



## Infusing Vibrancy into Science Learning through Weismann: An Educational Game for Learning Plants and Animals' Reproduction Systems

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### Abstract

*This research endeavours to develop an educational game, Weismann, designed to enhance the engagement and effectiveness of teaching and learning about plants and animals' reproduction systems. Named after August Friedrich Leopold Weismann, the pioneering scientist behind the germplasm theory, the game aims to infuse vibrancy into the learning experience. Adopting a Research and Development (R&D) framework, the study employs sourced data from multiple channels, including expert validation assessment scales as well as science teachers and their students' feedback on their practical experiences as users. The findings reveal Weismann to be highly valid, scoring 91.2, and remarkably practical, with teachers and students rating it at 95.9 and 83.9, respectively. These results affirm the game's efficacy as a valuable tool for science education, offering a dynamic and effective approach to learning.*

**Keywords:** Educational Game; Science Learning; Reproduction Systems

### Introduction

Planning, implementation, and evaluation of learning are three important things in the learning process (Panigoro, 2018). This is the reason learning evaluation is an activity that is as important as knowledge transfer. Educational evaluation involves 3 stages: input, process, and outcome; evaluation of student learning is a method used to monitor the process, progress, and revision of learning outcomes (Rokhim et al., 2021). The student evaluations and student learning assessments serve as an important lens through which to examine the teaching (Fisher, 2019). In his book "Becoming a Critically Reflective Teacher", Stephen Brookfield (1995) makes the case that critical reflection on one's own teaching is a crucial

component of growing as a teacher and enriching students' learning experiences.

During the observation, some information was collected: (1) The lack of willingness, interest, enthusiasm, motivation, and enthusiasm of students to do the evaluation tests. That is because the evaluation model tends to be the same from time to time, which affected most of the students who did not complete the evaluation test; (2) The test question models without pictures or animations force students to imagine something abstract. Furthermore, evaluation tests also tend to make students tense and nervous; (3) In the pandemic era, the time for one hour of face-to-face lessons has been reduced, resulting in students not having enough time to do evaluation tests; (4) In general, students have the ability to

operate digital technology; and (5) Students generally have a high interest in digital games. Maki (2002) states instructors assist students in "understanding their strengths and shortcomings and reflecting on how they need to progress over the course of their remaining courses" by examining their performance through formative assessment and sharing the results with them.

Based on observations, it is known that junior high school students are Digital Native Students (DNS). DNS are the generation that was born when technology was already in their environment (Dingli & Seychell, 2015). This fact can facilitate the implementation of evaluations in the era of the pandemic, considering that everything must be done with the help of digital technology. One of the evaluation methods that can be used is game-based learning. An educational game needs to be developed as an evaluation tool. Previous research related to game-based learning includes: (1) Sasongko and Suswanto (2017) found that the games developed were valid to be used as learning evaluation tools; (2) Naimah et al. (2019) proved that the developed science adventure game can improve the problem-solving skills of junior high school students in science learning; (3) Rohwati (2012) found that educational games can increase student activity in the learning process, apply ICT in learning, and have a good impact on language acquisition; (4) Indra et al. (2018) said that the instructional game with the Luther Model was effective in improving science learning outcomes.

This study aimed to develop a valid and practical game as an evaluating tool for science learning by adopting the principle of "Stealth Assessment". Stealth Assessment is a method that utilises digital games to discreetly assess students' level of conceptual understanding (Georgiadis et al., 2021). Thus, students feel that they are only playing a game, not taking a test. Students can play educational games without worrying about the availability of storage space on their smartphones. In this case, the game was

developed based on a web browser by utilising Google Sites. This game was named "Weismann", derived from the name of the scientist who created the germplasm theory, August Friedrich Leopold Weismann.

## **Methodology**

The type of research conducted is Research and Development (R&D) with the Plomp development model. The Plomp model developed by Tjerd Plomp consists of three stages: preliminary research; prototyping stage; and assessment phase (Plomp, 2013). The preliminary research stage involves the needs of student, curriculum, and concept analysis; the prototyping stage involves formative evaluation (self-evaluation, expert review, one-to-one evaluation) and small group evaluation. This study is limited to practicality testing through small group evaluation. The data came from two sources: first, testing the validity of the product by experts, which involves three Science Education lecturers at Universitas Negeri Padang; and second, involving four junior high school science teachers and 30 junior high school students for a practicality questionnaire. The expert validation questionnaire covers three aspects: the learning design; the visual communication; and the device. The product assessment questionnaire by users includes four aspects: usability; ease of use; attractiveness; and clarity.

