

# Menstrual Eduhub: Mobile-Based Menstrual Learning Application Using 3D Animation Technology

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**Abstract:** Menstrual health education is an important instrument for shifting culture about periods particularly among students who undergo a variety of changes as they grow. While government-standardized textbooks have been the traditional way of conveying information, the market has seen growth in the application of menstrual education. Although these applications are widely available, they often lack specificity and fail to align with the KSSM syllabus. To address this issue, Menstrual Eduhub is aims to deliver a comprehensive educational experience for Form 1 student incorporating with quiz module to reinforce the students' understanding of menstrual cycle through Multimedia Mobile Content Development (MMCD) technique. Moreover, this application incorporates clear 3D animations for each cycle phase, enhancing the learning process. User acceptance and functionality testing, measured using the System Usability Scale (SUS), yielded satisfactory results with a positive feedback rate of 86.50%, demonstrate that the Menstrual Eduhub application is effective as a learning aid for Form 1 students.

**Keywords:** Menstrual Education, Mobile Learning Application, 3D Animation

## 1. Introduction

A set of cyclic changes in which affecting the reproductive organ of female's body that take place once every month can be defined as a menstrual cycle [1]. In other words, menstrual cycle is a typical vaginal bleeding that happens monthly as part of a woman's cycle [2]. Based on research in 2021, it has been stated that lack of education in managing the menstrual cycle was a common concern among adolescent girls as they were negatively having discomfort handling the period's pain symptoms [2]. Gaining a scientific understanding and knowledge of how bodies function is vital for everyone, regardless of gender.

In general, menstrual education is delivered and presented through the syllabus for science subjects which starts as early as Form 1. Usually, the students will be learning this topic by the textbook standardized by the government that is available at school. However, there are some educators who use others learning website to enhance the students' understanding for each concept such as watching

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animated video through YouTube or using 'Quiziz' to conduct formative assessments for students. In recent years, the market for menstrual cycle learning applications has become increasingly competitive with new apps arising but often fail to cater to the specific requirement of students following the Standard Based Curriculum for Secondary Schools (KSSM) syllabus. Due to the limited availability of KSSM-aligned menstrual cycle learning apps, students and teachers have turned to other learning platform which then lead to the complex process as there are multiple platform are being utilized during the learning sessions.

The objective of this study are to design menstrual learning application using 3D animation approach based on the Standard Based Curriculum for Secondary Schools (KSSM), to develop an interactive learning application using Android technology through the concept of the VARK model and to perform functionality and user acceptance testing. This project is a mobile-based menstrual learning application which deliver a comprehensive educational experience to Form 1 students incorporating with quiz module to reinforce the students' understanding of menstrual cycle through Multimedia Mobile Content Development (MMCD) technique. There are two main modules, learning module and quiz module in which provide users a comprehensive learning experience through engaging 3D animations and incorporating quiz functionalities.

The rest of the paper is structured as follows: The domain study, the technology used, and the comparative analysis are all covered in Section 2. The Multimedia Mobile Content Development (MMCD) technique that is used in this project is described in Section 3, along with the results and discussion in Section 4. Lastly, the conclusion of the entire development will be outlined in Section 5.

## **2. Related Work**

In this section, the study domain, technology used, and the comparative analysis are discussed.

### **2.1 Menstrual Cycle Education**

Several countries have recently initiated curriculum reforms in response to global trends and the need to address developmental limitations among children. Malaysia, in particular, has prioritized addressing learning issues following the government's revision of the learning standards document in 2017 [3]. Menstrual education as a subtopic of sexual and reproduction, started gaining attention from the Malaysian government in the late 1990s. Research on sexual and reproductive health in Malaysia has revealed that teenagers still had little understanding of this issue, with 75% of them claiming they felt uncomfortable seeking medical attention for issues like dysmenorrhea [4]. Thus, based on the study shows that menstruation education is important for students' knowledge to prevent potential social problems in the future, including sexual abuse, unsafe abortion, and unintended pregnancy.

### **2.2 Technology Used**

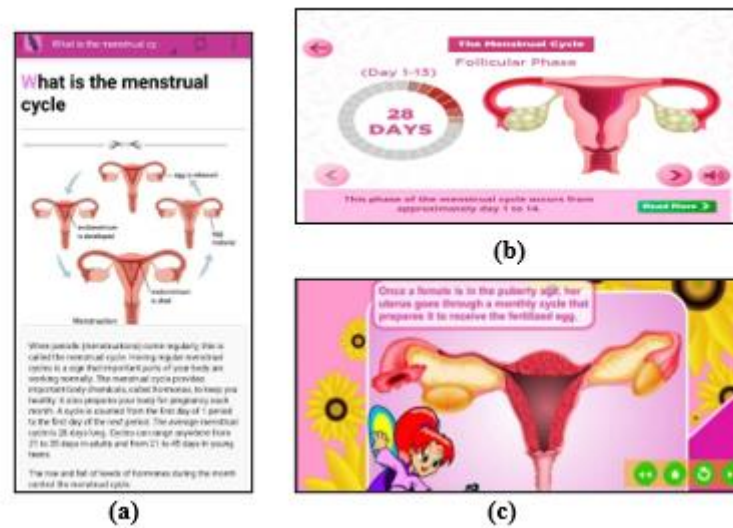
The rapid advancements in technology and science have led to innovative approaches in the field of education, including the utilization of 3D animation in the learning process. 3D animation refers to the procedure of generating moving objects in a three-dimensional digital realm [5]. In the context of education, 3D animation not only enable interactive learning but also facilitate experiential learning as it presents abstract concepts through visuals. It is particularly suitable for mobile learning, as it delivers concise and engaging videos for complex topics. According to Siehoff [6], kids this day is most likely to enjoy and prefer short-form videos like TikTok rather than lengthy videos. Additionally, if the students find an animated video intriguing, they might decide to watch it again thus fostering captivation within the educational process and facilitating easy knowledge acquisition. Consequently, the use of 3D animation proves beneficial in assisting students in visualizing the chronological of the menstrual cycle.

In the development of Menstrual Eduhub, the VARK model learning technique, devised by Neil Fleming [7], has been employed. This model encompasses various learning styles, including visual, auditory, reading, and writing. In this study, visual learning has been incorporated in the development process to enhance students' understanding and retention of the subject matter. It is important to acknowledge that individuals' abilities to comprehend and grasp lessons vary depending on their

preferred learning style [8]. When learning is purely relying on textbooks, the majority of students are less engaged in the subjects they are studying and have fewer meaningful learning experiences as a result [9]. Hence, by utilizing a mobile app that delivers visual learning resources, such as images and animations, Menstrual Eduhub offers students a diverse learning experience that captures their attention and aids in their understanding of menstrual education.

### 2.3 Comparative Analysis

Table 1 below depicts a comparative analysis of the existing applications, namely Periods Game for Girls, Menstrual Cycle Ovulation, and Menstrual Cycle, in relation to the development of the Menstrual Eduhub application. Figure 1 illustrates the interfaces of the three existing applications, highlighting their distinct approaches to content presentation. The Menstrual Cycle Ovulation application utilizes a text-based format to deliver information on the menstrual topic while Periods Game for Girls application used 2D animation technology in presenting the learning content. On the other hand, the Menstrual Cycle application used 3D animated video to visualize the concept of menstrual cycle in the short and precise way. After a thorough review of these existing applications, it was determined that 3D animation technology would be the optimal choice for delivering the content.



