DEVELOPMENT OF MULTIMEDIA INTERACTIVE SCIENCE LEARNING BASED ON CROSS PLATFORM ON HUMAN REPRODUCTIVE SYSTEM MATERIALS IN THE NINTH GRADE OF JUNIOR HIGH SCHOOL

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Abstract. This study aimed to develop a multimedia interactive science learning product that is cross-platform-based (handphone and Laptop) with Articulate Storyline 3 Software. The research method used was Research and Development (R&D) with a waterfall process model from Pressman. The data analysis applied to this study consists of quantitative and qualitative data. The research results: 1). Media expert testing obtained an average value of 3.56, with a very decent category; 2). Material expert testing obtained an average value of 3.77, with a very decent category; 3) Limited Scale Test, using usability assessment on students and teachers, obtained an average system usability scale (SUS) value of 75.625, with an excellent category, so it can be concluded that interactive science learning multimedia on human reproductive system material developed is acceptable (proper) used in the process of teaching and learning activities in the ninth grade of junior high school.

Keywords: multimedia interactive science, waterfall process, cross-platform

INTRODUCTION

The development and improvement of Information and Communication Technology (ICT) in Indonesia in the 4.0 era significantly influences the paradigm shift of learning in schools, especially in junior high schools (SMP). Information and communication technology (ICT) is essential for educational change. Especially in the learning system, ICT has changed the traditional learning system into a modern technology-based learning system, including computer media with the internet (Galang M. et al., 2016).

Students of SMP Al-Islam 1 Surakarta the ninth grade consider that learning science material is difficult, especially in the Human Reproductive System material, because the material is abstract, there are too many words that need to be memorized, and many scientific terms or names are difficult to remember and understand. This resulted in a decrease in Shiva's learning outcomes in junior high school. After obtaining data on learning outcomes, grade IV human reproductive system material scores at SMP Al-Islam 1 Surakarta must be more adequate and complete because 14 students still get scores below the Minimum Completeness Criteria (KM>= 75). The percentage of students who still need to complete it is 58.33%, the average score is 67.5; the highest score is 84, and the lowest score is 40. So, based on these data, researchers feel the need to take action in learning to help teachers increase the value

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of learning outcomes and student attraction to science subjects with human reproductive system material.

Based on observations with teachers who teach the ninth grade human reproductive system subjects at SMP Al-Islam 1 Surakarta, teachers still use PowerPoint media and simple learning modules. So, based on the observations of the class teacher, students are less interested in and have less understanding of the material presented (Muhammad & Sukirman, 2021). This is exacerbated by conditions during the COVID-19 pandemic, which require students to be more independent and increase perseverance in reading and studying science learning materials. With a short meeting duration when face-to-face learning is limited to only using PowerPoint media and modules, it is difficult for teachers to understand students, especially on the material of the human reproductive system. The material of the human reproductive system should be explained thoroughly, interestingly, and clearly, because otherwise, it will lead to misunderstandings and the emergence of taboo understandings.

In science subject matter, many learn about abstract concepts (Putu Agus Putra Dwipayana, I Wayan Redhana, 2020); Syahdiani et al., 2017), for example, in biology subjects, namely human reproductive system material. The menstruation and fertilization processes in the human reproductive organs will be challenging to study in detail. This is because no direct material object can be studied visually, clearly, or interestingly. Therefore, the concept of the human reproductive system subject matter needs to use Cross-Platform-based interactive learning multimedia so that the concept of material that is difficult to understand directly can be simulated with educational games and animated visualizations moving in a learning application (Aripin, 2017).

