Development of Interactive Learning Media for Simulating Human Blood Circulatory System

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***Abstract*—Human circulatory system is a topic that is very important to be learned. But in the process to learn it, it takes a high level of understanding because it is difficult to say with verbal language. Processes that occur in it are difficult to observe, happened so fast or even too slow. One way to understand it is through multimedia. This application will resemble the human circulatory system more interactive and interesting, in which players actively involved in the learning process. Starting from blood, blood vessels, heart, circulatory, until disease. There is also a test to measure the ability of a user. This application is created for Windows PC platform. From the questionnaire result and human computer interaction test, proved that the simulation strongly supports the process of understanding the material. Therefore, user's interest in learning is increased, coupled with the easiness of application usage and user friendly.**

Keywords—Multimedia; interactive; human blood circulatory system.

I. INTRODUCTION

In the delivery of a lesson, book is generally used. There are so many theories listed in the book, but there are many students who are not interested in it, not even reading the book because it is considered less interesting. This is because the book uses only one of the five senses in its use, the eyes. Images and text alone are not sufficient in the delivery of material.

The use of multimedia in a software will stimulate some important human senses, such as vision, hearing, action and sound, delivered via images, texts, videos and interactive animations. With the many senses used in the learning process, the easier it is for the learner to absorb all the material. In its application, multimedia will greatly help users, especially for ordinary users.

In some concepts of a particular subject, the role of a learning media is very important. It mainly deals with the concepts of subjects that require a certain level of understanding and are difficult to convey in verbal language. The material about the human circulatory system is one of the hardest material to convey with words, the processes that occur in it are difficult to observe, occur so quickly or even occur too slowly.

Adobe Flash will be used to create the application. Adobe Flash itself is one type of popular program to create interactive learning media based on computer. The advantage of Flash is, it will run in any platform, from PC, Mac, Linux, Android. Using Flash, the interactive application for learning human blood circulatory system will be created.

II. LITERATURE REVIEW

A. Interactive Media

Lexically, multimedia is divided into two, multi and media. According to Merriam Webster, multimedia means using, involving, or encompassing several media. From the meaning of the word "multi-" and "media", it can be said that multimedia is some tool or means that can be used to communicate (as an intermediary).

To get an interactive predicate, a multimedia must provide navigation control to the player so that players can explore the content at will, this term is called nonlinear multimedia or can be called interactive multimedia which is the gateway to the absorption of information [1].

B. Game Based Learning

Game based learning is a learning method that uses the game as its medium. Game based learning is also used to describe educational games or for educational purposes. Games have great potential as a learning tool, for example games can help players to improve their problem solving, negotiation, narrative and communication skills, as well as nonlinear thinking patterns.

The game-based learning environment can also increase the interest and motivation of participants in exploring and engaging in learning activities, need to be underlined as well as digital games as a place of learning has the benefit of being a virtual place to conduct learning activities safely, for example for chemistry learning is laboratory simulation [2].

C. Human Circulatory System

The circulatory system in human blood can be divided into two parts, namely small blood circulation and large blood circulation. Because of these two circulatory systems, the circulatory system in human is called the double circulatory system [3]. Human blood circulation is always

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through the blood vessels, therefore, the human blood circulation is called closed blood circulation.

Small blood circulation is also called lung blood circulation. This circulation starts from the blood filled with carbon dioxide and the remnants of metabolism that are in the right ventricle pumped out (when the heart contracts), leading to the pulmonary artery. Two branched pulmonary artery, one left lung and one right lung. Arriving in the lungs, carbon dioxide is released from the body and blood binds oxygen. From the lungs, oxygen-rich blood flows into the left and right pulmonary veins. The left and right pulmonary veins then coalesce into the pulmonary veins. After passing through the pulmonary vein, blood filled with oxygen enters the left atrium of the heart.

