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