Based on the constraints above, the researchers made Android-based interactive learning media on human reproductive system material using Articulate Storyline 3 software and the website2apk builder. The media consisted of learning videos, interactive images accompanied by explanations, text or audio, learning games that interest students in learning (Chamsudin & Asih, 2021), and quizzes to test students' understanding (Adhisa et al., 2022). In addition, researchers create applications that can be accessed anywhere, both offline and online, making it easier for students to learn the material delivered by the teacher, both offline and online, using various devices such as mobile phones and laptops, wherever students are. This is similar to Sujalwo and Sukirman's research, which utilizes various devices that make it easier for students to access learning applications (Sujalwo & Sukirman, 2017). Using interactive multimedia-based learning media by combining different media in learning activities makes the teaching process develop smoothly and effectively. It can help teachers make more interactive presentations (Munir, 2015) and improve the quality of learning (Abdulrahaman et al., 2020).

In previous research and development, it has also conducted multimedia testing of interactive learning that is feasible, effective, and can motivate students to be used as learning media, such as the development of cross-platform based learning multimedia on auditory sense material and creature sonar systems (Prigianata et al., 2016), the development of interactive learning media based on an articulate storyline on the ninth grade human reproductive system material (Muzdalifah, 2022), and the development of interactive learning media based on an articulate storyline on SMP solar system material (Nadzif et al., 2022). Based on pre-existing research and development, this study developed the latest interactive multimedia in cross-platform-based interactive learning multimedia development (mobile and laptop). In multimedia learning, learning materials have been integrated, including learning

videos, educational games, and learning evaluations to achieve learning objectives in the human reproductive system the ninth grade of junior high school.

Based on this background, the researcher has a goal: 1). Develop cross-platform-based science interactive learning multimedia products (mobile and laptop) with articulate storyline three software; and 2). Conduct media feasibility testing, namely media expert tests, material expert tests, and limited scale tests. Therefore, Android-based Science Interactive Learning Multimedia can be created on any device, such as mobile phones, laptops/ PCs, and online and offline devices.

METHOD

Types of Research

Research methods for making Multimedia Interactive Learning Science on human reproductive system material using research and development with waterfall model research methods. The reason for using this model is because the identification of potential problems and needs has been collected beforehand so that the step-by-step process that is passed systematically and linearly sequentially starts from the beginning to the end of the development of software (Pressman, 2015).

Research Procedure

The process of stages in the Waterfall Model in developing the Science Interactive Learning Multimedia application on the material of the human reproductive system can be seen in Figure 1.

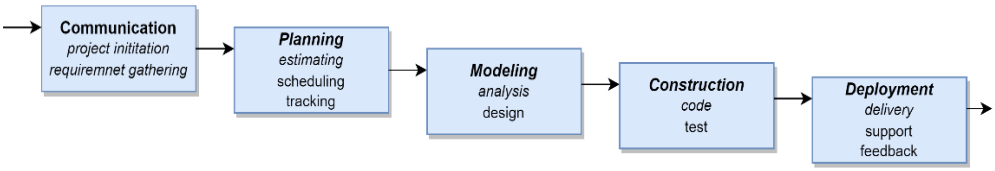


Figure 1. Stages of application development with the waterfall model
Pressman (2015)

The procedure in the waterfall model (Pressman, 2015) is as follows:

1. ***Communication***

   Before entering the planning stage, an analysis of the problems and needs of interactive multimedia on the material of the human reproductive system was carried out first. After students' main problems and needs were obtained, the next step was the development of interactive multimedia in science subjects.

a. Project Initiation Stage

   At this stage, it aims to decide what application needs to be made by considering the data that has been collected. At this stage, the application that is developed, namely the Android application "SiRema" is an Android-based application that presents material about the Human Reproductive System of Junior High School the ninth grade.

b. Requirements gathering stage

   This stage determines the requirements and tools used in developing multimedia interactive IPA. The tools are PC/laptop, articulate storyline version 3 software, website2apk builder, CorelDraw software, Adobe Photoshop, MS Excel, and SPSS version 20. Through this stage, users get vital specifications such as: 1). Users can access complete and explicit material. 2). Users can use educational games and interactive quizzes.

2. ***Planning***

At this stage, the goal is to technically explain the sundries of tasks, which include: 1). Division of team tasks and responsibilities based on areas of expertise. 2). Scheduling in media development. 3). Resources required by the system in developing applications. 4). Prototype of the work to be achieved. 5). Risks that may occur during the application creation process. 6). Tracking the work process of the work system.