In the large blood circulation, the blood must reach various organs and upper and lower body parts. Therefore, large blood circulation is called the blood circulation of the body because the blood flow from the heart to the whole body and back to the heart. Clean blood inside the left ventricle of the heart is pumped into the aorta. The aorta branches toward the upper part of the body (head and hands) and leads to the lower body. Aorta that leads to the lower body there is to the liver, intestines, stomach, kidneys, limbs, and to the lower body tissues. From these organs, the blood returns to the heart through the superior vena cava and the inferior vena cava. Then go into the left atrium of the heart.

III. Application Design

The interactive learning media application for human circulatory system is divided into three major parts, namely the main menu, study menu, and exam menu. The structure of the application can be seen in Fig. 1.

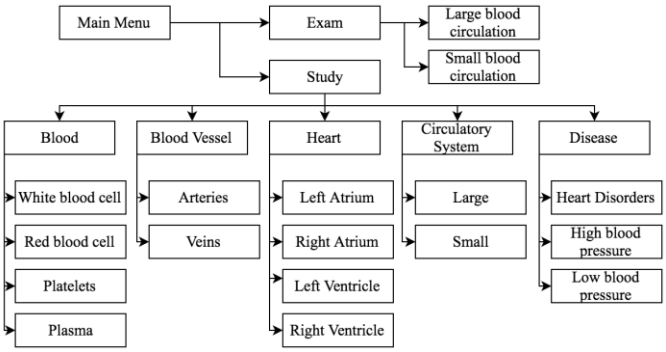

Figure 1. Application Structure

A. Main Menu

Figure 2. Main Menu Interface

In the main menu, user can choose between study and exam. The user interface of the main menu can be seen in Fig. 2.

In the main menu shown in Fig. 2, the play button is actually the same with study, but it starts from the beginning (blood course), so that the user can easily play without choosing. The study menu is shown in the form of book shelf at the top, where user can choose to start from any course.

B. Study Menu

In the study menu, user has a freedom to choose where to start, because user will often come back to this menu and they will usually need to find some forgotten information. The first time user come to study, user can start from the beginning. The course materials can be described as follows:

1) Blood

Blood simulation describes the blood components, which is red blood cells, white blood cells, platelets, and blood plasma. Each object (blood components) can be clicked and hovered. If clicked, the description will change according to the selected object. If hovered, the object will be highlighted. The interface can be seen in Fig. 3.

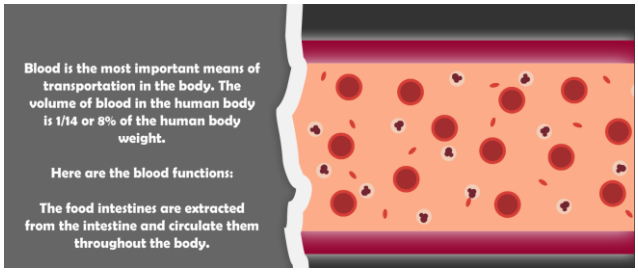

Figure 3. Blood Components UI

2) Blood vessel

Simulation of blood vessels explains the types of blood vessels, i.e. arteries and veins. Each object (blood vessel) can be clicked and hovered. If clicked, the description will change according to the selected object. If hovered, then the object will be highlighted. The interface can be seen in Fig. 4.

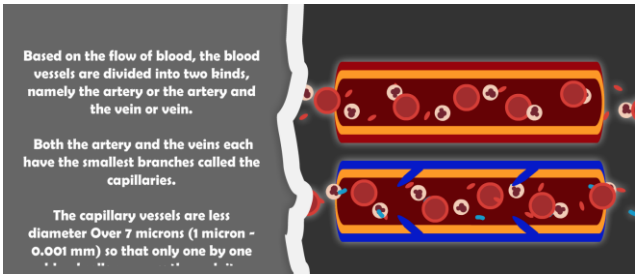

Figure 4. Blood Vessel UI

3) Heart

Heart simulation describes the components of the heart i.e. right ventricle, right atrium, left ventricle, and left atrium [4]. Each object (heart component) can be clicked and hovered. If clicked, the description will change according to the selected object. If hovered, then the object will be highlighted. The interface can be seen in Fig. 5.