## **Results and Discussion**

The product developed in this study was the educational game "Weismann" based on Google Sites, which contained the concept of the Breeding System in Plants and Animals for Junior High Schools. Product development was based on the lack of availability of digital evaluation tools for students on the product concept. This game was expected to help visualize evaluation test objects that were difficult to observe directly, which could be in the form of images, animations, and sounds. In addition, the evaluation system also allowed for deep

interaction between multimedia and students as users. With this two-way interaction and supported by appropriate media types, learning activities will be more interesting, the learning environment more dynamic, and learning more effective (Asyhar et al., 2012).

### 1. Preliminary Research

Interviews conducted with science teachers revealed significant concerns regarding students' motivation and enthusiasm for participating in evaluation tests. Students often displayed a lack of willpower, interest, and passion when it came to completing assignments and quizzes. This disengagement frequently led to incomplete work and negatively affected students' overall academic performance. Furthermore, evaluation tests often induced anxiety and nervousness among students, which contributed to scores falling below the average mark. When asked, students identified repetitive and unchanging teaching methods as primary reasons for their lack of interest, indicating that the monotony led to feelings of boredom.

The research also involved an in-depth analysis of the Kompetensi Dasar (KD) outlined in the standard science curriculum, which served as a foundation for developing an educational tool called “Weismann.” Focusing on the concept of the Reproductive System in Plants and Animals for Grade 9, the analysis delineated several key competency indicators. These include:

1. Classifying angiosperm plants based on vegetative reproduction,
2. Interpreting the roles of different pollination intermediaries,
3. Describing various seed dispersal mechanisms,
4. Sequencing the life cycles of angiosperms, gymnosperms, ferns, and mosses,
5. Categorizing animals based on reproductive strategies,

6. Grouping animals by their life cycles,
7. Sequencing the life cycle of jellyfish, and
8. Identifying different types of reproductive technologies in both plants and animals.

This curriculum mapping ensures that the educational tool aligns with the competencies required for Grade 9 science, with a strong emphasis on visualization to aid students' comprehension of complex concepts.

Junior high school students, typically aged between 12 and 15 years, are in a developmental stage known as the formal operational phase, characterized by heightened emotional sensitivity and rapidly shifting enthusiasm for learning. According to Muhibbin (2007), these students require learning experiences that support critical thinking and cater to their emotional and cognitive development. They are drawn to vivid, harmoniously contrasting visuals and benefit from interactive and engaging learning methods. Given their psychological and cognitive profiles, this age group also thrives on having a degree of freedom and experience-based learning opportunities.

The Reproductive Systems chapter includes multiple life cycles—such as those of angiosperms, gymnosperms, ferns, and mosses—that are conceptually abstract and difficult to internalize through traditional verbal explanations. Incorporating visual aids into evaluation tools, such as diagrams and animations, can enhance students' understanding and retention. Visual content serves to create longer-lasting mental images, making complex information more accessible and memorable.

An analysis of students' needs and preferences provided crucial insights into designing an effective evaluation tool. Understanding the characteristics and interests of students highlighted the necessity for an engaging, game-based, and mobile-friendly evaluation format. Asyhar et al.

(2012) noted that students in this age group often prefer digital games, which informed the decision to create a mobile-based assessment tool. This approach capitalizes on students' enthusiasm for gaming and leverages it to increase motivation and improve academic performance.

Game-based evaluations have several advantages. According to Smaldino (2011), games are highly effective at capturing students' attention and fostering motivation, leading to the development of targeted skills in an engaging way. Additionally, the curriculum analysis and feedback from students indicated that traditional methods of quizzes and assignments were perceived as

monotonous and abstract. Tools that integrate games and visual content can clarify and simplify complex scientific concepts, preventing overly verbal or text-heavy presentations and making learning more appealing (Arief & Sadiman, 2009).

## 2. Prototyping Stage

### a. Self-Evaluation

Table 1 showed the self-evaluation result of the educational games product. There are only two aspect which does not meet the qualification, that are some errors of the part of the product and the display of the image and text on the product. Those parts are become suggestion to revising the product.