3. ***Modelling (system design)***

A comprehensive design of the science interactive learning multimedia application system was carried out at this stage. The design started with the design of data structures, application workflow systems, and application system user interfaces. More details can be seen in Figure 2.

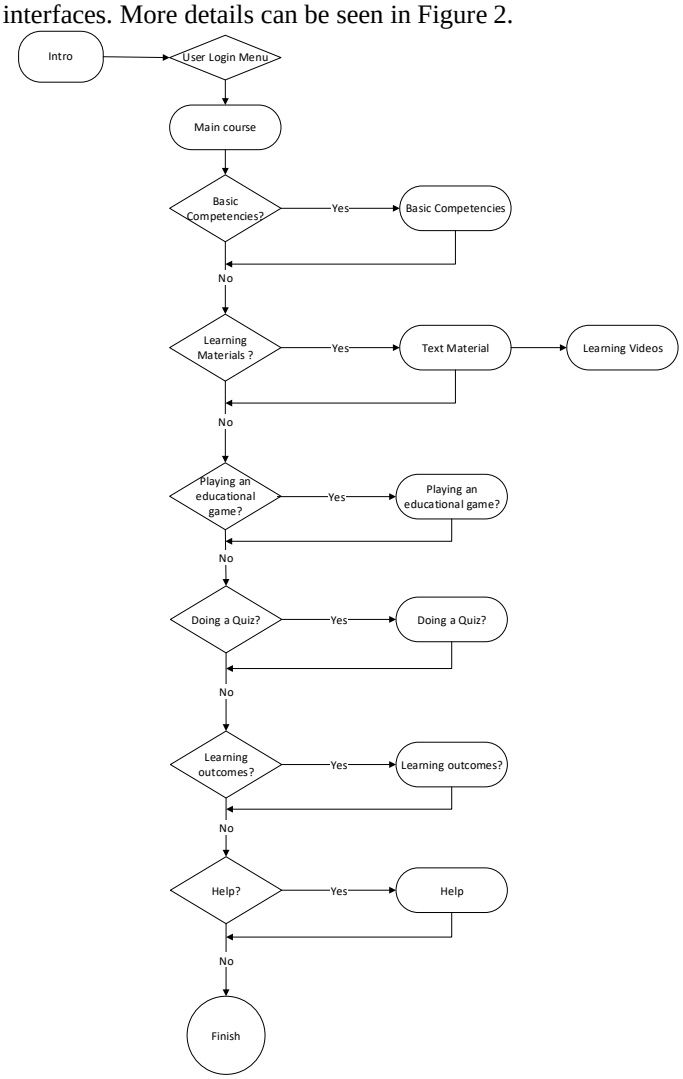


Figure 2. Flow chart for users

4. *Construction*

The application design model is developed into an Android application at this stage, in the process of making applications with the help of articulate Storyline version 3 software made without coding. The display design (user interface) process uses several applications, such as Adobe CorelDraw and Photoshop. The following process continues with the application testing/debugging system, which aims to discover system errors or trigger usage errors that may occur and be corrected.

5. *Deployment*

This stage is the final stage in using the waterfall process model, which was implemented by users, checking applications, improving applications, and developing an application based on user responses that have provided feedback. In addition, it is necessary to conduct a Group Discussion Forum (FGD) for teachers or users and test the validation of media experts and materials first, as well as small-scale (limited) tests.

Research Subjects, Data, and Data Collection Techniques

In this development research, the test subjects were tested by two media experts from lecturers of the Informatics Engineering Education study program and two material experts from lecturers of the Biology Education study program, ten students, and one science subject teacher at SMP Al-Islam 1 Surakarta with a saturated sampling method because the population is relatively small. Quantitative data, namely questionnaire data from product assessment, is obtained using a multilevel scale (Likert). Some instruments are used for data collection, such as interviews and questionnaires. At the same time, qualitative data is obtained from feedback/responses from media experts, material experts, and users of the application developed.