**Figure 1: Interfaces of (a) Menstrual cycle ovulation [10], (b) Periods game [11] and (c) Menstrual cycle [12] applications**

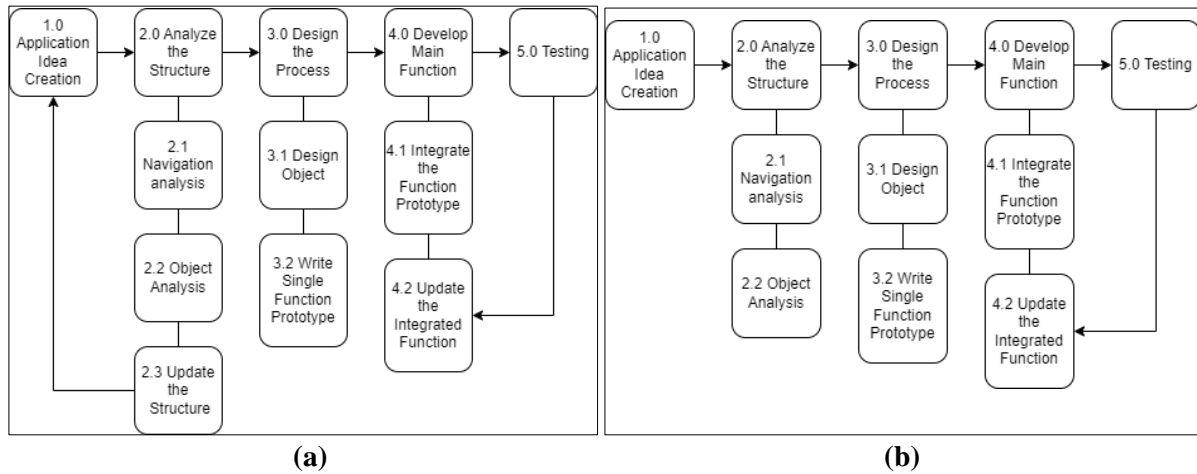
**Table 1: Comparison Table**

Features	Periods Game for Girls	Menstrual Cycle	Menstrual Cycle Ovulation	Menstrual Eduhub
Developer	Nutfrolics.	DOST – Science Education Institute.	App4Lifedev.	Puteri Nur Hazwani.
Language	English.	English.	English.	English.
Target user	Rated for 3+	Rated for 3+	Rated for 3+	Form 1 Students
Platform	Compatible with Android 5.0+	Compatible with Android 5.0+	Compatible with Android 2.3.3+	Compatible with Android 5.0+
Objective	To provide a basic learning of menstrual periods.	To provide basic concept of menstrual cycle in each stage.	To provide basic female menstruation, menstrual cycle, ovulation, and periods in simply explanation.	To provide an educational 3D animation about the menstrual cycle, based on the KSSM syllabus, incorporating with quiz module.

Features	Periods Game for Girls	Menstrual Cycle	Menstrual Cycle Ovulation	Menstrual Eduhub
Module	<ul style="list-style-type: none"> <li>a) Introduction of menstrual.</li> <li>b) Body parts of female.</li> <li>c) Symptoms of menstrual.</li> <li>d) Menstrual cycle.</li> <li>e) Menstrual hygiene.</li> </ul>	<ul style="list-style-type: none"> <li>a) Menstrual cycle.</li> </ul>	<ul style="list-style-type: none"> <li>b) Introduction of menstrual.</li> <li>c) Symptoms of menstrual.</li> <li>d) Menstrual cycle.</li> <li>e) Menstrual hygiene.</li> </ul>	<ul style="list-style-type: none"> <li>a) Sexual and asexual reproduction.</li> <li>b) Human reproductive system.</li> <li>c) Menstrual cycle.</li> </ul>
Quiz Module	Available in each learning module.	Available which provide total of ten questions only.	No available.	Available in four categories which each set consist of ten questions.
Features	<ul style="list-style-type: none"> <li>a) The contents are presented in 2D animation and also text-based with the inclusion of sound elements.</li> <li>b) Provide step by step teaching.</li> <li>c) Provide a total of 50 question for each topics.</li> </ul>	<ul style="list-style-type: none"> <li>a) The contents are presented in a 3D animated video.</li> <li>b) A playback controller included in which able to replay and back to previous stages.</li> <li>c) Provide evaluation quiz with 5 simple questions.</li> </ul>	<ul style="list-style-type: none"> <li>a) The contents presented in textbased.</li> <li>b) Contained a few subtopics related to menstrual education.</li> </ul>	<ul style="list-style-type: none"> <li>a) Refer to KSSM Standard syllabus.</li> <li>b) Content presented in 3D animation.</li> <li>c) Provide four module sets of quizzes which each sets contain ten questions.</li> <li>d) Provide playback controller to replay and pause the video content.</li> </ul>
Drawbacks	<ul style="list-style-type: none"> <li>a) Not follow the KSSM textbook syllabus.</li> <li>b) Many advertisement appear randomly while browsing the application.</li> </ul>	<ul style="list-style-type: none"> <li>a) Not follow the KSSM textbook syllabus.</li> <li>b) Lack of content as it only involve menstrual cycle topic only.</li> <li>c) Lack of module questions.</li> </ul>	<ul style="list-style-type: none"> <li>a) Not follow the KSSM textbook syllabus.</li> <li>b) The absence of quizzes to measure student knowledge.</li> </ul>	<ul style="list-style-type: none"> <li>a) Only cover subtopic from sexual and asexual reproduction to menstrual cycle only.</li> </ul>

### 3. Methodology

The MMCD methodology has been selected for the development process of the Menstrual Eduhub application, with a focus on user needs. This methodology was initially proposed to streamline the development process by managing navigation, content, and application logic through a database used for quizzes [13]. It consists of five major components which are application idea creation, structure analysis, process design, main function development and testing as shown in Figure 2(a). In Figure 2(b), the update structure substage is excluded from the development process, as the project does not involve returning to the application idea creation phase after completing the second phase.



**Figure 2 : Methodology of (a) MMCD and (b) Modified MMCD**

#### 3.1 Application Idea Creation

During the first stage, the necessary information about the developed application including the target device, target users, type of application is identified before moving to the next stage. To gather relevant insights, an interview with a Subject Matter Expert (SME) who is a science teacher is conducted through an online platform. The findings from the user analysis is tabulated in Table 2. This table provides a comprehensive overview of the identified user requirements and preferences. Meanwhile, Table 3 provides an information checklist for the developed application, ensuring that all essential components are accounted for during the development process.

