

THE EFFECT OF AUGMENTED REALITY LEARNING MEDIA ON THE KNOWLEDGE AND SKILLS OF MIDWIFERY STUDENTS: A LITERATURE REVIEW

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KEYWORDS

Augmented Reality, Learning Media, Skills, Midwifery Students.

ABSTRACT

Objective: To provide a comprehensive overview of the effectiveness of using *Augmented Reality* (AR) learning media in education and become the basis for developing more effective learning strategies and contribute to the improvement of students' knowledge and skills.

Methods: Literature review based on National and International Scientific Journals, with a search strategy using Data-base: *Pub-med*, *Google Scholar*, *Science-Direct*, and *Semantic Scholar*, publication year 2019-2024.

Results: The initial literature search based on the specified criteria obtained 110 journal articles. Subsequently, the articles were analyzed based on publication, abstract, *full-text*, *open access*, and discussion results, resulting in 49 journals that were used as study material in accordance with the objectives of this literature review. The final process was carried out by reading, summarizing and selecting journals that were in accordance with the objectives and 30 relevant articles were determined based on the specified criteria.

Conclusion: The use of *Augmented Reality* (AR) learning media in learning can increase knowledge, skills, and confidence in student competence. The development of AR applications is very helpful for a more interactive and effective learning process.

INTRODUCTION

National Higher Education Standards (SN-Dikti) is a set of standards that includes national education standards, research standards and community service standards. One of the standards required in SN-Dikti is the graduate competency standard which is the minimum criteria to show the achievement of learning outcomes regarding the competence of attitudes, skills and knowledge at the end of the education programme⁽¹⁾.

Midwives as service providers must be prepared to overcome various health problems in the community. Midwifery services must be based on knowledge and competence in midwifery science developed according to patient needs². The main competence of a midwife is to be able to apply clinical skills in midwifery services based on *evidence (evidence based)* at every stage and target of midwifery services³. Knowledge and skills are the ability to master concepts, theories, methods, which are obtained through student learning⁴. Therefore, the world of education must be able to make new breakthroughs in the learning system. Especially in courses or practicum lessons, because if educators are not able to prepare an efficient learning system, it will worsen the condition of student knowledge and understanding⁽⁵⁾.

The use of media in learning can help educators provide subject matter to students interactively and can streamline learning time⁶. In addition, learning media is one of the tools so that learning activities take place effectively, and can be used to stimulate the thoughts, feelings, attention and skills of students⁷. According to Zahwa, F, et al (2022), that all educational media have features, advantages, and disadvantages, so that learning media must be designed so that the material can be delivered and received properly. In this modern era, information technology has developed very quickly. The utilization of information technology, such as the internet, mobile phones, laptops, and so on, is very important in the world of education. Thus, learning through this media is not limited to teachers or books⁽⁸⁾.

Laboratory practicum activities can provide opportunities for students to integrate the knowledge and skills they have acquired in practice. However, the available practical media is less attractive to students due to the inadequate condition of the practical tools that cause students to not have good skills and make it difficult for them to reach their full potential^{9,10}. In the learning process Application Media can facilitate learning facilities in various fields of education, especially about the introduction of body anatomy¹¹. As for computer-based learning, web-based, and learning using computers is a form of ICT utilization that must be implemented in the world of education¹². And one of the educational technology innovations that are starting to be applied today is *Augmented Reality (AR)* based technology.

Although there are many skills regarding the advancement of *Augmented Reality (AR)* and *Virtual Reality (VR)* based technologies, AR is the first application where 3D virtual objects are integrated into real environments in real time, with the aim of "visualizing" images into real space¹³. Based on the overview of Chen, Y et al., (2019) in recent years, the rapid development of *Augmented Reality* technology has attracted wide attention from researchers. Driven by computer vision and artificial intelligence technology, AR technology has shown strong development momentum¹⁴. AR learning media has an

entertainment aspect that is useful in increasing students' interest in the learning process and can project realistically and involve the interaction of all five senses of students⁽¹⁵⁾.

