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Android-Based Constuct 3 Educational Game Development With ADDIE Model To Improve Human Reproductive System Learning Outcomes

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Abstract

Background: *The lack of interest and low learning outcomes of students in biology, especially in the complex and sensitive topic of the reproductive system, is the urgency of this study. Innovative media that can attract attention and suit the characteristics of the digital generation are needed. Therefore, this study aims to develop an Android-based educational game using Construct 3 on the subject of the human reproductive system for second grade (11Th class) high school students.* **Methodology:** *This research is a research and development (R&D) study using the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The instruments used include expert validation sheets, teacher and student response questionnaires, and learning outcome tests, with data analysis conducted using descriptive qualitative and quantitative methods.* **Findings:** *The validation results showed that the media was highly valid, with a score of 87.5% from subject matter experts and 98.8% from media experts. The practicality test obtained a score of 92% from students and 97,5% from teachers, while effectiveness was indicated by an N-Gain value of 0.79 (high category).* **Contribution:** *These findings imply that Construct 3-assisted digital educational games are not only practical to integrate into biology learning but also effective in increasing student participation, motivation, and learning outcomes.*

Keywords: *Android; Biology; Construct 3; Educational Game; Reproductive System*

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INTRODUCTION

The development and use of information and communication technology in the 21st century has brought about major changes in various sectors, including education (Maritsa et al., 2021). Information and communication technology enables learning to take place in a more flexible, interactive, and adaptive manner to the needs of students. According to Jannah et al., (2023), the integration of technology with learning can improve the quality of education by providing more varied and innovative media, especially in adapting to the characteristics of the current digital generation. Sujarwo et al., (2022) emphasize that technology in the learning space has been proven to increase student participation, motivation, and interest in learning, while also encouraging more exploratory and active learning styles.

One form of technology integration in learning is the development of educational games. This type of game is designed by combining educational and entertainment elements, with the aim of increasing students' active participation in the teaching and learning process (Sulistyowati et al., 2022). The application of games in education can create a fun, challenging, and interesting learning atmosphere, thereby potentially increasing motivation and strengthening student learning outcomes (Permatasari et al., 2022). Educational games can be used in the learning process to increase students' interest and reduce boredom during the learning process (Wiryaningtyas et al., 2023). Compared to passive lecture or video methods, educational games allow for active interaction that leads to improved conceptual understanding and cognitive skills (Lamada et al., 2022).

Particularly in biology education, the challenges faced by teachers are not only related to the complexity of the material, but also to the low level of student interest in learning (Reychan et al., 2025). Biology is often considered a challenging subject that is not interesting enough for most students (Sholeh et al., 2024). This is reinforced by the findings Heri (2019) that interest and motivation are directly related to learning outcomes. Students with high interest will find it easier to focus and understand the material, while students with low interest tend to be passive. Therefore, the use of innovative digital-based media is necessary so that complex material can be understood more optimally. This statement is reinforced by research conducted by Deadara (2017) that the use of educational games in teaching the reproductive system significantly increases student interest and learning outcomes. Therefore, the development of educational games is one relevant approach to address the challenges of teaching the reproductive system.

The human reproductive system is one of the most challenging topics. It contains many scientific terms, intersects with ethical and social norms, and often causes taboo among teenagers. An interview with a biology teacher at SMA Negeri 2 Percut Sei Tuan (February 3Rd, 2025) revealed that learning is still dominated by lectures and video screenings. This approach is not interactive enough, making students passive and difficult to understand the concepts of reproductive organ anatomy, the fertilization process, puberty, and related diseases. Similar findings were reported by Albar et al., (2023), whose research showed that reproductive system material is still considered taboo among adolescents, so students often feel embarrassed or uncomfortable discussing it in the classroom. In addition, conventional learning

media such as textbooks and workbooks are considered ineffective in explaining complex concepts because they are limited in their visualizations.

In responding to these challenges, the Game-Based Learning (GBL) approach has emerged as a promising alternative. GBL integrates the principles of learning through games, where students learn through exploration, challenges, and problem solving in the context of games. Gui et al., (2023) in a meta-analysis study of 86 international publications, concluded that digital educational games have a significant effect on greater learning achievement, especially in cognitive aspects. The effect size was in the moderate to high range ($g \approx 0.624$), indicating that games can be an effective medium for mastering science learning materials.

