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Development of learning media for the female reproductive system based on augmented reality

Devy Kurnia Ramadhani [a, 1*], Dian Trisnasari [a, 2], Agus Sugiono [b, 3]

[a] Poltekkes Kemenkes Yogyakarta, Tata Bumi Street No.3, Banyuraden, Gamping, Sleman, DIY, Indonesia 55293
[b] Magelang, Jawa Tengah, Indonesia 56482
[1] devy.ramadhani@poltekkesjogja.ac.id*; [2] dian.trisnasari@poltekkesjogja.ac.id ; [3] onowdev@gmail.com
*corresponding author

ABSTRACT

Midwifery practice has contributed to the reduction of maternal and child mortality by applying biomedical sciences, one of which is anatomy. Anatomy education learning usually uses cadavers, models, and books, but they are considered less effective. This study aims to develop applications based on augmented reality for learning media on the female reproductive system. This research was a research & development research and uses a waterfall application development model to get applications for learning media. The research and development steps carried out in the research included: needs analysis, design, and implementation. The research was conducted at the Department of Midwifery, Poltekkes Kemenkes Yogyakarta in 2021. Based on a needs analysis, interactive learning media were developed, one of which was using Augmented Reality technology. The development design uses Unidentified Modelling Language (UML) i.e., use case diagram, class diagram, and sequence diagram. Development implementation in the form of markers, 3D animation, and application implementation. The Augmented Reality application for the Female Reproductive System can be used for learning and requires usability testing.
Keywords: applications, 3D animation, anatomy, physiology

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Introduction

Competent midwives have a major impact on maternal and child health(1). Midwifery practice has contributed to a significant reduction in maternal and child mortality rates and has a key role in achieving the SDGs goals. Midwifery education is the basis for equipping midwives with appropriate competencies to provide care that meets standards(2). Midwife education aims to produce professional staff who work as women's partners to provide support, care and advice throughout the life cycle from conception to menopause through efforts prevention, promotion, curative and rehabilitative(3). Midwife professional competency standards explain that midwives must have a scientific basis for midwifery practice by applying biomedical science, one of which is the female reproductive system.

The COVID-19 pandemic has caused rapid and drastic changes in health education. Currently, the best approach for midwifery students and lecturers is still being developed by digitalization and distance learning to ensure the required competencies and skills acquired by midwifery students will be achieved at the same level as before the pandemic(4). Therefore, the development of learning aids is teaching using a digital process is one solution to continue providing quality education during the pandemic.

Anatomy education lessons usually use cadavers, models, and books(5). Although the use of cadavers is the best standard for teaching anatomy, it has financial, ethical, and supervisory constraints in its use(6). For this reason, anatomy lessons are more common. using physical models in the form of phantoms, diagrams or images(7). However, the use of two-dimensional images also depends on students' ability to visualise spatial and physical features into actual forms. There are also many physical models that are not detailed enough to be understood. With the help of anatomy learning technology using interactive media based on virtual reality (VR) and augmented reality (AR)(5,7,8). The use of VR and AR in the health education process has proven to be beneficial. Both VR and AR can visualise in a 3-dimensional view that is like the original condition. However, developing VR-based applications requires quite a long time and costs a lot of money, in contrast to developing AR, which is simpler, so it requires lower costs than VR. Apart from that, AR-based application development also has the advantage that information can be combined with the real world. This allows for a presentation of the anatomy of the female reproductive organs that is closer to reality and offers more interactive learning opportunities. Application users can also connect virtual objects spatially with existing reality(9–13).

This research aims to develop appropriate technology for learning media in the form of AR-based applications on the female reproductive system. Making applications using AR technology which has lower costs. The use of AR technology can visualise the female reproductive system in 3D, providing a real physical picture. Apart from that, the accessibility of the tools for lecturers, education staff and students is also easier.

Material and Method

This research is research and development uses a waterfall application development model. The research was conducted at the Clinical Laboratory of the Midwifery Department, Poltekkes Kemenkes Yogyakarta in 2021. The research and development steps carried out in the research included: needs analysis, design, and implementation. Tools for collecting data in needs analysis include literature studies, interviews, and observations.

Result and Discussion

Needs analysis

The results of interviews, direct observation and literature review were obtained as follows: (1) Some students had problems in learning anatomy and physiology; (2) The female reproductive system material is critical material that must be mastered by midwifery students(3); (3) Not all students can understand and imagine illustrations of the female reproductive system well(5,7,8); (4) Learning media for female reproductive system material currently used include: cadaver (not yet owned by the institution, can be accessed if students do practicum in a medical laboratory that collaborates with the institution), phantoms/models, and 2-dimensional images(14); (5) Interactive learning media is needed so that it can attract interest and help students' learning process related to female reproductive system material(15 -17); (6) Almost all students, lecturers and educational laboratory staff can operate computers.