Based on the results of the Bestari AD & Wiwaha G (2020) literature review, it is concluded that AR technology has benefits for Midwifery Education. For students, the delivery of interesting material using AR can increase learning motivation so as to increase their knowledge. As for lecturers, AR technology facilitates the delivery of material because it provides a real picture of the object described¹⁶. The implementation of training in the use of AR media for midwives by Sudirman J, et al (2023-2024) shows the results that after attending training midwives have good knowledge and are able to apply AR technology in designing digital-based media to be used in education in midwifery services^{17, 18}. Although the use of AR in media has positive potential, it cannot be ignored that there are also challenges that must be overcome. By considering these potentials and challenges, research on the role of AR in improving the media user experience is relevant and important⁽¹⁹⁾.

The purpose of this literature review is to provide a comprehensive overview of the effectiveness of AR learning media in education, and make the basis for developing more effective and innovative learning techniques, as well as how this AR technology plays a role in improving students' knowledge and skills.

METHODS

The method used is a review of the literature related to learning media that utilize *Augmented Reality* (AR) technology in the learning process based on national and international scientific journals. The search strategy uses databases: Pub Med, *Google Scholar*, Science-direct and *Semantic Scholar*, which were published between 2019-2024, using the keywords "*Augmented Reality, Learning Media, Knowledge and Skills, Midwifery Students*". The search results found 210 articles, after which the 2019-2024 publication year was filtered. Literature based on the criteria amounted to 110 articles, then analyzed based on abstracts, *full-text, open access*, discussion results and duplication obtained 49 articles that could be used as study material according to the research objectives. The final process of reading and selecting 30 relevant articles based on the criteria (Figure 1). Each article will be sorted by :

1. Inclusion Criteria

- a. The article discusses the *Augmented Reality* (AR) technology-based learning method to increase knowledge and skills.
- b. Publication year 2019-2024
- c. International and National Publications
- d. National journals have ISSN
- e. Articles in Indonesian and English
- f. Original article, abstract, full text and open access

2. Exclusion Criteria

- a. Type of research other than literature review

The article search strategy can be seen in Figure 1.