One popular and user-friendly educational game development platform is Construct 3, a web-based software with drag-and-drop features that allows the development of interactive games without programming skills (Ramadani, 2025). Construct 3 also supports file export in .apk format for Android, so that the developed games can be used directly on students' mobile devices. Zuhlina (2023) proved that the use of games contributes to improving students' understanding of the human digestive system. In addition, Permatasari et al., (2022) developed a Construct 3-based mathematics educational game called "MaTriG" for junior high school students, which aims to improve mathematics comprehension through more participatory procedures. Another study conducted by Permana et al., (2023) developed an Android-based adventure game set in a zoo using the Construct 3 platform. The results of this study prove that this educational game meets the criteria as an effective and enjoyable learning tool and is able to increase students' knowledge and skills regarding various types of animals in the zoo.

However, to date, no research has been found that specifically develops learning media using Construct 3 related to the topic of the human reproductive system. This gap opens up opportunities for research and development of Construct 3-based educational games as an alternative for learning about the reproductive system. With the interactive and visual approach offered by this platform, it is hoped that students will become more enthusiastic about learning and be able to master the concepts more deeply. In addition, this media also has the potential to improve learning outcomes through the integration of competency-based questions and direct reinforcement of material.

Referring to the problems described above, this study aims to develop a Construct 3-assisted digital educational game on human reproductive system material for 11th grade high school students. The resulting product is expected to be valid, practical, and effective for use in biology learning, as well as providing a real contribution in providing technology-based learning resources that suit the needs of the current digital generation.

METHOD

Population and Sampling Techniques

The population in this study was all 11th grade students at Senior High Scholl of SMA Negeri 2 Percut Sei Tuan in the 2024/2025 academic year. The sample consisted of 32 students from class XI-E, 1 biology teacher, and 2 expert validators (one media expert and one subject matter expert). The sample was selected using

purposive sampling, which is the deliberate selection of samples by considering direct involvement in biology learning, the suitability of the validators' fields of expertise, and the participants' willingness to take part in the entire research process.

Test Subjects

This study involved one material validator, one media validator, one biology teacher, and 32 students from class XI–E of SMA Negeri 2 Percut Sei Tuan who were selected through purposive sampling, which is a method of sampling deliberately by considering the competence and relevance of the subjects to the objectives of the research being conducted. The inclusion criteria for students included being registered as active students in class XI–E who were studying reproductive system material and were willing to participate in the trial. Students who were absent or did not complete the research instrument were excluded. For teachers, inclusion was determined by Biology teachers teaching class XI who were willing to assess the practicality of the media, while teachers who did not meet these criteria were excluded.

Research Design

This research is part of an R & D (Research & Development) study. The development model used to develop educational games in this study is the ADDIE model. The stages in the ADDIE model consist of five stages: *analysis, design, development, implementation, and evaluation* (Branch, 2009).

Development Procedure

The development research stages refer to the ADDIE model with the following stages:

Analyze Stage

This analysis phase determines what will be taught to students, namely through needs analysis and material analysis. Data was obtained through interviews with biology teachers using a guide sheet containing questions about the curriculum, student difficulties, media use, and expectations for the development of educational games. In addition, student needs analysis was conducted through questionnaires covering learning difficulties, device use, interest in digital media, and expectations for educational game features.

Design Stage

The second stage involves the preparation of a preliminary design or storyboard as the basis for product development (Mawarni & Hendriyani, 2021). At this stage, a systematic design of the main components in the development of Android-based digital educational games developed using the Construct 3 platform is carried out. This stage begins with the preparation of learning objectives designed in line with the learning outcomes in the Merdeka Curriculum, especially on the topic of the human reproductive system taught in second grade high school. Next, the material is designed to cover important concepts such as the reproductive organs and their functions in the male and female body, the process of fertilization, puberty, diseases or disorders of the reproductive system, as well as reproductive ethics and technology. The reproductive system material is integrated into the platformer game element.

The game mechanism is designed so that every time the character touches an interactive box, a score-based quiz or "Did You Know" information related to the material appears. Correct answers increase the score, while wrong answers reduce lives, so that the delivery of material is visual, interactive, and challenging. This stage also includes the preparation of a game storyboard to visualize the game flow, user interaction, and the presentation of material and evaluation questions. The game is developed in a single track with a duration of ± 15 – 20 minutes, containing 10 quiz questions, 5 Did You Know information, and obstacles that can reduce lives. Key features include platformer movement mechanics (running and jumping), a score and life system, and automatic feedback on each question. Flowchart Design of Educational Game found on figure 1.