**Table 1.** Self-Evaluation Results

No	Statement	Evaluation	
		Yes	No
<b>A Navigation</b>			
1.	There are guides	✓	
2.	Can be operated on all smartphone brands	✓	
3.	Button function works fine	✓	
4.	Consistent button placement	✓	
5.	Not easy to error		✓
<b>B Test Questions</b>			
1.	The questions presented are in accordance with KD	✓	
2.	Questions are presented sequentially	✓	
3.	If there is a question that involves something abstract, then it is simulated with pictures and animation	✓	
4.	Game contains questions on essential concepts	✓	
5.	Questions tailored to the growth of students	✓	
<b>C Graphics</b>			
1.	The animation is according to concepts of the breeding system in plants and animals.	✓	
2.	Images and text are correct and legible		✓
3.	Colour according to the characteristics of students	✓	
4.	Animation can run well	✓	
5.	Using communicative sentences	✓	

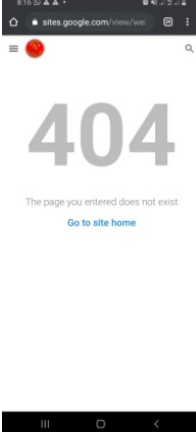



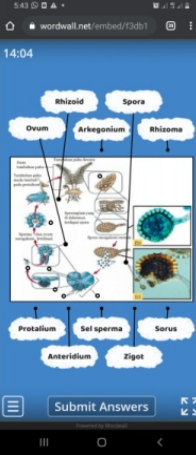
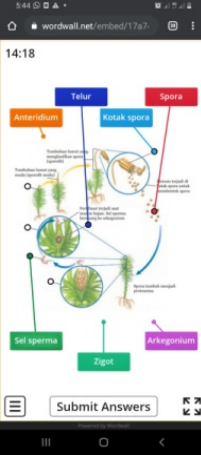
### a. Expert Review

At this stage the educational game “Weismann” was tested and assessed by the experts. The product was validated by three experts who are competent in their fields. There are some errors on the

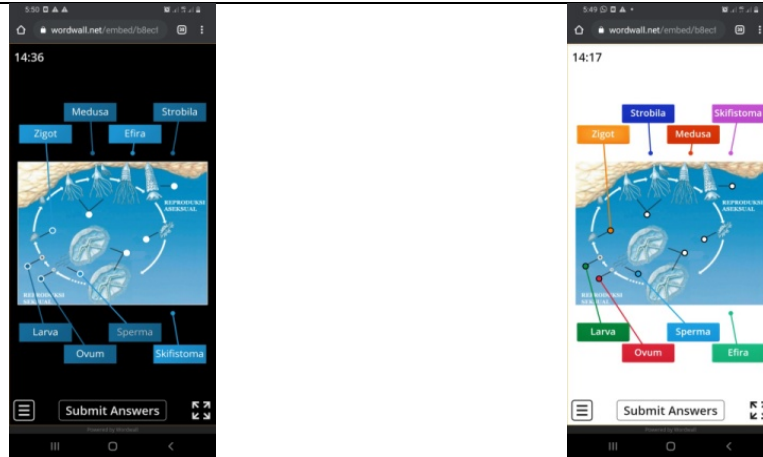
product and the result of the test is in line with the result of the self-assessment process. So, the revision was conducted based on those test results.

The appearance of the product before and after revision is shown in table 2.

**Table 2.** Revision Result based on Expert Review

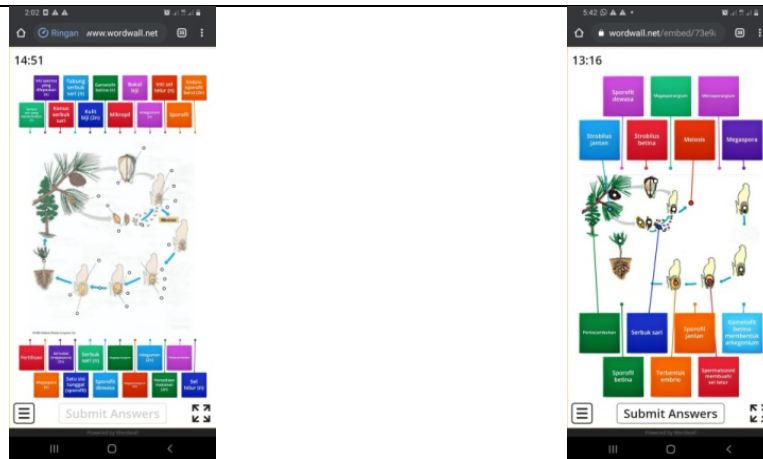
No	Before Revision	After Revision
1		
<p>There was an error display when accessing the game on stage 10. This problem was because there was an error in entering the code, so it failed to run.</p>		
2		
<p>Stage 10 was constantly displaying the loading icon. This results in the user not being able to start the game because it was only stuck until the initial loading.</p>		
3		
<p>Stage 6, which had the same appearance as stage 5. This happened because of the wrong code entered. The code used to build stage 6 was copied from the previous code, which was stage 5.</p>		

4



Changing the background colour of the game on stage 9. This was because the initial design had the same colour as the drag line in the answer. It was feared that it could cause doubt for users.