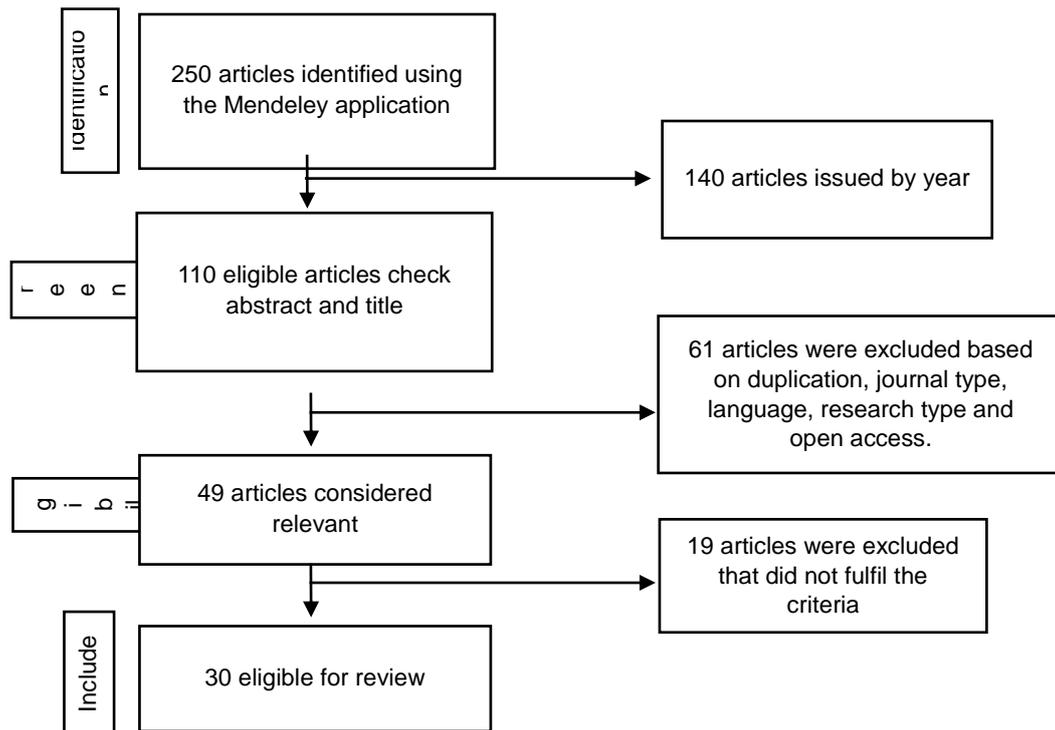


Figure 1. Flow Chart of Article Search

This Literature Review is structured with a narrative approach, where the extracted data is grouped based on the similarity of the measured results to achieve the set objectives. Some of the number of articles analysed relating to Augmented Reality (AR) can be seen in table 1.

Table 1. Extraction of research results

No	Author/Year	Title	Research method	Results
1.	Z. Sri Nurlaily et al, (2021)	Effectiveness of Augmented Reality (AR) based learning media on increasing the physical examination system of pregnant	Experiment with quasi-experimental non-equivalent control group design	This study showed a significant increase in the skills of respondents in the control group and intervention group, with a value of $P < 0.001$ ($P < 0.05$). However, the average skill improvement in the intervention group using AR learning media was better when compared to the control group who did not use AR

		women's urinary system.		learning media.
2.	Rahmat, B & Darmiati (2021)	Development of Learning Media with Video Based Learning at Pelamonia Midwifery Academy.	Development of video-based learning media.	The results of the development and testing of learning media with <i>Video Based Learning</i> in Gadar Mat-Neo material have been reviewed by material experts with very good learning results. Media expert assessment with excellent display and programming results. Student testing is divided into two groups: small groups average percentage value of 92% with the criteria "very interesting". The conclusion of this research is that the video media developed is "very feasible" to use.
3.	Sari DM et al. (2022)	Development of <i>Articulate Storyline</i> Learning Media Based on Animation for Anatomy and Physiology Subjects	Designed with the <i>Analysis, Design, Development, Implementation, and Evaluation</i> (ADDIE) research model.	The results of the validation of the animation-based <i>Articulate Storyline</i> learning media in the subject of Anatomy Physiology of Hair showed a score for all aspects of the media of 87.3% in the good category. For all aspects of the material the score is 79.5% with a good category. So that the animation-based <i>Articulate Storyline</i> learning media is categorized as good and can be a learning aid for students.
4.	Baran B et al, (2020)	Reproductive System Augmented Reality Application for Sexual Health Classes.	Quantitative research experimental design.	The significant increase from <i>pretest</i> to <i>post-test</i> showed that the application of AR improved participants' knowledge of reproductive organs and their positions.