**Table 2: User analysis**

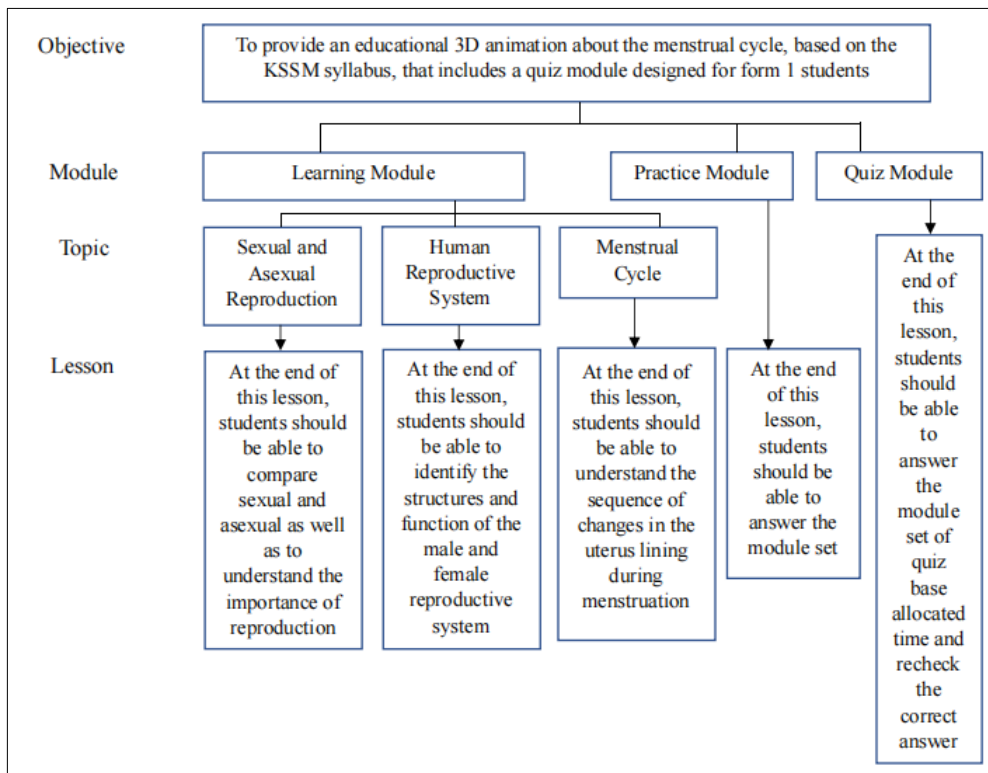
Stakeholder category	Role in product	Design implication	Action needed
Subject Matter Expertise (SME)	Content consultant expert in Science subject	Content must follow the latest KSSM syllabus format	<ul style="list-style-type: none"> <li>Acquire the most recent KSSM Science Textbook and use it as a guideline in putting the content.</li> </ul>
		Easy to navigate	<ul style="list-style-type: none"> <li>Contains previous, next, home and menu icons to navigate to relative pages.</li> <li>Apply the standard size of button.</li> </ul>
		Ease of use	<ul style="list-style-type: none"> <li>Avoid unnecessary button or text to reduce confusion for the users.</li> <li>Apply playback button to give easy control to the user to pause and play the animation.</li> </ul>
		Quiz module	<ul style="list-style-type: none"> <li>Adjust timer which suitable for the users to complete 10 questions.</li> <li>Question must relate to the learning objectives.</li> </ul>

**Table 3: Application idea creation checklist**

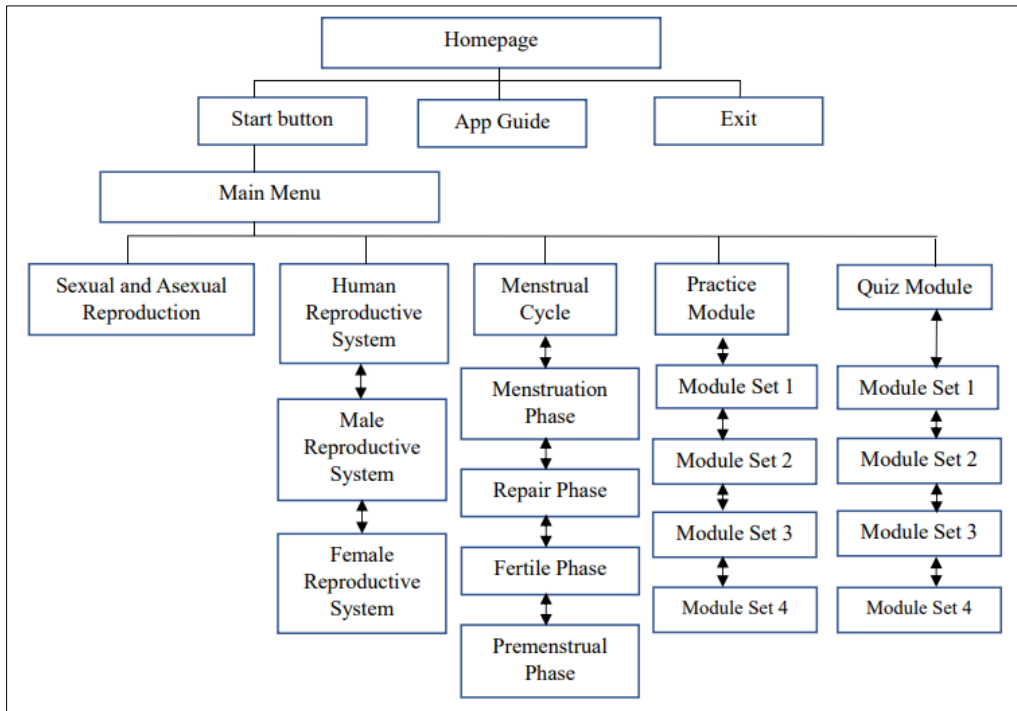
Item	Note
Type of application	Mobile Learning
Target Device	Android platform
Target Users	Form 1 Students
Application Settings	Programming language: C#
GUI	Background (Learning module and Quiz module)
Images	Icons, background image, image of contents
Video	3D animated video of menstrual cycle
Audio	Sound effect, time-out sound effects, voice-over audio
Application Synopsis	Menstrual Eduhub is a mobile learning application which will help Form 1 students in visualizing the concept of menstrual cycle clearly with underlining a true facts. The application will follow the latest KSSM format which allow student to learn and revise menstrual topic by answering set of questions.

### 3.2 Analyze the Structure

During this stage, the hierarchies and structure of the Menstrual Eduhub application are analyzed. Figure 3 provides a comprehensive overview of the content structure, showcasing the topics covered in each module and the lessons acquired through each topic while Figure 4 illustrates the navigation structure, indicating how users can navigate through the application to access various features and information. Next, Table 4 provides the functional requirements, specifying the specific features and capabilities necessary to meet user needs, while Table 5 outlines the non-functional requirements, covering criteria such as performance, usability, security, and accessibility. Lastly, Table 6 outlines the hardware and software requirements necessary to support the optimal functioning of the Menstrual Eduhub application.



**Figure 3 : Content structure of Menstrual Eduhub**



**Figure 4 : Navigational structure of Menstrual Eduhub**

**Table 4 : Functional requirements**

Functional Requirement	Module	Description
Autonomous System Activities		<ul style="list-style-type: none"> <li>▪ The animation should play when user enter each phase in Menstrual Cycle learning module.</li> <li>▪ Timer shall automatically start counting once the user enters quiz module.</li> <li>▪ The application shall navigate the user to the next question once they answer the current question.</li> <li>▪ The application shall display the current number of questions during answering the quiz.</li> <li>▪ During an interactive exercise, the application should display a correct and incorrect indicator, along with accompanying sound effects.</li> <li>▪ The application shall display the score once they complete answering the question.</li> </ul>
User Interaction	Learning	<ul style="list-style-type: none"> <li>▪ The application shall allow the user to select a topic by clicking on the labelled buttons.</li> <li>▪ The application shall allow the user to click the next and previous button while viewing the infographic of each subtopic.</li> <li>▪ The application shall allow the user to pause and play the animation when viewing the content.</li> </ul>
	Quiz / Practice	<ul style="list-style-type: none"> <li>▪ The application shall provide the user with the ability to answer a total of ten question for each set module in 5 minutes only.</li> <li>▪ The application shall allow the user with the ability to check the correct answer.</li> <li>▪ The application shall allow the user to retry the quiz of current set module by clicking on retry button.</li> </ul>