The data analysis applied to this study consists of quantitative and qualitative data. Scale measurement on questionnaires for media and material validation consists of 4 categories, namely very good (SB) with point 4, good (B) with point 3, less (K) with point 2, and significantly less (SK) with point 1. This category level refers to the standard curve with calculations using the ideal average (Mi) and ideal standard deviation (SDi). The formula is Mi = 1/2 × (highest score + lowest score) and SDi = 1/6 × (highest score – lowest score) (Mardapi, 2012). Table 2 provides the Likert scale score conversions.

Table 2. Ratio scale formula on the linkert scale of four categories

Ratio Scale	Criterion
$X > Mi + 1.5\ SDi$	Very worthy
$Mi \leq X < Mi + 1.5\ SDi$	Eligible
$Mi - 1.5\ SDi \leq X < Mi$	Less worthy
$X < Mi - 1.5\ SDi$	Not eligible

Source: Mardapi (2012)

If the questionnaire assessment data is included in the categorization, the following values are obtained as seen in Table 3.

Table 3. Ratio scale value on linkert scale 4 categories

Ratio Scale	Criterion
$X > 3.25$	Very worthy
$2.5 \leq X < 3.25$	Eligible
$1.75 \leq X < 2.5$	Less worthy

Ratio Scale	Criterion
X < 1.75	Not eligible

The usability assessment on learning media consists of 5 categories: strongly agree with point 5, agree with point 4, neutral with point 3, disagree with point 2, and strongly disagree with point 1. Here is Table 4 of the usability assessment.

Table 4. Usability assessment questions on learning media applications

		Strongly disagree				**Totally agree**
Code	**Questions on the Questionnaire**	1	2	3	4	5
R1	I'm thinking of using this app again.					
R2	I find this app complicated to use.					
R3	I find this app easy to use.					
R4	I need help from other people or technicians in using this app.					
R5	I feel like the features of this app are running properly.					
R6	I feel that there are a lot of things that are inconsistent (mismatched in this application).					
R7	I feel like others will understand how to use this app quickly.					
R8	I find this app confusing.					
R9	I feel that there is no obstacle in using this application.					
R10	I need to familiarize myself first before using this app.					

The questionnaire assessment is based on the system usability scale (SUS) from John Brooke (Brooke, 2020). There are rules for calculating the Total SUS questionnaire; if the question number is odd (1, 3, 5, 7, or 9), then the question score was reduced by 1. Meanwhile, if the question number is even (2, 4, 6, 8, or 10), then the maximum score in the SUS questionnaire category, which is 5, was reduced by the score given by the user (student). The total number of SUS questionnaire scores was multiplied by 2.5 to calculate the SUS score. Here is the formula for calculating the SUS score:

skor SUS= ((R1 - 1) + (5 - R2) + (R3 - 1) + (5 - R4) + (R5 - 1) + (5 - R6) + (R7 - 1) + (5 - R8) + (R9 - 1) + (5 - R10)) * 2.5)

After calculating the score results of each respondent, then determine the average score of all samples/respondents with the equation:

$$Average\ value = \sum_{i=1}^{n} \frac{X_i}{N}$$

Information:
Xi = Sample/respondent score values
N = Number of samples/respondents

(Brooke, 2020)

If you have obtained the average value using the SUS Score equation above, then determine the predicate of the results of an application based on the SUS table (Brooke, 2020) as follows:

Table 4. SUS table

Score SUS	Value	Adjective	Percentiles
84.1-100	A+	Best Imaginable	96-100

Score SUS	Value	Adjective	Percentiles
80.8-84.0	A	Excellent	90-95
78.9-80.7	A-	Excellent	85-89
77.2-78.8	B+	Excellent	80-84
74.1 – 77.1	B	Excellent	70 – 79
72.6 – 74.0	B-	Excellent	65 – 69
71.1 – 72.5	C+	Good	60 – 64
65.0 – 71.0	C	Good	41 – 59
62.7 – 64.9	C-	Good	35 – 40
51.7 – 62.6	D	OK	15 – 34