5.	Faatih FM & Zakariyah M (2023)	Mobile Augmented Reality-based Human Respiratory and Digestive Organs Introduction Learning Application.	The research method used includes research stages consisting of system analysis, system design, implementation, and finally testing.	This application introduces human respiratory and digestive organs through 3D visuals based on AR technology. Test results using <i>black box</i> testing. This application has run as expected. The application that has been designed has the potential to increase the effectiveness of learning in understanding organs in the respiratory system and digestive system.
6.	Sintaro et al., (2020)	Learning Application of Basic Futsal Techniques Using Android-Based <i>Augmented Reality</i>	Development of AR technology learning application made with <i>Unity 3D</i> and <i>Vuforia SDK</i>	This application has met the requirements based on the results of black box testing. Beta test results that 83% of respondents are interested in using the AR 3 Futsal Basic Techniques Learning Application.
7.	Bahiyah N, et al., (2020)	Product Introduction Application Using Augmented Reality with Marker Method	This research is an R&D, Research and Development study.	Augmented reality applications can be used to help sellers introduce products more effectively without having to show physical goods. With three-dimensional objects, sellers are able to more interactively introduce furniture products to potential buyers.
8.	Ahmad I, et al. (2022)	Application of Augmented Reality on Human Body Anatomy to Support Learning of Alternative Medicine Cupping Points	Android-based application development by utilizing Augmented Reality technology.	The cupping point AR application can be operated on an Android <i>smartphone</i> . The human <i>functional suitability</i> quality test is able to perform its function 100% correctly. Usability aspect quality test obtained a value of 93.23%. Test the quality of portability aspects on several devices with Android operating system versions, Lollipop, Marshmallow, Oreo with portability aspect values reaching 100%.

9. Arpin I & Suryaning sih Y (2019)	Development of Biology Learning Media Using Android-Based Augmented Reality (AR) Technology on the Concept of the Nervous System	Development (R&D) by adopting the Akker model	AR-based learning media developed, according to expert assessment, is feasible to use with the results of excellent assessment for media aspects, good value for content aspects, and excellent value for pedagogical aspects. The results of the implementation of AR media Biology learning developed are classified as effective and can increase the achievement of student learning completeness by 76%.
10. Apriyanto & Pangaribu an H (2023)	Designing Augmented Reality as an Android-based Human Anatomy Lesson	Using the <i>Marker Based Tracking</i> method based on android.	This application is designed as a learning media by utilizing <i>Augmented Reality</i> technology. The benefits of this media can be used as a learning tool. By using this <i>Augmented Reality</i> technology, learning becomes interactive and the application of this application can be used in <i>real time</i> .
11. Lutfiyah D, et al. (2021)	Development of learning media about the heart organ using Android-based technology	AR-based application development using 3D Blender software, and supporting software, Unity 2017.	This 3-dimensional learning media is presented in a simulation of the Heart Surface, Cardiovascular System and how to handle heart attacks and cardiac arrest.
12. Hikmanda yani et al, (2021)	Learning media based on augmented reality (AR) increased the skill of physical examination of the integumentary system of pregnant women in midwifery students.	Quasi-experiment with Non-Equivalent Control Group Design	There was a difference in the measurement of skill improvement in the control and intervention groups before and after the intervention. More significant skill improvement occurred in the intervention group with a P-value <0.001. Application-based skills (AR) increased by 66.1%. After two weeks it increased by 93.5%, and after two weeks it increased by 100%. So it is statistically concluded that AR-based learning

				media is significant in improving the skills of physical examination of the integumentary system in pregnant women.
13.	Susilawati E, et al, (2023)	Learning Media for Implant Contraceptive Installation on Midwifery Students' Knowledge and Skills	Quantitative research with experimental design using <i>one group pre-test</i> and <i>post-test</i> design.	The results of the study were that AR technology-based <i>e-book</i> learning media for implant placement was very effective and there was a significant effect in improving the knowledge and skills of midwifery students before and after using this learning media.
14.	Nauko YS & Amali LN (2021)	Introduction to Body Anatomy Using Android-based <i>Augmented Reality</i> Technology	MDLC (Multimedia Development Life Cycle) method.	The results of the research are in the form of an application for introducing the anatomy of the human body using AR technology that can help students find information and become a means of learning media for human organs. This learning media visualize abstract concepts to understand the structure of an object model, and makes the media more effective in accordance with the objectives of the learning media.
15.	Setiawan AE, et al., (2023)	Human Anatomy Recognition Using Augmented Reality With Marker-Based Method Tracking	Development of ANAR (Anatomy in Augmented Reality) application, using mobile augmented reality technology using Marker Based Tracking method.	App ANAR (Anatomy in Augmented Reality) successfully built a user-friendly system with a high level of usability by showing accuracy of learnability, 87.6% efficiency, 90% memorability, 70% errors, and 85.50% of satisfaction. This application is very useful in providing visualization of learning materials and creating a better interest in learning the subject of anatomy material.