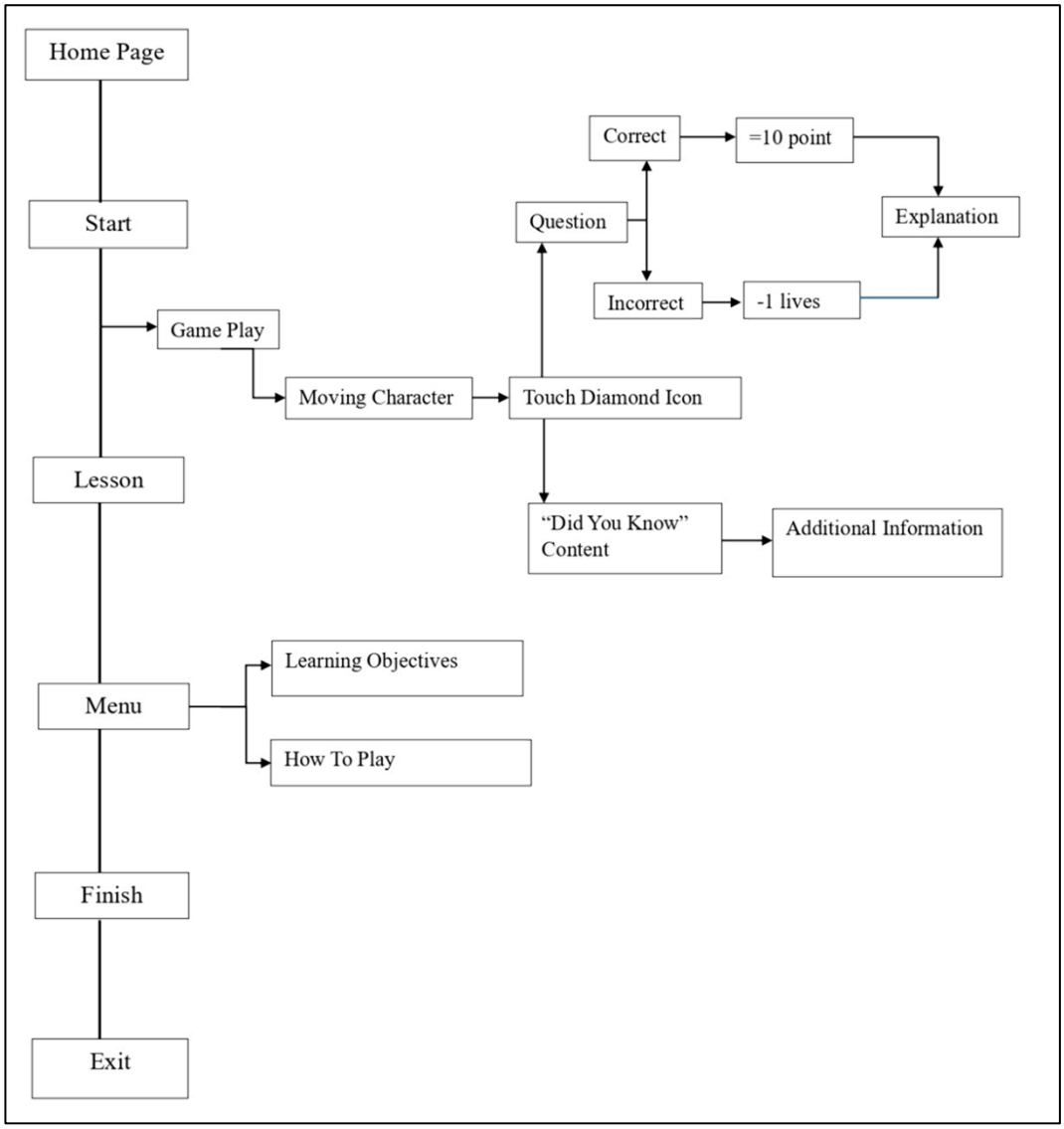


Figure 1. Game Flowchart Design
Source : Personal Documentation

In addition, assessment instruments were also developed, both for product validation by experts and for evaluating the effectiveness of the game on student learning outcomes. The assessment instruments included media, material, and question validation instruments, as well as learning outcome test tools. At this stage, student and teacher response sheets were also developed to measure the practicality of the media used. Finally, a learning strategy was determined for use in the game, namely game-based learning, which combines educational and entertainment elements to increase student engagement and motivation to learn in an active and enjoyable way.