**Table 5 : Non-functional requirements**

Non- Functional Requirement	Description
Usability	<ul style="list-style-type: none"> <li>▪ The application shall provide ease to use and familiarity in terms of design to the users.</li> <li>▪ Users shall learn quickly as it applies a simple user interface design.</li> </ul>
Performance	<ul style="list-style-type: none"> <li>▪ The application should be available for use 24 hours per day, 365 days per year.</li> <li>▪ The average response time of the application for every process shall be within 5 seconds.</li> <li>▪ The application should be able to load all the modules.</li> </ul>
Cultural	<ul style="list-style-type: none"> <li>▪ The application will apply simple English language.</li> <li>▪ The application shall use a familiar metaphor such as icon button which understandable for Form 1 students.</li> </ul>
Legal	<ul style="list-style-type: none"> <li>▪ The users shall view the content of application but not allowed to modify.</li> </ul>
Operational	<ul style="list-style-type: none"> <li>▪ The application should be able to operate on Android version 5.0 and above.</li> </ul>
Graphical User Interface Support	<ul style="list-style-type: none"> <li>▪ The application shall support all multimedia elements such as graphics, animation, video, text, and audio for a different screen sizes of display resolution on Android devices.</li> </ul>


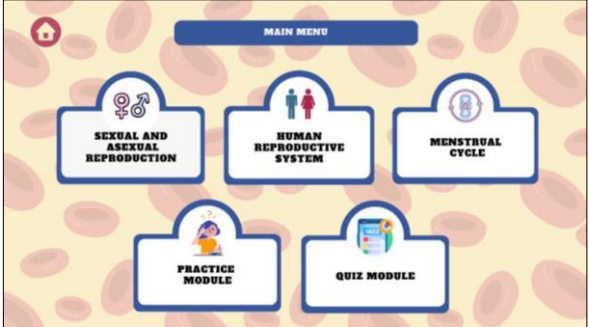
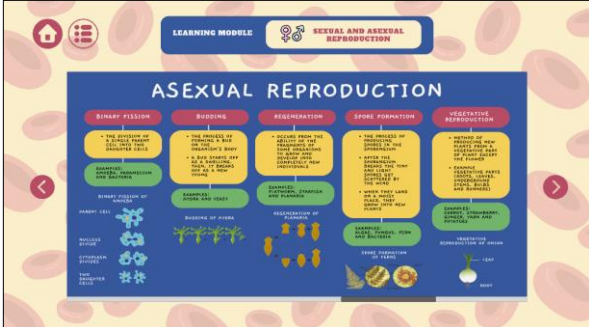
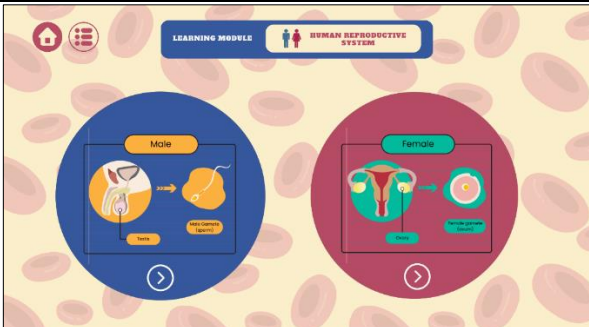
**Table 6: Hardware and software requirements**

Requirement	Item	Description
Hardware	Laptop Asus VivoBook	Allow the developer to use Unity and Blender to develop the application. Specification as follow: <ul style="list-style-type: none"> <li>▪ Processor: AMD Ryzen 5 3500U with Radeon Vega Mobile Gfx (2.10 GHz)</li> <li>▪ Installed Memory (RAM): 12.0 GB</li> <li>▪ Storage: 256GB</li> </ul>
	Android Smartphone	Allow the developer to test the application. Specification as follow: <ul style="list-style-type: none"> <li>▪ Operating System: Android 12</li> <li>▪ Resolution: 1080 x 2340</li> <li>▪ RAM: 8GB</li> <li>▪ Internal Storage: 128GB</li> <li>▪ Processor: Octa-core Max2.0GHz</li> </ul>
	Output device	Allow the developer to communicate with the Laptop use: <ul style="list-style-type: none"> <li>▪ Mouse/Touchpad</li> <li>▪ Keyboard</li> <li>▪ Microphone</li> <li>▪ External hard disk</li> </ul>
Software	Unity 2020.3.22f1	Used to integrate the function prototype.
	Blender	Used to create female reproductive system in 3D model as well as animation of menstrual cycle by phase.
	Visual Studio 2022	Used to write C# scripts for Menstrual Eduhub application.

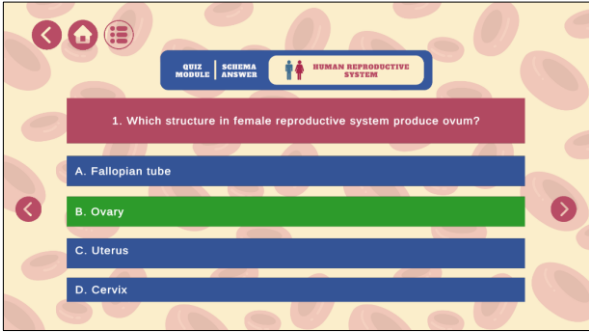
### 3.3 Design the Process

In this stage, the interface is illustrated to outline the content and hierarchy of each scene. Canva has been utilized in the development of assets to create the button, menu navigation, and graphic text. Throughout the graphic development process, the adjustment of sizing in terms of fonts and buttons has also been considered to sense of uniformity across all elements. Table 7 below depicts as an informative overview of the interface elements employed within the Menstrual Eduhub application. It outlines the four main interface components, namely the homepage, main menu, practice module selection, and quiz menu selection.

**Table 7: Interface of Menstrual Eduhub application**

Interfaces	Description
	<p>Homepage interface</p> <ul style="list-style-type: none"> <li>The homepage interface provides a start button to go to the next page and exit button to exit the application.</li> <li>App guide will deliver the guidelines on how to use the application step by step.</li> </ul>
	<p>Main Menu interface</p> <ul style="list-style-type: none"> <li>Divided into five selection of module which are Sexual and Asexual Reproduction, Human Reproductive System, Menstrual Cycle, Practice Module and Quiz Module</li> </ul>
	<p>Sexual and Asexual Reproductive Module interface</p> <ul style="list-style-type: none"> <li>Content is delivered in infographic notes.</li> <li>User can interact with the content by clicking next and previous button or either slide the content to view further information.</li> </ul>
	<p>Human Reproductive System Module interface (Female Reproductive System)</p> <ul style="list-style-type: none"> <li>The user can view and interact with the 3D model of human reproductive system by rotating the model.</li> </ul>