16.	Murdhani IDAS, et al., (2022)	Learning Media for the Introduction of the Human Organ System Through <i>Augmented Reality</i> Using Unity Applications	Research and Development (R&D) Method	This research produces an AR app that explains human organ material, besides that there is a quiz, and is equipped with 3D objects to provide interactive learning, increase interest in learning, can see and interact with virtual human organ models. This learning media is developed using Unity application.
17.	Amalia EL, et al. (2019)	Augmented Reality for Human Respiratory System	Creation of AR application with android platform using game engine unity	AR design in the respiratory system and blood circulation is made with the Blender application. Making AR applications with the Android platform using the game engine unit. Based on functional tests conducted by researchers, it can be concluded that by implementing the application, users can obtain information related to the human respiratory system and blood circulation that can be delivered in an interesting and interactive way to students.
18.	Efendi M, et al., (2021)	Development of Learning Materials for Physiological Anatomy Based on <i>Augmented Reality</i> Technology	AR learning media development	Based on the results of the assessment of media experts, materials, and users, this anatomy teaching material is technically and substantively feasible to use as a learning material for human physiological anatomy. The inclusion of AR technology for reinforcement of certain materials in this learning material provides a significant increase in understanding.
19.	Pujiastuti H & Haryadi R (2024)	Effectiveness of Using Augmented Reality on Geometry Thinking Skills of Junior High School Students	The research design used in this study was a quasi-experimental nonequivalent control group design.	The results of observations made during learning activities using augmented reality show that students look active and make students more excited when learning Geometry. The response results show that 39 students become more proactive in

				learning Geometry by using augmented reality applications.
20.	Arifitama, B et al, (2022)	Comparative Analysis of the Effectiveness of Marker and Marker-less Tracking on <i>Augmented Reality</i> Objects.	Done implementation of each marker, namely <i>marker-based-tracking</i> and <i>marker-less-tracking</i> in <i>augmented reality</i> .	The research was conducted by comparing <i>marker-based tracking</i> and <i>marker-less tracking</i> . The <i>marker-less tracking</i> method is 93.3% superior compared to <i>marker based tracking</i> which is 80.3% on identical <i>augmented reality</i> objects, the longest distance, and produces 86% accuracy for <i>marker-less tracking</i> compared to 50% on <i>marker based tracking</i> for close distances.
21.	Sungkono S, et al, (2022)	Learning Media Based on Augmented Reality Technology	Research & Development (R&D) method with Assessment/Analysis, Design, Development, Implementation & Evaluation (ADDIE) model.	The results of the research are in the form of AR technology-based learning media on GEO3DAR pyramid material. The feasibility of content quality and objectives is in the feasible category. The feasibility of instructional quality is in the very feasible category.
22.	Arianto IW, et al., (2023)	Development of Android-based <i>Augmented Reality</i> Application of Hearing System Material in Humans	Research and Development (R&D) research method	The test results showed that the application received a positive response from users, and increased interest in learning about the human sense of hearing. As well as contributing to the development of more interactive and effective learning methods in the field of biology.