5



Enlarging the resolution of the stage 4 image. This was because the initial image had a blurry appearance.

Besides testing the function of the product, the experts also do the validation of the product. The validation process used a questionnaire and consisted of three components: learning design (D), visual communication (K), and devices (P). The validation result of each aspect can be seen in figure 1.

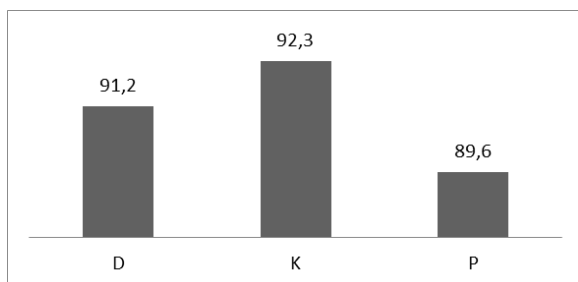


Figure 1. Result of Validity Assessment

The average score on the instructional design component was 91.2. This showed that

its validity score was in the ‘very good’ category. An average score of 92.3 was obtained for the visual communication component. Similarly, this shows that the validity of the display component was in the ‘very good’ category. The last was the device component. If averaged, it had a score of 89.6. This shows the validity score of the system components was in the ‘very good’ category.

The results of the product validity assessment in the learning design aspect were included in the very valid category. Based on this, the game developed by the goals and learning indicators that had been set. In addition, the games developed could also measure the achievement of competence and were in accordance with the direction of learning. This game could make the evaluation process more interesting and

interactive. Most importantly, the games developed were in accordance with students' ability level and could also train students to think fast, be creative, and work independently. Thus, based on the value obtained, it could be concluded that the product developed had met the valid criteria for the learning design aspect.

In the aspect of visual communication, product validity is in the very valid category. Based on this, it can be concluded that the language used in the game is easy to understand, the game contains good and correct language rules, the sentences are communicative, effective, and efficient, and the vocabulary used is correct. In addition, the images, layouts, menu designs, and animations used have been included in the good category. Based on the score, it can be concluded that the product developed has met the valid criteria in the aspect of visual communication.

In the aspect of the device, the validity of the product is included in the very valid category. Based on this, it can be concluded that the game does not make errors when played. The game can also run well even without certain applications.



Moreover, the game can be used on all smartphone brands and does not interfere with other systems on the smartphone used. In addition, the operation of the game is relatively easy and simple, can be used repeatedly, and does not require a large amount of RAM. Most importantly, the games developed have met the principle of originality.

The conclusion that can be drawn from the validator's validation of the three aspects of product validity is that the game developed is included in the valid category. Validation is the process of requesting approval or ratification of the suitability of the product developed so that the product developed is feasible and suitable for use in learning evaluation (Asyhar, 2012).

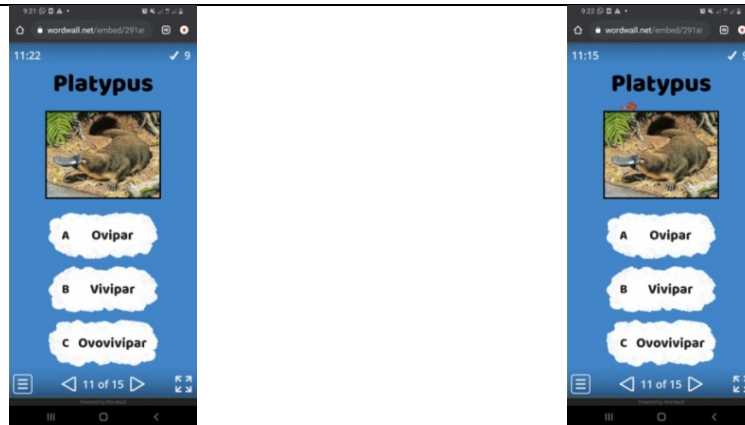
**b. One-to-One Evaluation**

The last part of prototyping stage is one-to-one evaluation. On this part the product was tested by random users. They give some suggestions for improving the user interface, accessibility, and the function of the product. The revision result based on the on-to-one evaluation process was shown on table 3.