Source: Sauro (2018)

RESULTS OF RESEARCH AND DISCUSSION

1 Develop cross-platform-based science interactive learning multimedia products (mobile and laptop) with Articulate Storyline version 3 software

This research conducts the development of multimedia interactive learning science based on cross-platform (mobile phones and laptops) in junior high school in the ninth grade on human reproductive system material can be applied to various devices such as mobile phones (Android) or laptops both offline and online so that it makes it easier for students to access and not depend on whether there is no internet network for learning activities both in direct face-to-face and limited face-to-face conditions (Noviar, 2016). This learning medium was created using Articulate Storyline 3 Software, website2apk builder, Adobe Photoshop, and CorelDraw software. The page on this learning medium is made as attractive as possible, with a striking and elegant dominant blue colour. In addition, pages and buttons are voted on to attract students' attention (users).

This medium is easy to use (user friendly) because there are connecting buttons from one page to another and are accompanied by instructions for using the application. The following navigation/connecting structure is applied to interactive learning medium in Figure 3.

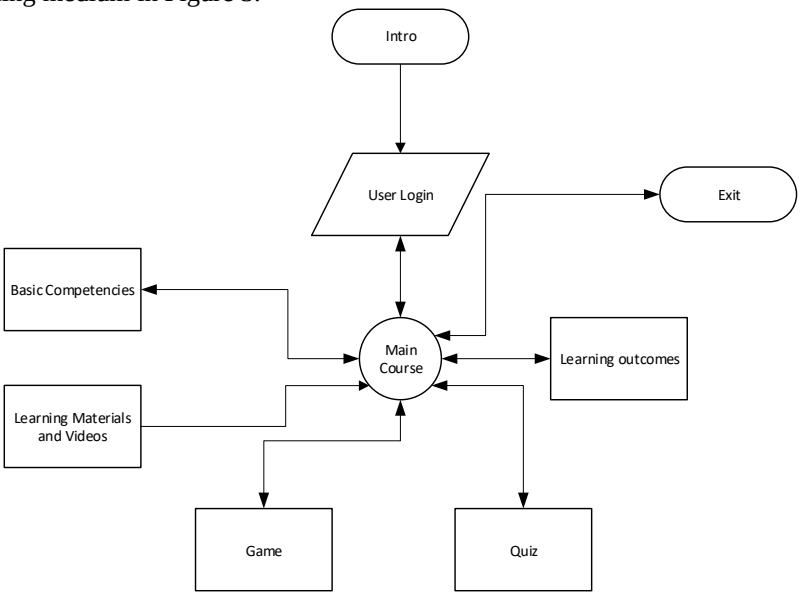


Figure 3. Application navigation/connecting structure

The following is the user interface of this interactive learning multimedia as follows:

1) Intro view and login menu

The intro/opening menu on this medium contains the agency's logo, medium title, and user name field menu.

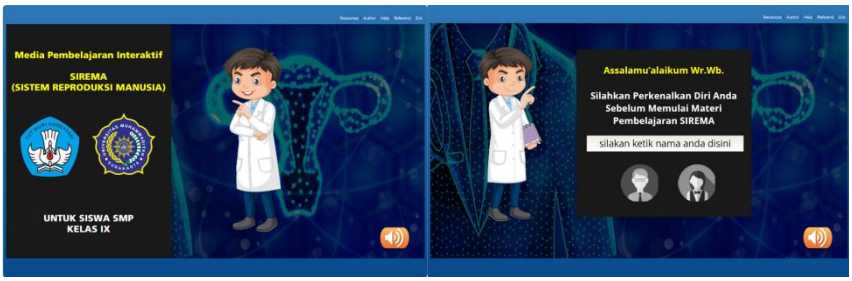


Figure 4. User intro and login pages

2) Main Menu Page Display

The main menu page contains seven buttons: Basic Competencies, Learning Materials, Games, Quizzes, Learning Outcomes, Audio settings, and a menu bar containing Resources, Author, Help, references, and Exit button.