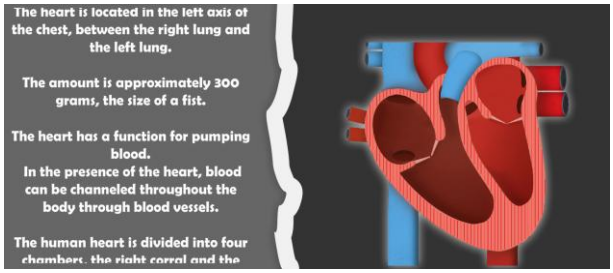

Figure 5. Heart Simulation UI

4) Blood Circulatory

In the blood circulatory simulation there are two choices, i.e. small blood circulation and large blood circulation. Each menu has the same simulation, but the animated circulation is different. The buttons on the bottom panel can be clicked to change the desired circulation. The interface can be seen in Fig. 6 and Fig. 7.

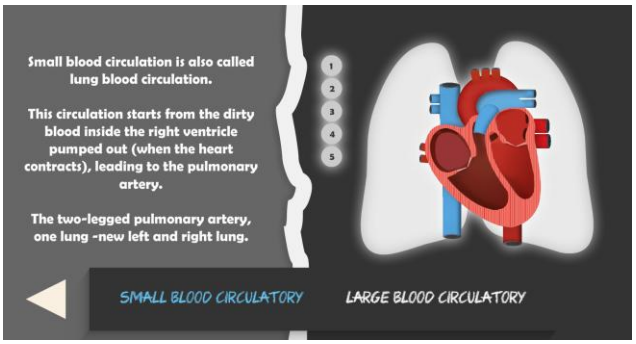

Figure 6. Small Blood Circulatory UI

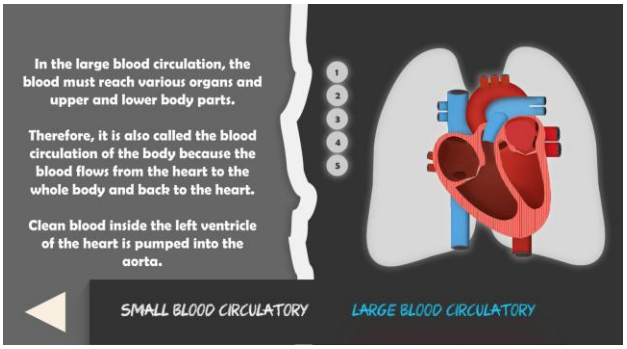

Figure 7. Large Blood Circulatory UI

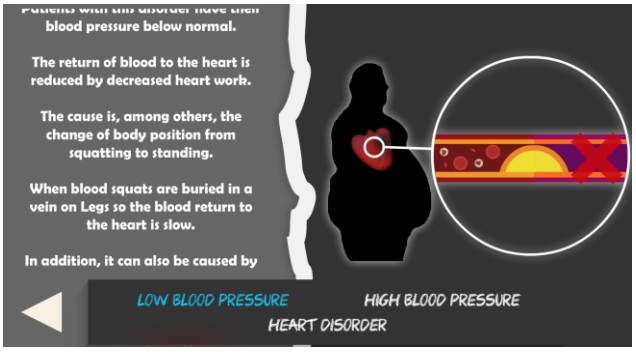

Figure 8. Low Blood Pressure UI

5) Disease

There are three choices of heart/blood related disease, i.e. high blood pressure, heart disorders, and high blood pressure. Each menu has a different simulation. The buttons on the bottom panel can be clicked to change the desired circulation. The interface for low blood pressure can be seen in Fig. 8.

C. Exam Menu

The exam page has three menus: Small Blood Circulation, High score, and Large Blood Circulation. The blood circulation button will take the user on each exam page. While the high score button takes the user on the high score page, if the user ever played the exam. The score is stored locally in the form of browser cookies (SharedObject class in Adobe Flash). The main menu for exam can be seen in Fig. 9.

Figure 9. Exam Main Menu

1) Exam for Large/Small Blood Circulatory

The small and large circulation exam page features a blood circulation simulation, where the user is asked to sort the small or large blood circulation occurs by clicking on the circulatory components. The interface for small blood circulatory exam can be seen in Fig. 10. The large blood circulatory is almost the same, but with different components.