Development Stage

During the development stage, the previously created design began to be realized in the form of a real medium in the form of an Android-based educational game using Construct 3. This initial product then underwent a series of validation processes to measure the validity of the learning medium before being tested extensively.

The validation process involved two expert validators, namely: (1) Media experts, who assessed the appearance, navigation, interface suitability, interactivity, and overall effectiveness of the game design; and (2) A subject matter expert, who examined the suitability of the content with the Merdeka Curriculum, the accuracy of biological concepts, especially material on the human reproductive system, the integration of the material with the game features, and the clarity and cognitive level of the learning outcome test questions integrated into the game. Validators were selected purposively, considering minimum academic qualifications of a master's degree in education/biology, teaching or research experience in relevant fields, and competence in assessing the suitability of learning media.

After validation and revision based on expert input, the product was proven suitable for larger-scale implementation. The product was tested through a large-scale trial involving 30 students on 11^{Th} grade and 1 teacher of biology at the Senior High School of SMA Negeri 2 Percut Sei Tuan. At this stage, students were asked to use the educational game and then fill out a practicality response questionnaire, which covered ease of use, visual appeal, material comprehension, and learning motivation. Teachers were also asked to assess the practicality of the media in the context of classroom learning.

The data from the questionnaire was used to evaluate the level of practicality of the media and as a basis for refining the product before the effectiveness evaluation stage. Through this development stage, it is hoped that a learning media product will be obtained that meets the criteria of validity and practicality in the context of biology learning in schools.

Implementation Stage

At this stage, the product should be used directly by educators and students to determine its effectiveness in supporting the learning process. In this study, the implementation stage could not be fully realized due to the limited time available during the research period.

Evaluation Stage

The evaluation in this study was conducted continuously throughout all stages of development, starting from analysis and design to limited implementation. Evaluation during the development stage was carried out through assessment by media and material experts with the aim of assessing the suitability of the content, appearance, and feasibility of the features in the educational game that was designed. The responses and recommendations from the experts were used as a reference in the product refinement process.

After improvements based on expert validation, the product was then evaluated by practitioners, namely biology teachers who assessed the practicality of using the media in learning. In addition, the educational game was also tested by students to obtain their responses regarding its ease of use, engagement, and usefulness in assisting the learning process. The results of this evaluation are used to determine the extent to which the developed media can be accepted and used effectively in the context of classroom learning.

Data Analysis

Research findings were collected in both qualitative and quantitative data. Descriptive information sources included interviews with teachers and critiques and responses provided by validators. Quantitative measurement results were obtained through assessments using validation sheets, pre- and post-tests, and student and teacher response questionnaires. The collected data were then reviewed and processed qualitatively and quantitatively using a descriptive approach. Data analysis aimed to obtain a suitable medium that was easy to apply and provided optimal results. This study applied the Likert scale assessment method, with details presented in Table 1.

Table 1. Likert Scale Assessment Guidelines. Source: (Nanda & Ulfa, 2024)

Score	Assessment Criteria
1	Very Poor
2	Not Good
3	Good
4	Very Good

The scale of 1–4 reflects the assessment categories from very poor to very good. Validity analysis was conducted based on the results of the validation sheet filled out by media validators and material validators. The calculation formula for the validation sheet uses Formula (1), which refers to (Nanda & Ulfa, 2024). The data from the validation sheet was analyzed to measure the level of validity using the following Formula 1:

$$\text{Percentage (\%)} = \frac{score\ obtained}{score\ maximum} \text{ x } 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (1)}$$

Table 2. Validation Assessment Criteria. Source: (Sugiyono, 2017)

Percentage (%)	Assessment Criteria
76 – 100	Very Valid
56 – 75	Valid
40 – 55	Quite Valid
0 – 39	Invalid

The practicality test was conducted by reviewing the data obtained from student and teacher response questionnaires. The learning media was considered practical if it achieved a practicality level of above 70.01%, as shown in Table 3. The practicality analysis of the educational game was calculated using Formula (2), which refers to Maharani et al., (2023).

$$\text{Percentage (\%)} = \frac{score\ obtained}{score\ maximum} x100\% \quad \text{..... (2)}$$

The effectiveness of the Educational Game was tested using a test instrument to measure learning outcomes, consisting of a number of questions designed to assess students' mastery of the material after using the developed media. The level of effectiveness was calculated using the N-Gain formula (3) with refers to Kurniawan & Hidayah (2020), and the calculation results were interpreted based on the reference in Table 4.