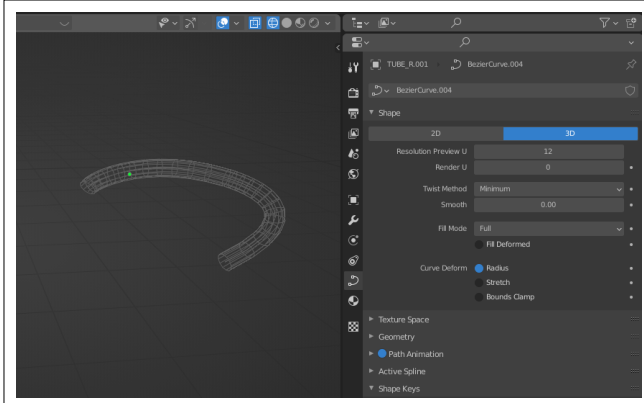
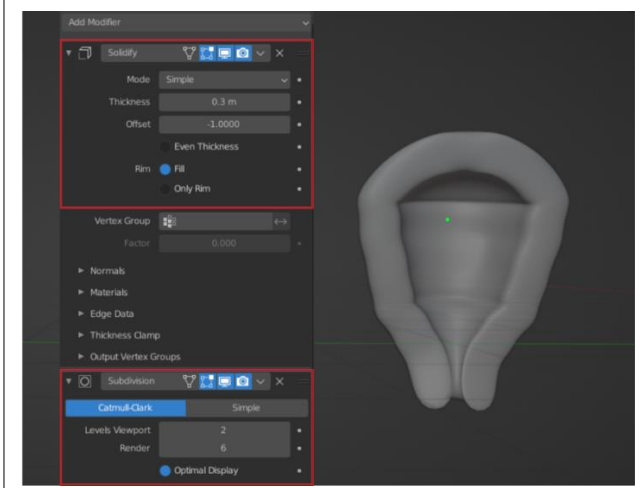
Interfaces	Description
	<p>Menstrual Cycle Module interface</p> <ul style="list-style-type: none"> <li>3D animated video is played throughout the menstrual cycle topic.</li> <li>The user can control the playback button either to pause or play the video.</li> <li>The user also can adjust the volume settings on the right top of application.</li> </ul>
	<p>Quiz Module interface</p> <ul style="list-style-type: none"> <li>The quiz provided a total of ten questions in five minutes.</li> <li>Every time user click the answer, the graphic text will display indicate whether the answer chosen is correct or incorrect as well as the sound effects</li> <li>The system will automatically end the quiz if the allotted time expires.</li> <li>The score will display at the end of the quiz.</li> <li>The user able to reattempt the quiz of module set</li> <li>The user able to recheck the schema answer</li> </ul>

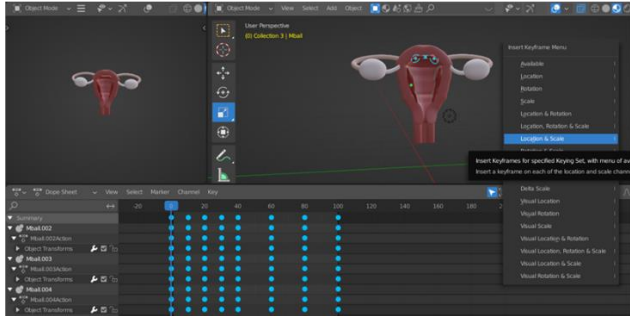
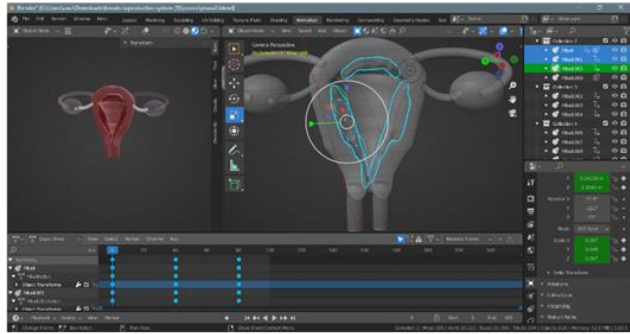
Interfaces	Description
	

### 3.4 Develop Main Functions

In this stage, the application encompasses three primary functions which are the quiz module system, 3D model development, and 3D animation of the menstrual cycle. Table 8 below showcases how the functions collectively contribute to the comprehensive nature of the application, providing users with interactive quizzes, realistic 3D models, and dynamic animations to enhance their learning experience.

**Table 8: Application Assets Development**

Development	Description
	<ul style="list-style-type: none"> <li>To create curve and bends in the tube, Bezier curve is used by adjusting control points to shape the fallopian tube</li> </ul>
	<ul style="list-style-type: none"> <li>An UV Sphere is added to the scene and "Solidify" modifier to give thickness to the sphere, simulating the walls of the uterus.</li> <li>Next, the "Subdivision Surface" modifier is applied to smooth out the geometry and for a more refined shape.</li> </ul>

Development	Description
	<ul style="list-style-type: none"> <li>A fluid simulation is incorporated to animate the behaviour and flow of the blood breaking from the uterine lining.</li> <li>The movement of the blood flowing out from the uterine lining is captured through keyframes to depict a dynamic flow of blood.</li> </ul>
	<ul style="list-style-type: none"> <li>To create a 3D animation of the fertile phase in the Menstrual Eduhub application, the process starts by adding a curve path that simulates the movement of the ovum from the ovary to the uterus.</li> <li>This curve path defines the trajectory and motion of the ovum during this phase.</li> <li>Next, keyframes for location and scale are added to animate the behaviour of the uterine lining.</li> <li>These keyframes define specific positions and sizes of the uterine lining at different points in time, allowing for a dynamic and visually engaging animation.</li> </ul>
<pre>public void correct() {     score += 1;     QnA.RemoveAt(currentQuestion);     PlayCorrectSound(); // Play the correct sound effect     correctImage.SetActive(true);     wrongImage.SetActive(false);     Invoke("generateQuestion", 1f); }  public void wrong() {     QnA.RemoveAt(currentQuestion);     PlayIncorrectSound(); // Play the incorrect sound effect     correctImage.SetActive(false);     wrongImage.SetActive(true);     Invoke("generateQuestion", 1f); } // Wait for 1 second before generating the next question</pre>	<ul style="list-style-type: none"> <li>For quiz module, the system is added the indicator graphic to depicts the selection answer is correct or incorrect to provide immediate feedback to the user, allowing them to easily identify their progress and understanding.</li> <li>A snippet of code from the quiz module, demonstrating the implementation of the indicator graphic and the corresponding score incrementation by one.</li> </ul>
<pre>void generateQuestion() {     if(QnA.Count &gt; 0) {         // Reset correct and wrong image pop ups         correctImage.SetActive(false);         wrongImage.SetActive(false);         currentQuestion = Random.Range(0, QnA.Count); // Randomize scene         QuestionTxt.text = QnA[currentQuestion].Question;         SetAnswer();          // Display current question number out of total         number of questions</pre>	<ul style="list-style-type: none"> <li>The provided code snippet is part of a function called generateQuestion() responsible for generating a new question for the user to answer in a quiz.</li> <li>The line currentQuestion = Random.Range(0, QnA.Count); is responsible for randomizing the selection of a question. It generates a random number between 0 and the total count of questions</li> </ul>

Development	Description
<pre> QuestionNumberTxt.text = "Question " + (totalQuestion - QnA.Count + 1) + " of " + totalQuestion; } else { Debug.Log("Out of Question"); // Reset correct and wrong image pop ups correctImage.SetActive(false); wrongImage.SetActive(false); GameOver(); } }</pre>	<p>(QnA.Count), assigning it to the currentQuestion variable.</p> <ul style="list-style-type: none"> <li>▪ The question text is set using QuestionTxt.text = QnA[currentQuestion].Question;.</li> <li>▪ It retrieves the question text from the QnA list using the index of the randomly selected question (currentQuestion).</li> </ul>

### 3.5 Testing

In this section, testing is conducted to ensure the Menstrual Eduhub application's functionality, usability, and overall performance are optimized.