23. Aji s, et al., (2019)	Simulation Integration in Augmented Reality on Human Respiratory System	In this research, the method used is the Multimedia Development Life Cycle, where this method has 6 stages, namely concept, design, material collecting, assembly, testing and distribution.	The application made in this study is the Integration of Augmented reality Simulation (AR) of the Human Respiratory System with the Marker-less Based Tracking method for android-based respiratory system information media, making this application using unity 3D software, blender, substance painter and AR Core. This application can be used by students, students, millennial's and the general public, thus utilizing the camera feature on a smartphone device to detect data surfaces, 3D animation simulations will appear.
24. Bestari AD, et al., (2023)	Utilization of Augmented Reality Technology as a Pregnancy Education Media: Alpha Test	This research method uses application development multimedia, namely the Development Life Cycle (MDLC) Method.	The results of alpha testing conducted by all parties involved in making AuRil state that AuRil can function according to the expected scenario. Based on the results of the alpha test, AuRil can be continued to the beta test stage to parties who are not involved in making such as pregnant women or midwifery students.
25. Ardhani R et al, (2022)	Augmented Reality 3D Heart as Learning Media at Midwifery Lab University of Aisyiyah Surakarta.	Experimental	Learning media for the introduction of the heart organ has been successfully made with a 3D modelling design, this learning media is integrated with android applications on Android smartphones and can be run on a PC using a web browser. Based on a survey conducted 77.2% of this application is very easy to understand, this makes this application very useful and easy to use.

26.	Vogel, K et al, (2024)	Augmented reality simulation-based training for midwifery students and its impact on perceived knowledge, confidence, and skills for managing critical incidents.	The study was descriptive exploratory using a pre-post design.	Students rated their competence significantly better after the survey than before the survey ($p < 0.05$). Simulation has an impact on self-assessment of professional knowledge, confidence and practical skills in emergency situations. It improved students' procedural knowledge and practical skills in complex contexts, complementing subject knowledge and building confidence.
27.	Lecoutre A, et al., (2024)	A prospective, single-centre study of the feasibility of the use of AR for improving the safety and traceability of injectable investigational cancer drug compounding.	A prospective, single-centre study evaluating the feasibility of implementing an AR approach for compounding injectable drugs.	User satisfaction surveys highlighted very high usage rates and a desire to expand the scope of merging performed with AR support. AR glasses are an innovative and cost-effective tool that increases safety levels without interfering with unit operating procedures. The versatility of this tool allows its integration into various work environments.
28.	Silva M, et al, (2023)	Effect of an Augmented Reality App on academic achievement, motivation, and technology acceptance of university students of a chemistry course	This study followed a pre/post-test design with a control group.	AR technology can help in the academic environment by allowing students to be more active in the learning process and thus more motivated, resulting in better performance and generalization of knowledge to the real world.
29.	Yurtsal ZB & Hasdemir O (2023)	Midwifery Students' Knowledge and Opinions on Virtual Reality and Augmented Reality Used in Midwifery	This study is a descriptive cross-sectional study and data collection was carried out using non-probability	In the results of the study, it was determined that most midwifery students had less knowledge about <i>virtual reality</i> and <i>augmented reality</i> , but they thought that their use in midwifery education could be beneficial.

	Education	sampling method.	
30.	Wulandari MR, et al, (2023)	Making Augmented Reality Video Profile With Motion Graphic Technique As A Promotion For The Siti Academy Of Midwife	MDLC method or <i>Multimedia Development Life Cycle</i> . The results of the <i>benchmark</i> diagram are in the <i>Above Average</i> category because each scale has a total average value above 1, so the respondent's perception is positive because the value of each scale is above average.

DISCUSSION

Effectiveness of *Augmented Reality* (AR)

Most of the studies in table 1 explore the utilization of Augmented Reality (AR) technology and it has great potential to improve learning effectiveness especially in health and science fields²⁰. According to Yurtsal ZB et al., (2023) most midwifery students have less knowledge about *virtual reality* and *augmented reality*, but they think that its use in midwifery education can be beneficial²¹. It is proven in the research of Vogel, K et al., (2024) that AR simulation-based training has an impact on self-assessment of professional knowledge, confidence, and practical skills in emergency situations²², and helps the academic environment make for students more active and motivated in the learning process so that it can produce better performance⁽²³⁾.