Table 3. Practicality Assessment Criteria. Source: (Sugiyono, 2017)

Percentage (%)	Assessment Criteria
81 – 100	Very Practical
61 – 80	Practical
41 – 60	Quite Practical
21 – 40	Not Practical

$$\text{N-Gain} = \frac{posttest\ score - pretest\ score}{maximum\ \ value - pretest\ score} \text{ x 100 \% ..... (3)}$$

Table 4. N-Gain Outcome Criteria. Source: (Kurniawan & Hidayah, 2020)

Percentage (%)	Classification	Criteria
$0.70 \leq n \leq 1.00$	High	Effective
$0.30 \leq n < 0.70$	Currently	Effective Enough
$0.00 \leq n < 0.30$	Low	Not effective

RESULT AND DISCUSSION

Research findings on the design and creation of learning tools in the form of Android-based educational games using Construct 3 on the subject of the human reproductive system for second grade (11^{Th} class) students. This media was developed using the ADDIE model.

Analysis Stage

The first step in developing learning tools following the ADDIE model began with identifying needs through interviews with second grade biology teachers at SMAN 2 Percut Sei Tuan. The findings from the interviews showed that the teaching and learning process had been conducted conventionally, such as PowerPoint presentations, educational videos, and online quizzes such as *Kahoot* or *Quizizz*. The teachers said that they had never used educational games as learning media in class. This condition indicates a need for learning tools that encourage student engagement.

The next stage involved a conceptual study by the researcher, which included curriculum analysis and student needs analysis. The curriculum analysis refers to the regulations of the Ministry of Education, Culture, Research, and Technology on 2022, specifically phase F for second grade high school students in the Merdeka Curriculum. The topic of the human reproductive system was chosen because it contains concepts that are not simple and are important for students to understand.

Next, a student needs analysis was conducted to determine the suitability and relevance of the learning tools to be developed. This analysis was carried out by distributing a student needs analysis questionnaire containing questions related to previous learning experiences, interest in interactive media, and their preferences for more interesting and enjoyable learning models.

These findings reinforce the basis that the development of Android-based educational games using Construct 3 is an innovation that suits the needs of students and is able to encourage an increase in their motivation and learning outcomes in understanding the material on the reproductive system.

Design Stage

The next stage in the design process involves designing a web-based educational game using the Construct 3 platform. This design process includes four main stages as follows: 1) Development of Reference Tests. At this stage, researchers collect core material on the human reproductive system, including the organs and functions of the human reproductive system, the fertilization process, the menstrual cycle, sexually transmitted diseases, and efforts to maintain reproductive health. This material is adapted to Learning Outcomes phase F in the Merdeka Curriculum for grade XI. This information is used as the basis for compiling pretest and posttest questions, as well as educational content to be included in the game. 2) Selection of learning media in the form of an Android-based educational game created with the help of the Construct 3 platform. This platform was chosen because it allows the development of interactive games without the need for application installation, so that it can be accessed directly through a browser. 3) Designing the Game Display and

Flow. The interface display and game flow are designed to be attractive, interactive, and enjoyable for students. The game concept adapts the side-scrolling platformer style, where players move through the track while facing various light challenges. Throughout the game, players will encounter interactive boxes, each containing 10 multiple-choice questions and 5 "Did You Know" content items, which are interesting and educational information about the human reproductive system. Every time a player touches one of the boxes, a question will appear that must be answered before they can continue the game. After answering, whether correctly or incorrectly, players will immediately be given a discussion of the question to reinforce their understanding. The questions are compiled with reference to learning indicators that refer to cognitive levels C1 to C4. In addition to the challenge element in the form of questions, the game also features concise material, learning objectives, and game instructions, all of which are designed using the Canva application to make them visually appealing and easy to understand. This material can be accessed through a special menu in the game before starting the adventure. To support the visual aspect, game assets such as player characters, backgrounds, and other supporting graphic elements are obtained from the digital asset provider website itch.io, which can be accessed at https://itch.io/ , and then adjusted to align with the theme of the reproductive system. The colors, icons, and layout in the game are designed with the characteristics of high school students in mind. 4) Game Format and Mechanism Design. The game is designed in a web-based format that can be run directly through a browser and can also be downloaded as an application for more flexible use. According to the findings Oula et al., (2024), Construct 3 can be used offline, even with the Chrome browser, so an internet connection is not required.