#### 3.5.1 Alpha Testing

Throughout the development process, comprehensive functionality testing is performed to ensure that the buttons in the Menstrual Eduhub application are fully operational and responsive. Starting from the early stages of development and continuing until the completion of the application, functionality testing focuses on thoroughly examining each button's behavior and ensuring it performs its intended function accurately. Table 9 showcases the results of Functionality Testing, wherein each button undergoes thorough testing. During testing process that an issue is identified with the animated video in the Menstrual Cycle learning module, specifically a glitch that occurs when pausing the video. To address this issue, the solution involves adjusting the video player settings to ensure smooth playback and eliminate glitches.

**Table 9: Result of functionality testing**

Test Case	Expected Result	Actual Result	Corrective
Start Button	Navigates to Main Menu	Works well as expected	Not needed.
Exit Button	Show exit confirmation	Works well as expected.	Not needed.
App Guide Button	Navigates to App Guide interface	Works well as expected.	Not needed.
Menu Button	Navigates to Main Menu	Works well as expected.	Not needed.
Subtopic 1 Button	Navigates to Sexual and Asexual Reproduction Learning Module	Works well as expected	Not needed.
Subtopic 2 Button	Navigates to Human Reproductive Learning Module	Works well as expected.	Not needed.
Subtopic 3 Button	Navigates to Menstrual Cycle Learning Module	Works well as expected.	Not needed.
Quiz Button	Navigates to Quiz Module	Works well as expected.	Not needed.
Module 1 Button	Navigates to Sexual and Asexual Reproduction Quiz Module	Works well as expected	Not needed.
Module 2 Button	Navigates to Human Reproductive Quiz Module	Works well as expected.	Not needed.
Module 3 Button	Navigates to Menstrual Cycle Quiz Module	Works well as expected.	Not needed.
Module 4 Button	Navigates to All Subtopic Quiz Module	Works well as expected.	Not needed.
Next Button	Navigates to next scene or content	Works well as expected.	Not needed.

Test Case	Expected Result	Actual Result	Corrective
Previous Button	Navigates to previous scene or content	Works well as expected	Not needed.
Reattempt Button	Able to reattempt the quiz again	Timer is not reset	Resetting the elapsedTime variable to 0
Volume settings	Able to adjust the volume	Works well as expected.	Not needed.
Pause and Play Button	Stops and Play the counting time or animated video when clicked.	The video is glitching	Setting video player settings.

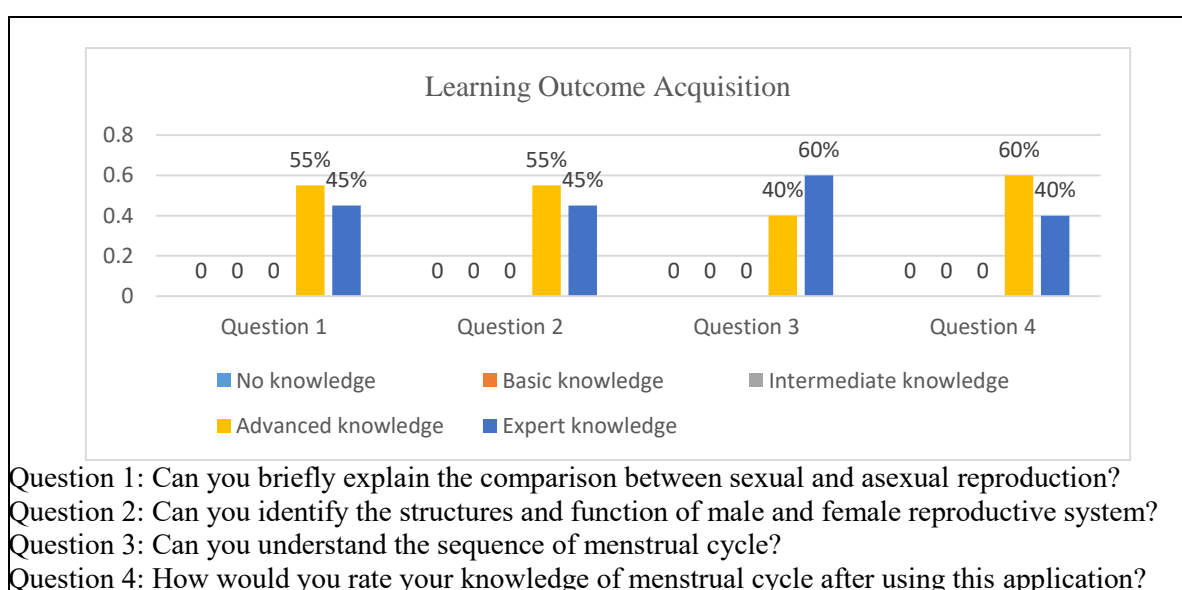
#### 4. Results and Discussion

In this section, the beta testing is collected and analyzed.

##### 4.1 Beta Testing

Beta testing was conducted by distributing a questionnaire via Google Form. The questionnaire consisted of three sections: "Respondent Information," "Learning Outcome Acquisition" with four questions, and "User Acceptance Level" with ten questions. The target users for the beta testing were Form 1 students from SMKA Sharifah Rodziah, Melaka. A total of 20 respondents participated in the testing, including 18 students and 2 teachers. The feedback collected from the respondents is divided into two categories which are positive feedback, as shown in Figure 6, and negative feedback, as shown in Figure 7.

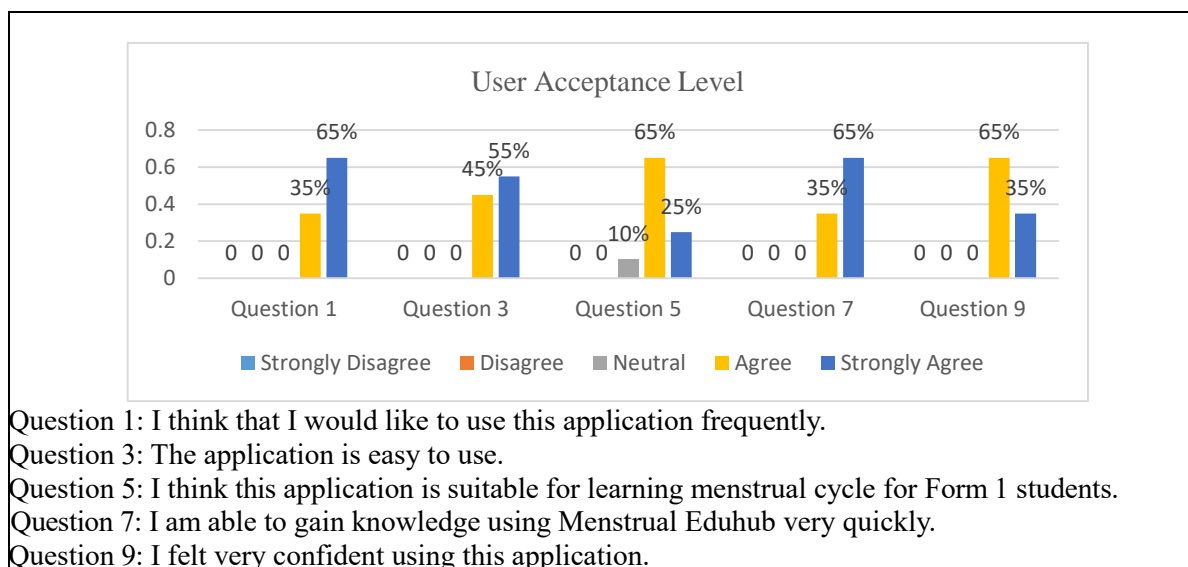
Based on Figure 5, there are four questions designed in the learning outcome acquisition section. Based on the analysis of this data, it was found that for Question 1, 55% of respondents had advanced knowledge, while 45% had expert knowledge in explaining the comparison between sexual and asexual reproduction. For Question 2, 55% of respondents had advanced knowledge, while 45% had expert knowledge in identifying the structures and functions of the male and female reproductive systems. Moving on to Question 3, 40% of respondents had advanced knowledge, while 60% had expert knowledge regarding the understanding of the sequence of the menstrual cycle. Lastly, for Question 4, 60% of respondents had advanced knowledge, while 40% had expert knowledge in the topic of menstrual cycle after using the Menstrual Eduhub application. The analysis of learning outcome acquisition provides compelling evidence for the application's efficacy in improving learning outcomes, further affirming the positive influence of integrating technology-based learning tools within the educational environment.