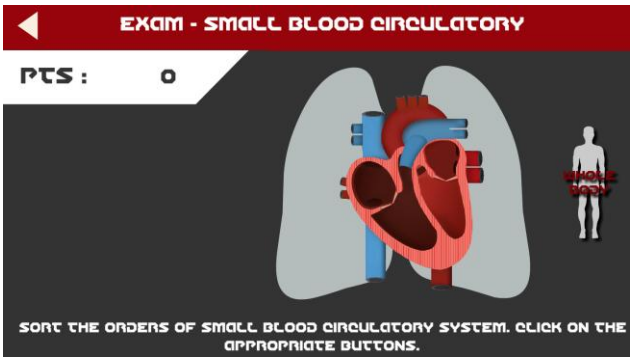

Figure 10. Small Blood Circulatory Exam

If the selected answer is correct, then the points will be added by 100 and an infographic will appear from the left of the screen containing the name of the selected object. If wrong, the points will be reduced by 50.

After the exam is completed, it will display the input form for name to be filled by the, and it will be displayed in the high score menu if the score is top 5.

IV. Application Testing

A. Human-Computer Interaction Test

Testing of human-computer interaction is done on five people. Testing is done by observing the user directly and giving an assessment on aspects of time to learn, speed of performance, error rate, retention over time, and subjective satisfaction [5]. The result of testing human-computer interaction can be seen in Table I, the amount shown in the table is the number of people (in percent) who got the value.

The result column (in percent) is the conclusion of each aspect, the value is derived from the total of all the multiplication of the number of people (in percent) with the given value (very less = 1, less = 2, good = 3, excellent = 4) divided by four (the number of options tested).

TABLE I. Human-Computer Interaction Test

Aspect	*Very Less*	*Less*	*Good*	*Excellent*	*Result*
Time to Learn	0	0	20	80	95
Speed of Performance	0	0	60	40	85
Error Rate	0	20	60	20	75
Retention over Time	0	40	20	40	75
Subjective Satisfaction	0	0	40	60	90

B. User Feedback

The questionnaire is done to get feedback from the user directly. The questionnaires were conducted on 23 people at junior and senior high school level, 56.5 percent (13 people) of whom were men, and 43.5 percent (10 persons) were women. The results of the questionnaire can be seen in Table II. The number listed in the table is the number of people (in percent) who choose the answer option.

TABLE II. User Feedback (Questionnaire)

Aspect	*Very Less*	*Less*	*Good*	*Excellent*	*Result*
Materials are good	0.0	4.3	65.2	30.4	81.45
Images are good	0.0	0.0	52.2	47.8	86.95
Animations are good	0.0	4.3	65.2	30.4	81.45
Colors match the game	0.0	0.0	47.8	52.2	88.05
Audio match the game	4.3	8.7	73.9	13.0	73.85
Clear language	0.0	4.3	65.2	30.4	81.45
Simulations are good	0.0	0.0	65.2	34.8	83.70
Eager to use the game	0.0	4.3	43.5	52.2	86.98

The result column (in percent) is the conclusion of each aspect, the value is derived from the total of all the multiplication of the number of people (in percent) by the given value (strongly disagree = 1, disagree = 2, agree = 3, strongly agree = 4) divided by four (number of answer choices).

V. Conclusion and Suggestion

Based on the test results can be concluded things as follows:

- Use of application is very easy, with the average of 95% learning time percentage.
- The average player is satisfied with the application used, with an average of 90% subjective satisfaction percentage.
- Applications can be used quickly, with an average percentage of performance speed 85%.
- The composition of color and the selection of good images support the learning media with the average of the percentage of each 88.05% and 86.95%.
- The existing simulations help the understanding of the circulatory system with an average of 83.7% percentage results.
- Material, clear language and good animation supports the understanding of learning media with average percentage of 81.45%.
- With good materials, simulations, drawings and language, the player's interest in learning is growing with an average percentage of 86.98%.

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