The game consists of only one main level, as it carries a focused educational adventure concept. Even though there is only one level, the challenges in the game are still made interesting and challenging by adding a life system. Players will lose one life every time they touch a mine or obstacle scattered throughout the game.

Develop Stage

The next stage was the development stage, in which the Repsy Game educational media began to be developed after an assessment of its suitability by two validation experts, namely media validation experts and material validation experts who also validated the learning outcome test questions. Before the game was tested on students, the two validators provided some input, particularly regarding the quality of the questions, the readability of the text, and the visual appearance of the game. The improvements made included rewriting the questions to make them clearer, adding supporting icons, and adjusting the colors to make them more contrasting and attractive. A summary of the suggestions and revisions to this educational game media is presented in Table 5.

Table 6 shows that media content about the human reproductive system obtained a minimum score of 81 % in terms of language, while the attractiveness aspect obtained a maximum score of 100 %. The other two aspects, namely content and presentation, obtained scores of 91 % and 82 %, respectively. Overall, validation by subject matter experts resulted in a percentage of 87.5 %, which is considered a high level of validity and is declared suitable for use. Furthermore, this web-based

educational game with an adventure approach was also validated by media experts to ensure the suitability of its appearance and functionality. The assessments carried out by subject matter experts and media experts are shown in Table 6 and Table 7.

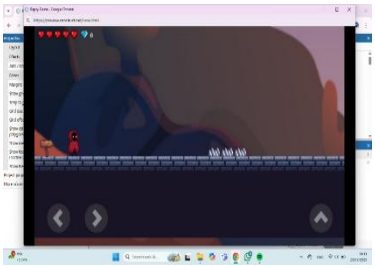
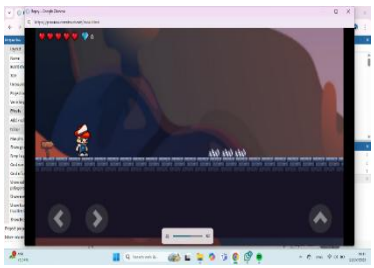
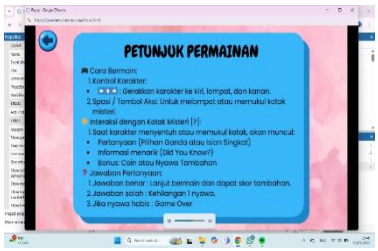
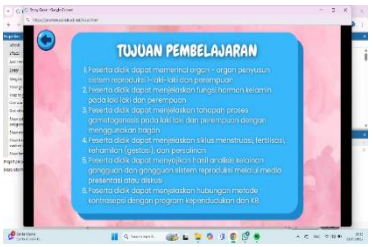
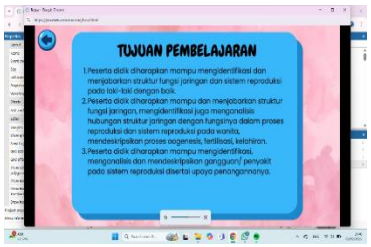
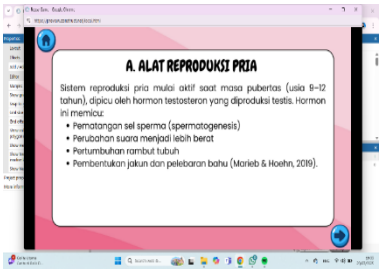
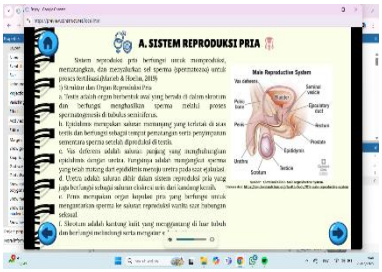
Table 5. Summary of Suggestions and Improvements for Educational Game Materials

No.	Game Content Before Revision	Validator Suggestions	Game Content After Revision
1.	The title is incomplete, only "Reproductive System."	Add whether it is the reproductive system in humans or animals?	Human Reproductive System
2.	Points of discussion directly related to male and female reproductive organs without introduction	First, explain what the reproductive system is and its functions. Include sources.	Adding an explanation of the reproductive system before moving on to the discussion points
3.	Sub-topic: Reproductive organ disorders	Change the title of the sub-topic to abnormalities and diseases of the reproductive system, adding details to the discussion.	The sub-topic title becomes "Abnormalities and diseases of the reproductive organs," then add material on reproductive organ health and hygiene.
4.	There is no sub-material on reproductive technology and ethics & morals in the reproductive system.	Adding 2 additional points	Presenting material on Reproductive Technology and Ethics & Morals in the Reproductive System
5.	There are no sources in the supporting images.	Add a source to each image	Adding sources to each image