**Figure 5: Analysis Result of Learning Outcome Acquisition**

Based on the positive feedback analysis in Figure 6, the user acceptance level of the Menstrual Eduhub application was determined using five questions. For Question 1, 65% of respondents strongly agreed and 35% agreed to frequently use the application. Regarding Question 3, 45% strongly agreed and 55% agreed with the application's ease of use. In relation to Question 5, 90% of respondents agreed that the application is suitable for learning the menstrual cycle for Form 1 students. In relation to Question 7, all of the respondents believe and agreed that they can acquire knowledge using the Menstrual Eduhub application, considering the comprehensive features and information. This demonstrates the application's success in delivering valuable educational content. Lastly, for Question 9, 65% of respondents strongly agree and 35% agree that they felt very confident using this application. Overall, the data analysis reveals a positive user acceptance level for the Menstrual Eduhub application, with users expressing satisfaction with its usability, suitability for learning, knowledge acquisition, and overall confidence in its features.

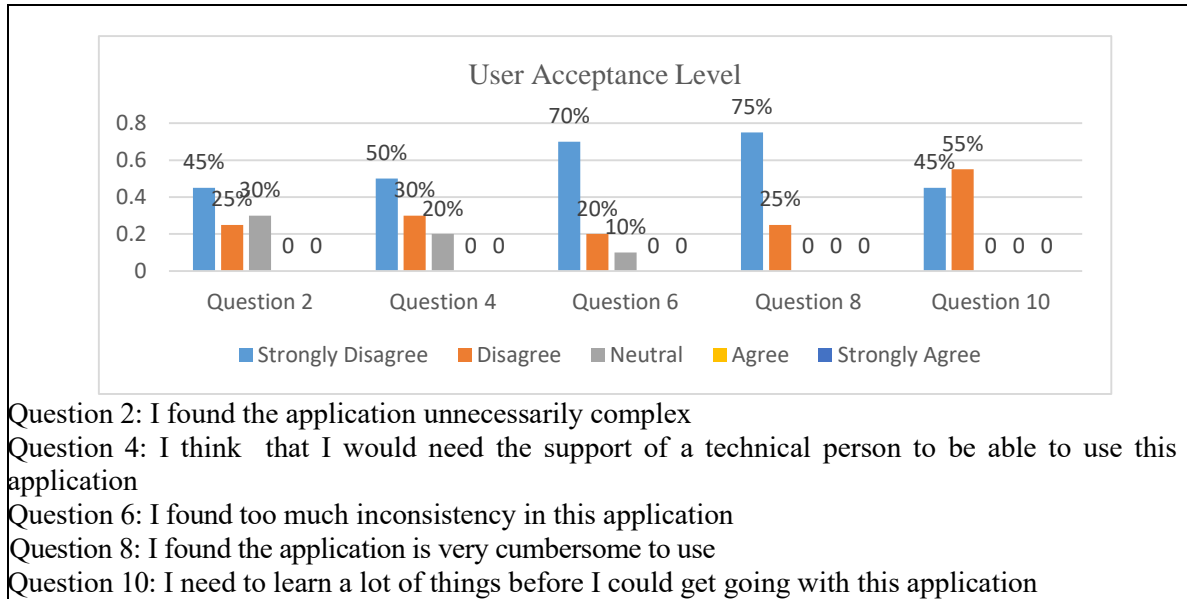
In relation to Question 7, all of the respondents believe and agreed that they can acquire knowledge using the Menstrual Eduhub application, considering the comprehensive features and information. This demonstrates the application's success in delivering valuable educational content. Lastly, for Question 9, 65% of respondents strongly agree and 35% agree that they felt very confident using this application. Overall, the data analysis reveals a positive user acceptance level for the Menstrual Eduhub application, with users expressing satisfaction with its usability, suitability for learning, knowledge acquisition, and overall confidence in its features.



**Figure 6: Analysis result of positive feedback**

Based on the analysis of negative feedback presented in Figure 7, the level of user acceptance was evaluated through five questions. For Question 2, 70% of respondents disagreed that the Menstrual Eduhub application is completely unnecessary, while 30% remained neutral. Similarly, for Question 4, 80% disagreed that a technician is needed while using the application, with the remaining 20% remaining neutral. In regard to Question 6, 90% of respondents disagreed that there is too much inconsistency in the Menstrual Eduhub application.

As for Question 8, all respondents disagreed with the statement that the application is very cumbersome to use. Lastly, for Question 10, 45% strongly disagreed and 55% disagreed that they need to learn a lot of things before being able to use the application. Upon analyzing the feedback, it can be concluded that the majority of users have a positive perception of the Menstrual Eduhub application. The feedback indicates that the application is deemed necessary, does not require the assistance of a technician, exhibits consistency, is not overly cumbersome to use, and does not require extensive prior learning.



**Figure 7: Analysis result of negative feedback**

**Table 10: Respondent’s Score (User Acceptance Test)**

Respondent	Item Score										Total Score
	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	
R01	5	1	4	1	4	1	5	1	4	2	90.0
R02	4	3	5	2	4	2	4	2	5	2	77.5
R03	4	2	5	2	4	1	5	1	4	1	87.5
R04	5	3	5	1	3	3	4	2	4	1	77.5
R05	5	1	5	1	5	1	5	1	5	2	97.5
R06	4	2	4	2	4	2	4	1	5	1	82.5
R07	5	1	5	2	5	2	5	2	4	2	87.5
R08	5	1	5	1	5	1	5	2	4	1	95.0
R09	4	1	5	1	4	1	4	1	5	1	92.5
R10	5	2	4	3	5	2	4	1	4	2	80.0
R11	5	3	4	3	4	1	5	1	5	2	82.5
R12	4	1	5	1	5	1	4	1	4	1	92.5
R13	5	3	4	3	4	1	5	1	5	2	82.5
R14	5	3	4	3	4	1	5	1	5	2	82.5
R15	5	3	5	1	3	3	4	2	4	1	77.5
R16	4	2	5	2	4	1	5	1	4	1	87.5
R17	4	2	5	2	4	1	5	1	4	1	87.5
R18	5	1	4	1	4	1	5	1	4	2	90.0
R19	5	1	4	1	4	1	5	1	4	2	90.0
R20	5	1	4	1	4	1	5	1	4	2	90.0
Average Score											86.50