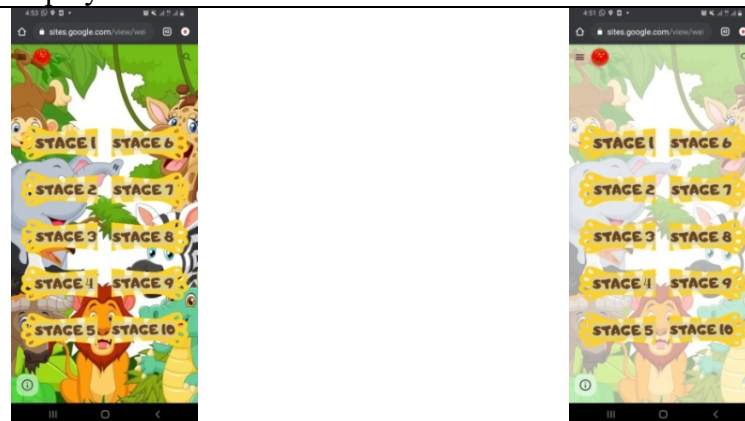
**Table 3** Revision Results based on One-to-One Evaluation

No	Before Revision	After Revision
1		

There were too many buttons. The solution offered was to eliminate buttons that have dual functions, such as the back button, because it has the same function as the back button on the user's smartphone.



- 2 Provide animation at the beginning, middle, and end of the game to raise interest and attention of the players.



- 3 The background colour was too dark. The solution offered was to make animal and plant images into watermarks on several game pages to enhance visual appeal.

### 3. Small Group Evaluation

Four junior high science teachers and 30 grade 9 students evaluated the practicality. Aspects of the assessment included usefulness (MA), ease of use (MD), attractiveness (KM), and clarity (KJ). From this assessment, the game products developed are included in the very practical category.

#### a) Practical Test Results by Teachers

The usefulness (MA) aspect received an average score of 95.5, indicating 'very good' category. For ease of use (MD) obtained a score of 93.3, while attractiveness (KM) had a score of 96.9. The clarity (KJ) component averaged 95.8. All placing them in the 'very good' category. The overall practicality of the educational game "Weismann" was determined by these four assessment components that had been analysed. The

results of the practicality assessment by the teacher can be seen in figure 2.

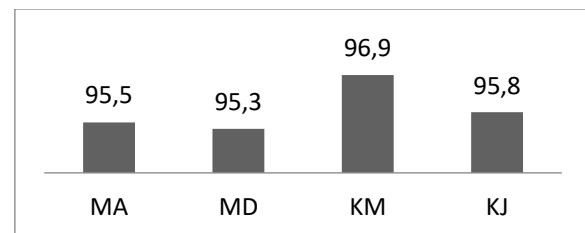


Figure 2. Practicality Assessment Result by Teachers

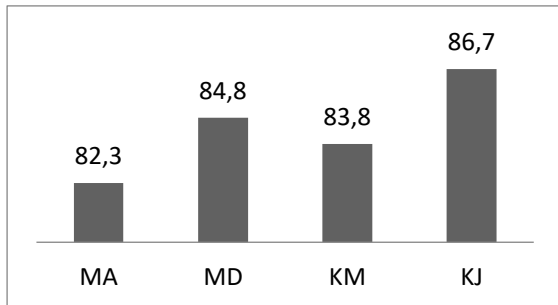
The average teacher practicality score was 95.9. This showed that the practicality score of using the educational game "Weismann" based on Google Sites was in the 'very good' category.

#### b) Practical Test Results by Students

The usefulness (MA) received an average score of 82.3, the ease of use (MD) component scored 84.8, attractiveness (KM) averaged 83.8, and clarity (KJ) received 86.7. All components were rated within the 'very



good' category. The practicality of the educational game "Weismann" could be obtained by determining the average of the four components that had been analysed. The results of the practicality score plot according to students can be seen in Figure 3.



**Figure 3.** Components of Practicality Assessment by Teachers

The average score of students' practicality was 83.9. This showed that the practical score of the educational game "Weismann" based on Google-based was in the 'very good' category.