From the results of the needs analysis above, it can be concluded that the need for developing learning media is as follows: (1) Analysis of material data needs: the data needed in developing this application is material data on the female reproductive system. The material included is based on reference books used in anatomy and physiology courses for

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midwifery students; (2) Analysis of Hardware Requirements (Laptop minimum Intel Core i-3 processor, camera minimum standard webcam, Printer for printing markers) and Software (Blender for 3D animation, A-Frame for Augmented Reality application development); and Functional Requirements Analysis (Applications can display 3D illustrations on markers, Applications can run 3D animations via virtual buttons, Applications can run videos on markers).

Design

Modelling in the form of design to facilitate development in building applications. Modelling here is in the form of a design as a reference for development. The designs created are in the form of user experience (UX) and user interface (UI) designs. Creating user experience designs is carried out using Unified Modelling Language (UML) as the modelling language. The diagrams used are use case, class, and sequence.

Use Case Diagram

Use case diagram in AR application development as follows:

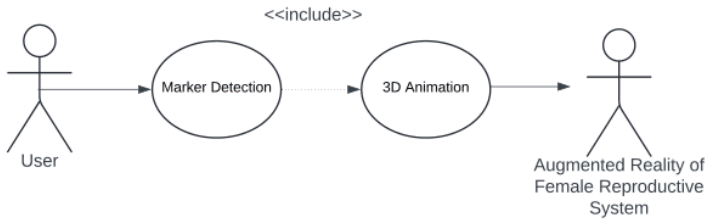

Figure 1. Use Case Diagram AR Learning Media for the Female Reproductive System

From the use case diagram above, it can be described as follows:

Table 1. Description of Use Case Diagram AR Learning Media for the Female Reproductive System

User	System
1. Open the Application 2. Point the camera at the marker	3. The application appears 4. Validate markers 5. If it is not valid, return to number 6. If valid, a 3D animation will appear

Class Diagrams

The class diagram describes the relationship between classes in the AR application for Learning Media for the Female Reproductive System which is used as a parameter for working on the application. Class Diagram can be seen in the scheme below:

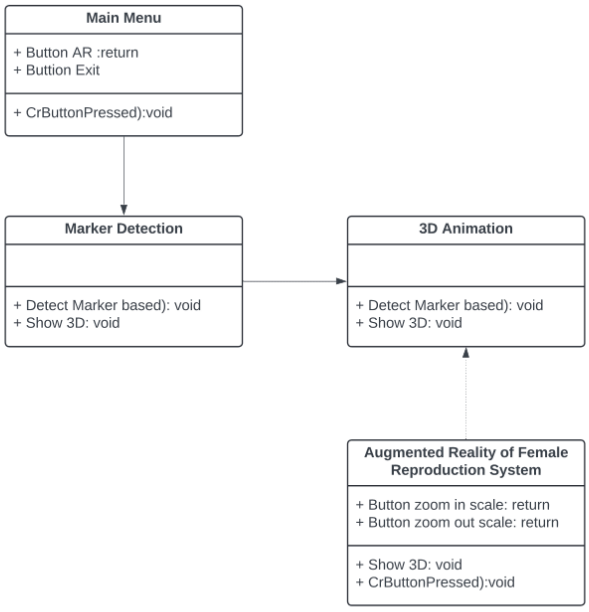

Figure 2. AR Class Diagram for Learning Media for the Female Reproductive System

Sequence Diagrams

Sequence Diagrams are used to understand the process flow and interactions between objects in the AR application for Learning Media for the Female Reproductive System. The following is the sequence diagram design for this application:

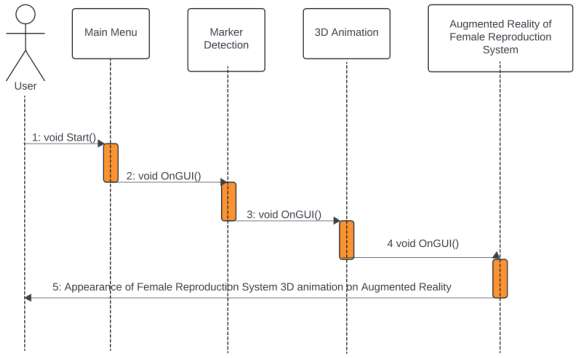

Figure 3. Sequence Diagram AR Learning Media for the Female Reproductive System

From the image above, the user can be seen opening the AR Media Application for Learning the Female Reproductive System then the main menu appears, then the user directs the marker to the camera and detailed information will appear in the form of a 3D animation.