Table 10 above shows the total score of usability value of Menstrual Eduhub application. System Usability Scale (SUS) is used for usability test to calculate the average score of user acceptance. The formula used to obtain usability results based on the SUS are:

$$\text{Total score} = (\text{odd items} + \text{even items}) \times 2.5$$

$$\text{Average score} = \frac{\text{Total score}}{\text{Total respondents}}$$

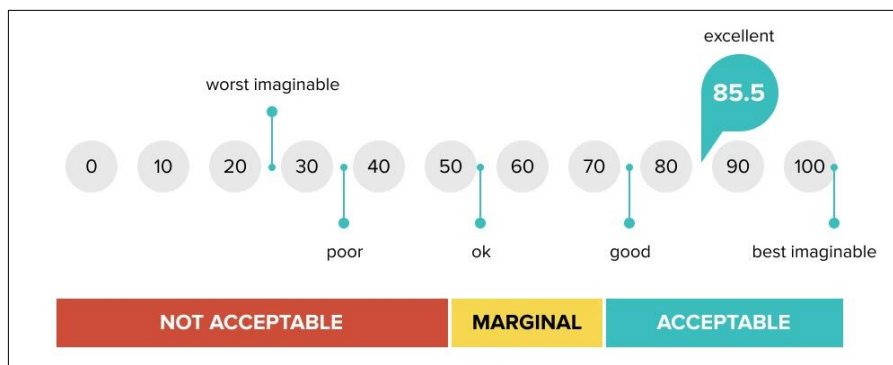
Where:

$$\text{Odd items (Q1, Q3, Q5, Q7, Q9)} = \text{contribution} - 1$$

$$\text{Even items (Q2, Q4, Q6, Q8, Q10)} = 5 - \text{contribution}$$

Therefore, Average score

$$= \frac{90.0 + 77.5 + 87.5 + 77.5 + 97.5 + 82.5 + 87.5 + 95.0 + 92.5 + 80.0 + 82.5 + 92.5 + 82.5 + 82.5 + 77.5 + 87.5 + 87.5 + 90.0 + 90.0 + 90.0}{20} = 86.50$$



**Figure 8: The Scale of The SUS Score [14]**

Based on the SUS score scale depicted in Figure 8, the average score of the usability value is 86.50 which falls in acceptable range. Overall, Menstrual Eduhub application can be classified as successfully meet the needs of the target users.

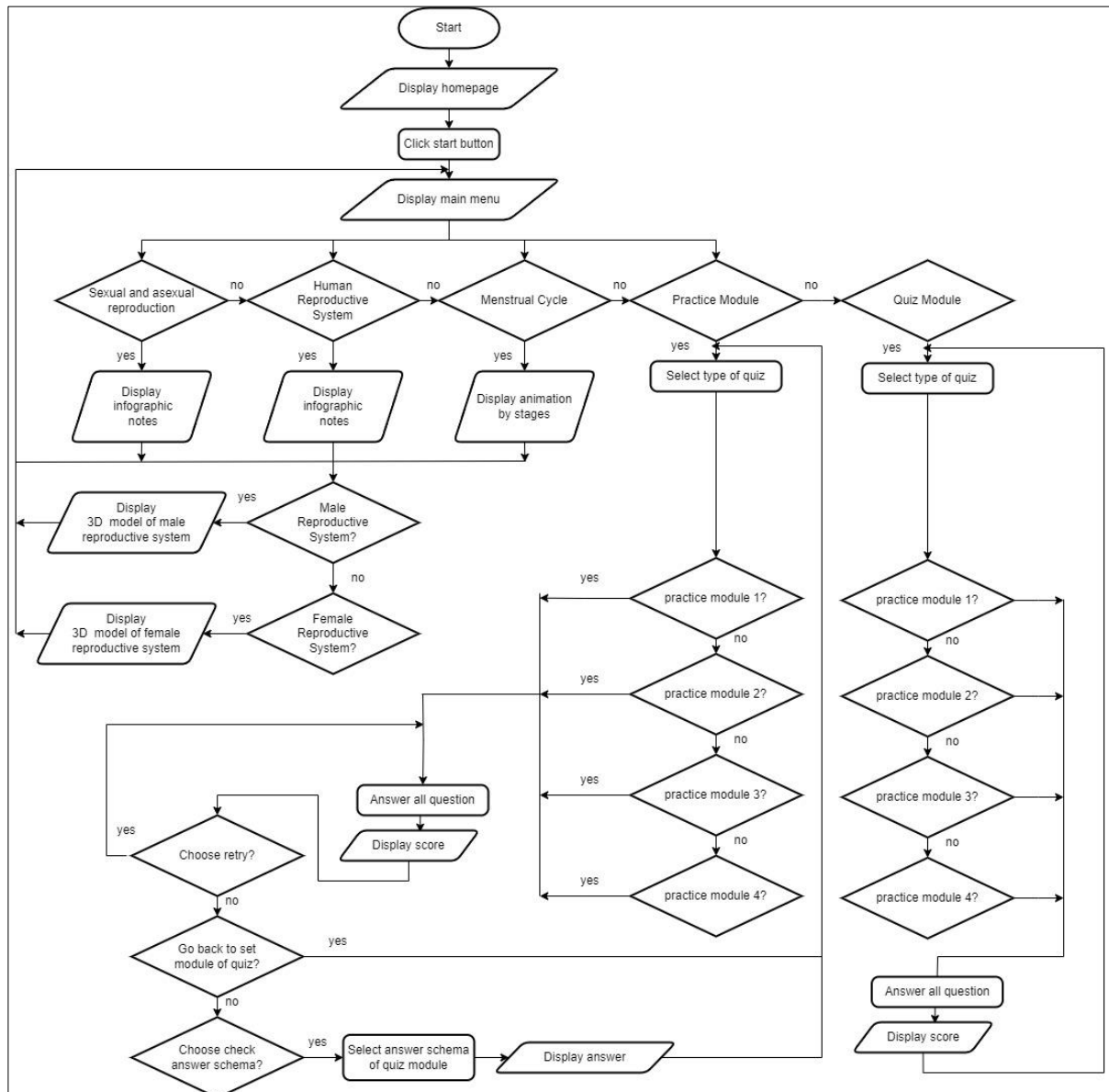
## 5. Conclusion

In a nutshell, Menstrual Eduhub application is a mobile-based menstrual learning application which designed for form 1 students. It offers a comprehensive and engaging learning experience for students in understanding the menstrual cycle topic through combination of visual content along with quiz for self-paced learning. Total of twenty respondents who participate in the beta testing agree that Menstrual Eduhub can help them learn menstrual cycle topics along with reinforce what they have learned through the quiz’s module. However, despite the successful development of the application and its achievement of the intended objectives, a few limitations have been identified in which the content of the menstrual cycle topic is limited to only three subtopics, potentially leaving out the other important aspects. Secondly, the application is currently available in English language only, which may hinder accessibility for non-English speakers.

To address these limitations and enhance the application's effectiveness, several ideas is suggested by expanding the content to cover a broader range of subtopics within the menstrual cycle to provide a more comprehensive learning experience. Additionally, adding more language options to make the application accessible to a wider range of students. To be concluded, Menstrual Eduhub is successfully developed and achieved all three objectives of the project with the assist of Multimedia Mobile Content Development approach (MMCD). It is hoped that this menstrual learning application can be used in a secondary school as a teaching and learning aid.

## Appendix A

This section outlines the flowchart of Menstrual Eduhub application.



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