Several studies have shown an increase in students' knowledge and skills in the physical examination of the urinary system and integument in pregnant women, as well as the skill of installing implantable birth control²⁴ (²⁵, ²⁶). In addition, the application of AR in learning also increases students' knowledge of reproductive organs and their positions²⁷, and improves the ability to think critically in various subjects such as Geometry⁽²⁸⁾.

In line with research by Rahmat B & Darmiati (2021) and Sari DM et al., (2022) that video-based learning media and animation have a high level of effectiveness in understanding Maternal Neonatal emergencies and learning Anatomy Physiology of Hair in students²⁹, ³⁰. Meanwhile, many authors have used *Augmented Reality* (AR) in anatomy education. In addition to financial and ethical advantages, AR has been described to reduce cognitive load while increasing student motivation and engagement⁽³¹⁾.

Augmented Reality (AR) Technology Development

Many studies have successfully developed learning media and have produced learning materials supporting Human Physiology Anatomy courses equipped with *Augmented Reality* technology³². As in the research of Amalia EL,

et al., (2019) and Faatih FM, et al., (2023) who have designed Android-based applications to introduce respiratory, digestive and blood circulation organs so that users can obtain information related to the material presented in an interesting way^{33, 34, 35}. In addition, this Android-based AR application in the research of Ahmad I, et al., (2022) has been tested for quality on the introduction of human body anatomy to support learning alternative medicine cupping points⁽³⁶⁾.

Currently, there are many studies that use the *Research and Development* (R&D) method to develop AR-based learning media³⁷. In addition, there are two types of markers used in the development of *Augmented Reality*, namely *Marker-Based Tracking* and *Marker less-Based Tracking*, which have been analysed for comparison of their effectiveness in Arifitama's research, B et al. (2022) with the results of the *Marker less Tracking* method of 93.3% superior to *Marker Based Tracking* which is 80.3% on identical *Augmented Reality* objects, the longest distance, and produces 86% accuracy for marker-less *tracking* compared to 50% on *marker based tracking* for close distances³⁸. *Augmented Reality-based* Learning Media in research Murdhani IDAS, et al., (2022) developed with the Unity application has explained the discussion of material from the human organ system³⁹. The development of AR pregnancy multimedia applications (AuRil) as a medium of pregnancy education in research Bestari AD, et al., (2023) has been tested can run well and according to the planned scenario⁽⁴⁰⁾.

Several studies have successfully developed AR technology-based learning media applications to become more effective learning media and create learner interest, especially in Anatomy learning materials⁴¹, including helping to introduce the cardiovascular system and handling heart attacks and arrests^{42, 43}, learning the auditory sensory system⁴⁴, and also on the concept of the nervous system^{45, 46}. Lecoutre A, et al., (2024) in his research has designed a new device, namely *Augmented Reality* (AR) glasses connected to an oncology drug management system, which has been tested, adapted and improved within the unit and is now used for the investigation of injectable cancer drug compounding⁽⁴⁷⁾.

In addition to the fields of education and health, the application of *Augmented Reality* (AR) technology has been developed in various fields such as product marketing without having to show physical goods⁴⁸ and also designed applications in the field of sports that can explain the basic techniques of futsal⁽⁴⁹⁾.

CONCLUSIONS

It has been widely proven that the use of AR technology has proven to be very useful as a medium for learning and understanding material, especially in the fields of science and health such as midwifery. In addition, AR technology has the ability to improve students' knowledge and skills and help educators provide material in the learning process. AR technology is interesting because it has features that do not exist in conventional learning media. By using augmented reality technology as learning media, it is possible to combine the differences between the virtual world and the real world. In addition, it is considered to be able to attract students' attention by using AR technology through *Smartphone*. AR multimedia applications have been used to show human organ systems as well as skills in pregnancy examination. Based on the results of the literature review,

further research is needed related to the development of AR technology as a learning media that can improve student skills, especially skills in midwifery care.

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