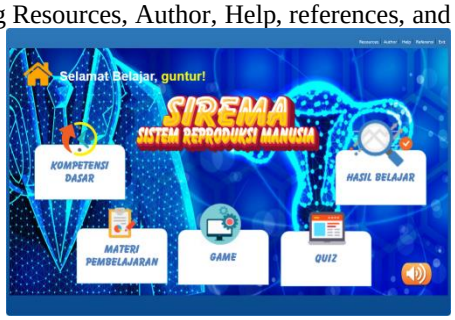


Figure 5. Main menu page

In Figure 5, students are asked to read the basic competencies first to determine the learning outcomes. Then, the next student, before doing Games and Quizzes, students can press the "Learning Material" button. Furthermore, after the learning material has been learned, students can deepen the material by playing Educational Games on the "Game" Button. Furthermore, to test the level of student understanding, students continue to work on interactive quizzes as an evaluation of learning on each learning achievement of human reproductive system material by pressing the "Quiz" button so that students can increase their understanding of learning material.

3) 3) Learning Material Page Display

This menu contains material buttons: 1). Menstruation, Fertilization, Pregnancy, and learning videos; and 2). diseases of the reproductive organs, along with learning videos.

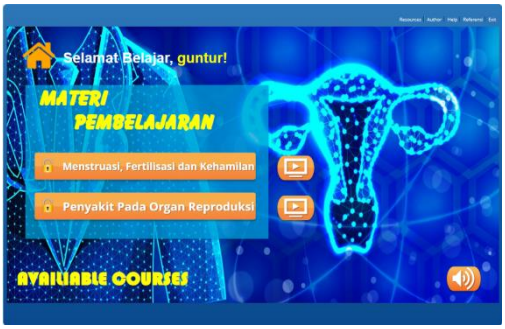


Figure 6. Learning material page display

In Figure 6, students can learn learning materials starting with menstruation, fertilization, and pregnancy, along with learning videos. This is so that students can learn about the process of menstruation, fertilization, and pregnancy. Here is what the learning materials and videos page looks like.

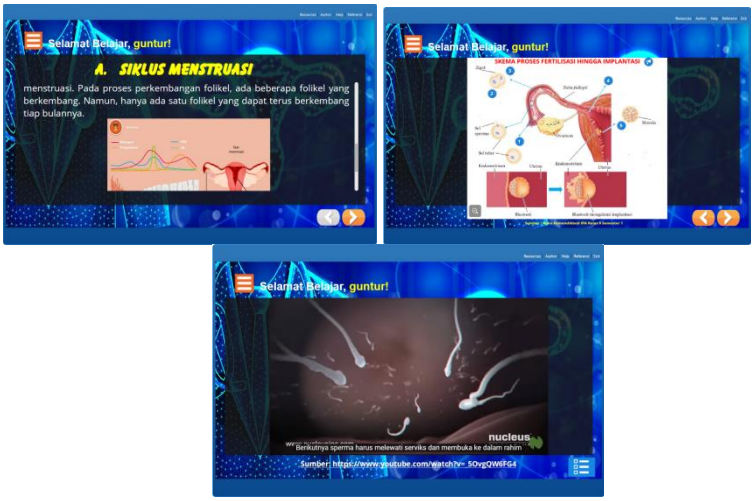


Figure 7. Learning materials and videos

In Figure 7, there are learning materials about menstruation, fertilization, and pregnancy accompanied by complete material explanation texts, colorful and clear images, and equipped with buttons that emit an explanatory sound when students press the number key. This is so that students more clearly understand the material. In addition, there are learning videos using videos from YouTube accompanied by translations containing information related to the material; this is so that students better understand learning videos well and there are no misconceptions of the material and clear images in the learning material (Susanti et al., 2018; Shohiby & Hermawan, 2022), likewise in learning materials and videos on diseases of the reproductive organs.