Table 6. Material Validation Test Results

No.	Aspect	Score Obtained	Score Maximum	Persentage (%)	Criteria
1.	Content	29	32	91	Very Valid
2.	Presentation	23	28	82	Very Valid
3.	Attractiveness	12	12	100	Very Valid
4.	Language	13	16	81	Very Valid
	Score obtained		77		
	Score maximum		88		
	Persentage		87.5 %		
	Criteria		**Very Valid**		

Table 7. Summary of Suggestions for Improving Educational Games

Game Design Before Revision	Game Design After Revision	Validator Suggestions
		It would be better to add a materials button on the main page.
		Replacing the player to better suit the character of the students. The player before revision was deemed not to reflect the character of the students.
		Change the font color to black so that it is easy to read and understand.
		Adjusting learning objectives to each material and question in the game and changing the font color to black
		Adding content, adding images and references.

After undergoing validation by experts and revisions based on the feedback provided, the final product, an Android-based educational game, was declared suitable

for use. This game was developed using the Construct 3 platform and can be played on Android-based mobile devices. For easy access, the developed game can be accessed via the following link:https://repsy.netlify.app/

Table 8. Results of Media Expert Validation Test

No.	Aspect	Score Obtained	Skor Maximum	Percentage (%)	Criteria
1.	Game Type	4	4	100	Very Valid
2.	Educational Game Format	16	16	100	Very Valid
3.	Game Elements	8	8	100	Very Valid
4.	Educational Game Principles	7	8	87.5	Very Valid
5.	Simplicity	12	12	100	Very Valid
6.	Integration	8	8	100	Very Valid
7.	Balance	12	12	100	Very Valid
8.	Color	8	8	100	Very Valid
9.	Shape	12	12	100	Very Valid
	Score obtained		87		
	Score maximum		88		
	Percentage		98.8 %		
	Criteria		**Very Valid**		

Referring to Table 6 and Table 8, the validity assessment results from two expert validators prove that this educational media is categorized as very feasible, with an average score of 98.8 % by media experts and 87.5 % by material experts. There are several aspects that received the highest ratings from media experts, such as visual design and game simplicity, while material experts placed more emphasis on the format of the material and its suitability for learning objectives. Thus, the media has met the eligibility standards in terms of content and technical aspects. This statement is supported by Wahidin (2025), who states that learning media is considered effective if it has visual appeal and supports conceptual knowledge.

Table 9. Practicality Test Results Based on Teacher Response Questionnaires

No.	Aspect	Score Obtained	Score Maximum	Percentage (%)	Criteria
1.	Content	22	24	91.6	Very Practical
2.	Learning Outcomes	12	12	100	Very Practical
3.	Presentation	32	32	100	Very Practical
4.	Relevance to Learning Needs	12	12	100	Very Practical
	Score obtained		78		
	Score maximum		80		
	Percentage		97.5 %		
	Criteria		**Very Practical**		

Table 10. Practicality Test Results Based on Student Response Questionnaires

Number of Respondents Obtained	Score Maximum	Percentage (%)	Criteria
1656	1792	92 %	Very Practical

The practicality of Android-based educational media assisted by Construct 3 on reproductive system material for 11th grade high school students was obtained through teacher and student response questionnaires after the media was validated by validators. Data obtained from the study showed that the percentage of practicality according to teacher responses reached 97.5 %, while that of students was 92 %, both of which were classified as very practical. The findings in this study are in line with several previous studies which stated that students responded positively to the use of educational games as learning media (Pramuditya et al., 2017). Teachers stated that this media was easy to use, fun, and appropriate for the material, while students felt more motivated and interested in learning through interactive and game-based activities. Research by Wengsti (2022) also reinforces this study by stating that the use of educational games as learning media can create a more exciting learning situation, increase student focus, and encourage student involvement in the teaching and learning process. Therefore, the media designed has been proven to be practical to use and has a positive impact on the learning experience of students.