Implementation

Marker Implementation

The AR application for learning the female reproductive system in this research uses marker based augmented reality. Therefore, applying augmented reality to an application requires a marker to be able to display 3-dimensional objects into the AR Camera. Markers are created

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and then inserted into the A-Frame application to display 3-dimensional images. The following are the markers used in the AR Media Application for Learning the Female Reproductive System.

Figure 4. AR Marker for Learning Media for the Female Reproductive System

3D Object Implementation

3D objects are created using the Blender application. The 3D object created will appear on the AR camera when the marker is recognized. Every 3D object loaded in the marker will be processed by A-Frame. The results of 3D modelling in blender are then saved in *.blend or *.fbx format for processing with the A-Frame application. An example of 3D modelling can be seen in the following image:

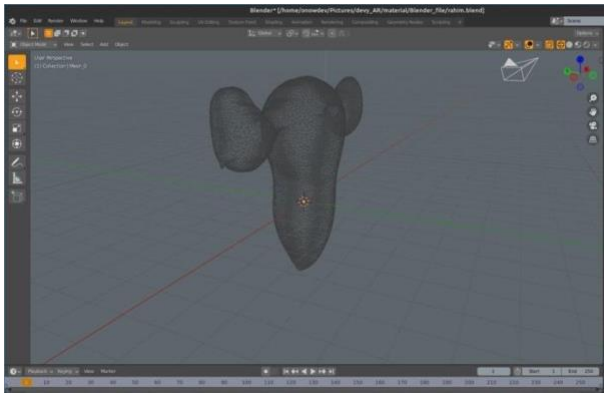

Figure 5. 3D Animation of the Early Female Reproductive System

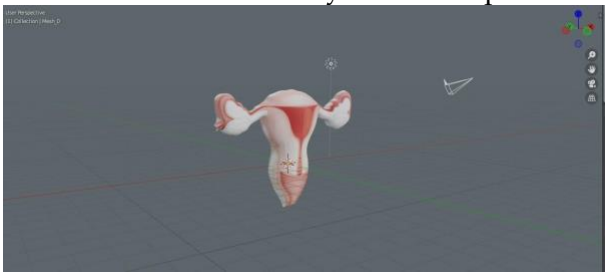

Figure 6. 3D Animation of the Late Female Reproductive System

Application Implementation

The following is a screenshot of the display layer of the AR Media Learning Application for Women's Reproductive Systems on the screen:

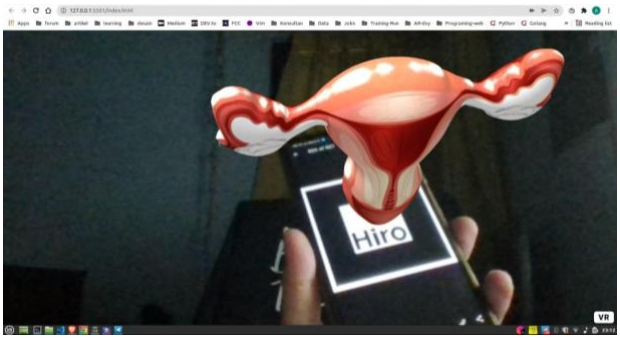

Figure 7. AR Implementation of the Female Reproductive System

Accurate and detailed knowledge on functioning of the female reproductive system is important, and can be beneficial for midwifery students to improve their body of knowledge about midwifery. Knowledge about the anatomy of female reproductive organs can increase knowledge about the specific competencies that midwives need to have to support the provision of midwifery services.(3) This skill can be improved by using several media to support competency mastery. 2D images in books may be ineffective tools for long-term recall of a subject, even when they are revisited at intervals. In the literature, it has been mentioned that teaching three-dimensional objects with complex structures in two-dimensional ways makes it difficult to learn. Through the manipulation of virtual representations of real objects, augmented reality applications facilitate the learning of ideas that are challenging to observe.(9) According to a 2019 study by Fuchsova and Korenova, participants found AR to be an easy way to understand human anatomy.(18) Additionally, a systematic review that looked at 27 papers came to the conclusion that AR was useful in medical education.(19)

The findings of this study indicate that AR learning material related to the female reproductive system can be easier to understand. Therefore, we recommend that universities and instructors increase the prevalence of AR, enrich AR materials, and raise awareness among academicians about the use of AR. However, this research requires further research to examine the usability of using AR applications to increase user retention, motivation, and satisfaction with these applications.

Conclusion

An augmented reality-based application was produced with a topic on the female reproductive system. Next, it is necessary to test the acceptance of the application if this application will be used as learning media.

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