4) Game Page View

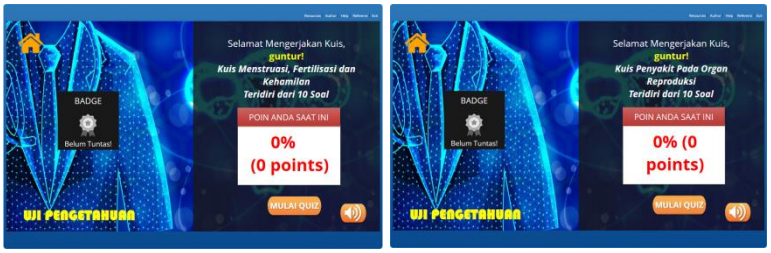
This page contains educational games related to material about menstruation, fertilization, pregnancy, and diseases of the reproductive organs, consisting of buttons that can be dragged and dropped, submit answer buttons, and issue the results of game work certificates. This educational game aims to positively influence cognitive

learning outcomes, such as understanding material content and conceptual application (Vlachopoulos & Makri, 2017) so that students understand the teaching material better.

Figure 8. Game examples fertilization process and score result certificates

5) Quiz Page View

This page contains an evaluation test on the understanding of Menstruation, Fertilization, and Pregnancy, as well as diseases of the reproductive organs, in the form of multiple choice with the number of questions in each material totaling 10 questions, which are also accompanied by feedback. This is useful for providing long-term retention effects as well as deeper understanding (Wang & Yang, 2021; Butler, 2018). Here is what the image looks like given in Figure 9.



(a) (b)

Figure 9. Front view of quiz questions:
(a) Quiz on Menstruation, Fertilization and pregnancy
(b) Quiz on diseases of the reproductive organs

Furthermore, the application was tested to determine the feasibility of cross-platform-based science interactive learning multimedia on the material of the human reproductive system of junior high school the ninth grade to experts. This validation test aims to determine the validity/feasibility of a product before the next test stage. This test involves two media experts and two material experts in their fields.

2 Media Qualification Testing

1) Testing to Media Expert

Testing by media experts obtain quantitative data as well as suggestions and inputs needed as application (product) improvements in the first stage. The initial or first stage of improvement was carried out by 2 (two) media experts who are lecturers of the informatics engineering education study program FKIP UMS. Expert validation of learning media is carried out to obtain assessments and input on the application (product) developed. As for the aspects of product assessment, namely 1). Software Engineering; 2).

Learning Design; and 3). Visual Communication (Murdoko et al., 2017). The following are the results of the media expert assessment given in Table 5.

Table 5. Media expert assessment results table

No.	Aspects	Average Score	Category
1	Software Engineering	3.63	Very Worthy
2	Learning Design	3.50	Very Worthy
3	Visual Communication	3.55	Very Worthy
	Average	**3.56**	**Very Worthy**

Based on Table 5, the average score is 3.56; cross-platform-based science interactive learning multimedia on the material of the human reproductive system is **very worthy** of use in learning. According to media experts, interactive multimedia based on an articulate storyline can be relied upon to facilitate students learning. The research results from Daryanes et al., (2023) show that articulate storyline-based media can make learning more accessible for users. The interactive media design developed is made attractive and straightforward by using consistent colors and is not too flashy because it is also adjusted to the level of students. According to Hadza et al., (2020), the choice of colors and backgrounds must be based on the level of students; elementary to secondary students tend to like many images and varied colors.

After a product evaluation (media) by media experts, suggestions and some input from media experts are needed to improve the application (product). After the first stage of the application (product) improvement process, the application is tested for the next stage.

2) Testing by a Material Expert

Material expert testing aims to determine the feasibility of learning material presented on learning media (products). Material validation testing uses 2 (two) material experts, namely lecturers of the biology education study program FKIP UMS. In this second stage, the assessment results are obtained through quantitative data and valuable suggestions for improvement (revision) on cross-platform-based science interactive learning multimedia on human reproductive system material. The assessment aspects of material validation are as follows: 1). Curriculum; 2). Material; 3). Grammar (Ketut Sinta et al., 2021). The following are the results of the material expert assessment as given in Table 6.