Based on the aspect of usefulness, both teachers and students consider this game can hone independence in learning. Because the game is designed for self-evaluation, teachers and students also strongly agree that this game can hone independence in learning and train users to think creatively. In addition, according to teachers and students, this game can also improve memory, boost thinking power, and train the mind to think quickly.

Based on the aspect of ease of use, if the product practicality assessment is carried out by teachers and students, there are no significant obstacles. The game can be run on each student's smartphone properly if there are no errors or stops suddenly. In addition, the game also has an uncomplicated display so that both teachers and students can play it

easily even though it is their first time playing it.

This game is designed to be operated without an application, addressing a common issue among gadget users which is limited storage space for running applications. One of the criteria for a good learning media is that it be practical, flexible, and durable. This criterion requires the teacher to choose an existing media that is easy to obtain, can be used in all conditions, and is easy to carry everywhere (Asyhar, 2012).

Based on the attractiveness aspect, the teacher and students said that the "Weismann" game has an attractive appearance and gameplay and stimulates students' interest in continuing playing. Students, as users, also admit that this game can foster their curiosity and interest in learning the concept of the breeding system in plants and animals. This can be seen from their enthusiasm when playing this game.

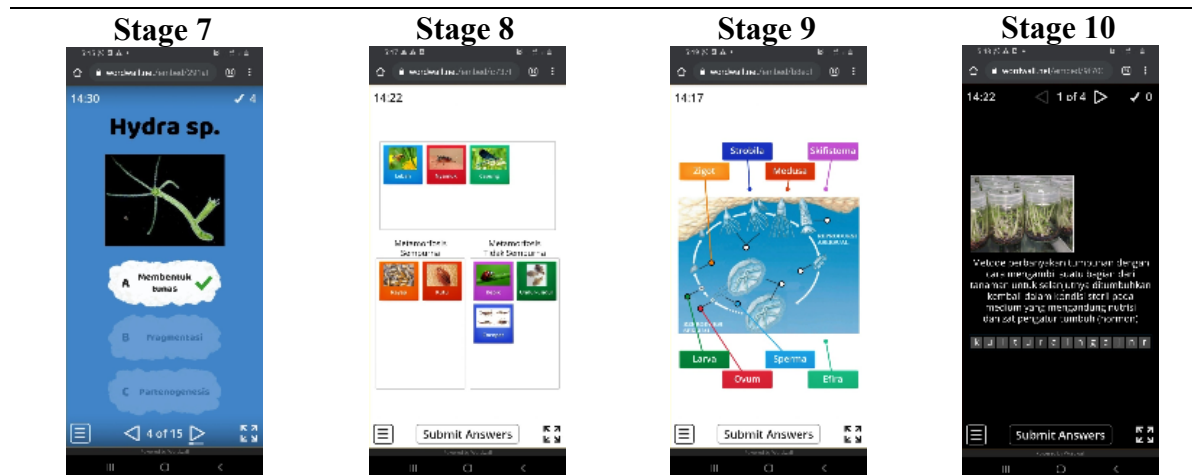
Based on the aspect of clarity, teachers and students stated that they could easily understand the flow of the game. This is because each stage provides game instructions. In addition, this game also contains images and high-quality animations. The conclusion that can be drawn from the user's assessment of the practicality of the product is that the games developed are included in the practical category.

#### 4. The Final Product

Based on all of test, evaluation, and revision process, the product then reaches the final version that ready to be used in the learning process. The sample appearance of the final product can be seen in table 4.

Table 4. Appearance of Final Product





## Conclusion

The educational game “Weismann,” designed based on an extensive analysis of student needs and the Grade 9 science curriculum, has been rated in the 'very good' category by both experts and users, confirming its effectiveness and validity for use in science learning. The game addresses significant issues identified with traditional assessments, such as a lack of student motivation and engagement due to repetitive methods that often resulted in incomplete assignments and lower scores. By incorporating interactive and visually appealing elements, “Weismann” makes complex concepts like plant and animal reproductive systems more accessible and engaging. The game aligns with *Kompetensi Dasar* (KD) standards, utilizing animations and pictorial aids to enhance understanding and retention. Moreover, its design caters to the developmental characteristics of junior high students, who benefit from game-like, digital learning experiences. This integration of educational content and engaging game mechanics ensures that the tool not only captures students’ interest but also effectively supports their learning outcomes.

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