Table 11. Effectiveness Test Results Based on N-Gain

Average pretest	Average posttest	Score N-Gain	Percentage (%)	Criteria
31.09	85.46	0.79	79	Effective

The effectiveness of the educational media developed was measured through pretest and posttest scores, where the average score increased from 31.09 to 85.46 on the posttest. The N-Gain score obtained was 0.79, which is classified as high, indicating that the use of this media is effective in improving student learning outcomes. The results of this study are in line with various other studies that support the effectiveness of game-based learning (GBL) in biology learning. Reychan et al., (2025) found that GBL significantly improved students' critical thinking skills in biology learning. In addition, Hidayat & Hamidi (2023) showed that GBL was more effective than traditional lectures in improving learning outcomes.

The absence of educational game-based media reinforces the urgency of developing innovative media that suits students' characteristics. The use of Construct 3 in creating Android educational games on the subject of the reproductive system has proven to be a potential solution. This is similar to the findings of Arista & Kuswanto (2018), which emphasize that the use of Android-based virtual laboratories in the form of educational games can increase students' learning independence and conceptual understanding.

The media validation process by validators indicates that the educational games developed are highly valid, with scores reaching 87.5 % and 98.8 %. Content- and aesthetics-based expert input—such as the addition of reproductive ethics

material, game layout redesign, and graphic sources—was accommodated to improve the quality and relevance of the media. According to Panjaitan et al., (2020), an important aspect that must be considered in designing game-based interactive media is the material because it serves as the main foundation in building educational content. This is also in line with Noris et al., (2023), who developed Construct 2-assisted biology learning media to improve students' critical thinking skills; the results of the study prove the high validity of the media, showing that the Construct platform can produce effective media that is suitable for practical use in the learning space. Thus, the validation and revision process not only strengthens the quality of the content but also maximizes the suitability of the media for learning objectives.

After validation, the media was tested in an second grade high school class and received very positive responses from teachers and students. The practicality score by teachers was 97 % and by students was 92 %, all of which fell into the very practical classification. Teachers stated that this media was easy to use and helped manage the class dynamically, while students felt more interested and active in participating in the learning process.

The improvement in student learning achievement can be seen based on the increase in the average pretest score from 25.26 to 85.46 on the posttest, with an N-Gain value of 0.79, which is categorized as high. These results confirm that Android-based educational games are highly effective in helping students master reproductive system material. Gui et al., (2023) emphasizes that game-based learning contributes significantly to student academic achievement, particularly in the cognitive domain and scientific concept understanding.

The use of Android-based educational games in biology learning opens up new opportunities for teachers to deliver lesson material in a more engaging, interactive, and appropriate manner for the characteristics of the digital generation of students. This is in line with the findings of Watrianthos et al., (2022), which state that students find interactive Android media more enjoyable and effective for learning biology. The reproductive system material, which has been considered sensitive and abstract, can be packaged in a way that is easier to understand through visualization, simulation, and challenges in games. Similarly, the findings Prayitno et al., (2022) prove that Android games on the circulatory system material are valid and practical for use by high school teachers and students, substantially increasing interest in learning.

This study has several limitations. First, although the game was developed for Android, the test results showed that it was more optimal to access it via a laptop than via the students' Android devices, because the display size and game controls were more stable on a wide-screen device. Second, this study was limited to one educational institution and only involved one class. Thus, the results obtained cannot be used as a general reference for other school contexts. Therefore, it is recommended that future studies involve a diverse population and cover other learning materials in order to obtain a more comprehensive picture of the effectiveness of the developed media.

CONCLUSION

Based on the completed research and development process, it can be concluded that the Android-based educational game using Construct 3 on the subject of the human reproductive system has a very high level of validity, practicality, and effectiveness, making it suitable for use in biology lessons for 11th grade high school students. Validation by subject matter and media experts proved a high level of feasibility, with scores of 87.5% and 98.8%, respectively. Practicality tests conducted by teachers and students scored 97% and 92%, which is classified as highly practical. In addition, the effectiveness test based on the pretest and posttest results showed progress in student learning outcomes with an N-Gain of 0.79, which is classified as high. The use of this educational game was able to improve learning outcomes, student participation, and understanding of reproductive system material, which has been considered abstract and uninteresting. Therefore, the educational game that has been developed can be an innovative alternative in technology-based biology learning, especially for complex topics that require a visual and interactive approach. Further research could expand the scope of testing to other populations and biology materials to test the consistency of the media's effectiveness. Practically, this game can also be adapted by teachers as a supporting medium for digital-based learning in the classroom or for student self-learning.

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