Table 6. Material expert assessment results table

No.	Aspects	Average Score	Category
1	Curriculum	3.67	Very Worthy
2	Material	3.64	Very Worthy
3	Grammar	4.00	Very Worthy
	Average	**3.77**	**Very Worthy**

Based on Table 6, the average score on the material validation assessment is 3.77. It can be concluded that the learning material presented in cross-platform base science interactive learning multimedia on the human reproductive system material, which is **very worthy** of use in material Menstruation, Fertilization, and pregnancy as well as menstruation, fertilization, and pregnancy.

According to material experts, interactive learning media has presented material through indicators of achievement of competencies and learning objectives. The correctness of the concept of the material conveyed is also perfect. Learning videos on interactive media also contain material based on basic competency achievement indicators and are easy to understand. The provision of learning videos can motivate students presented in interactive multimedia (Hadza et al., 2020). When viewed from grammar in interactive multimedia, it also fulfills the rules of good, correct, and simple language.

3) Validation of Usability Assessment on Learning Media

Improvement in the third stage is the last stage by users (students). Suggestions and input from students become a reference for the final improvement. Cross-platform based interactive science learning multimedia was assessed by ten students from SMP Al-Islam 1 Surakarta by filling out an online questionnaire that had been provided. The questionnaire used is based on the system usability scale (SUS) questionnaire by John Brooke, where the criteria for this SUS questionnaire use a ratio scale of 1 – 5. Table 7 shows the results of the questionnaire assessment.

Table 7. John Brooke's SUS Test

Respondent	Score Calculated Results	
	Sum	**SUS Score Value**
R1	32	80
R2	31	77.5
R3	32	80
R4	32	80
R5	36	90
R6	31	77.5
R7	32	80
R8	37	92.5
R9	34	85
R10	37	92.5
R11	29	72.5
Total SUS Score		**907.5**

Calculation of the average value of SUS with the equation:

$$Average\ value = \sum_{i=1}^{n} \frac{X_i}{N}$$

Information:

Xi = Respondent Score Value

N = Number of Respondents

$$Average\ value = \frac{907{,}5}{12} = 75{,}625$$

Based on Table 7, the results of the average calculation of the questionnaire with the number of respondents were ten students and one science teacher at SMP Al-Islam 1 Surakarta. The average value of SUS is 73.13, and the result is the **Excellent category** with a **grade scale of B**, obtained from calculations using a system usability scale (SUS). It can be concluded that usability in learning media is acceptable (worth) for use as cross-platform based science interactive learning multimedia on human reproductive system material.

CONCLUSION

Based on the results of the research conducted, producing interactive science learning multimedia on cross-platform (mobile and laptop) human reproduction system material for SMP the ninth grade, both online and offline, at limited face-to-face is very worth using in the process of teaching and learning activities at SMP Al-Islam 1 Surakarta the ninth grade.

Multimedia interactive learning science is based on validation tests on media experts and material experts, and SUS testing on students and teachers (as a limited scale test), namely, media expert validation results, with aspects: a). Software engineering, with a value of 3.63; b). Learning design, with a value of 3.50; c). Visual communication, with a value of 3.55. With an average score of 3.56, The results of material validation, with aspects: a). Curriculum, with a value of 3.67; b). Material, with a value of 3.64; c). Grammar, with a value of 4.00. With an average score of 3.77, usability assessment in students and teachers, an average SUS score of 75.625, and **the Excellent category**.

SUGGESTION

Based on the research that has been done, there are suggestions for researchers and development, namely adding teaching materials about cell division, male reproduction, spermatogenesis, female reproduction, and oogenesis to cross-platform-based interactive learning multimedia so that it can be applied comprehensively to the ninth grade human reproductive system material in junior high school.

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