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Digitalizing midwifery education: Trends, tools, and transformation

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ABSTRACT

The development of digital technology has brought significant changes to the field of education, including midwifery education. The integration of technology into the learning process is believed to improve the quality of education and the competencies of midwifery students. This study aims to explore the use of technology in midwifery education and its impact on student learning outcomes. A scoping review was conducted using the PEO framework (Population, Exposure, Outcome), focusing on midwifery students, the use of technology, and learning effectiveness. Literature was collected from databases such as PubMed, ScienceDirect, and Google Scholar, using keywords related to technology implementation, learning effectiveness, and midwifery education. Articles were selected based on systematically defined inclusion and exclusion criteria. Descriptive analysis was used to identify key themes, types of technology applied, and their effects on the learning process. The findings indicate that e-learning, virtual reality, and artificial intelligence are the most commonly used technologies. These tools have been shown to enhance theoretical understanding, practical skills, and learning motivation. However, challenges such as limited access, insufficient faculty training, and unequal infrastructure remain. Therefore, well-planned and sustainable implementation strategies are needed to optimize the use of technology in midwifery education.

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ABSTRAK

Perkembangan teknologi digital telah membawa perubahan signifikan dalam dunia pendidikan, termasuk di bidang kebidanan. Integrasi teknologi dalam proses pembelajaran diyakini mampu meningkatkan mutu pendidikan dan kompetensi mahasiswa kebidanan. Studi ini bertujuan untuk mengeksplorasi pemanfaatan teknologi dalam pendidikan kebidanan dan dampaknya terhadap hasil belajar mahasiswa. Metode yang digunakan adalah tinjauan skoping dengan pendekatan PEO (Population, Exposure, Outcome) yang memfokuskan pada mahasiswa kebidanan, penggunaan teknologi, dan efektivitas pembelajaran. Literatur dikumpulkan dari basis data seperti PubMed, ScienceDirect, dan Google Scholar, menggunakan kata kunci yang berkaitan dengan implementasi teknologi efektivitas pembelajaran, dan pendidikan kebidanan. Artikel diseleksi berdasarkan kriteria inklusi dan eksklusi yang ditetapkan secara sistematis. Analisis deskriptif digunakan untuk mengidentifikasi tema utama, jenis teknologi yang digunakan, serta dampaknya terhadap proses pembelajaran. Hasil menunjukkan bahwa e-learning, realitas virtual, dan kecerdasan buatan merupakan teknologi yang paling sering digunakan. Ketiga teknologi ini terbukti meningkatkan pemahaman teoretis, keterampilan praktik, dan motivasi belajar mahasiswa. Namun, tantangan seperti keterbatasan akses, kurangnya pelatihan dosen, dan infrastruktur yang belum merata masih menjadi kendala. Oleh karena itu, diperlukan strategi implementasi yang terarah dan berkelanjutan agar teknologi dapat dimanfaatkan secara optimal dalam pendidikan kebidanan.

Kata Kunci: *implementation; midwifery education; technology*

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INTRODUCTION

In today's educational landscape, the integration of technology into learning has become essential. The rapid development of digital tools has prompted educational institutions to create opportunities for students to engage in learning experiences that differ significantly from traditional approaches. The adoption and use of technology in the teaching and learning process is directly related to this change (Khatatbeh et al., 2024). Consequently, it is imperative that instructors use technology with intention and efficiency, and for institutions to embed technological competencies into their academic curricula (Khurshid et al., 2020). Technological progress has opened new possibilities for more dynamic and modern approaches to health education. Despite this, many educational institutions in Indonesia continue to rely on traditional classroom-based methods, where teaching and learning are confined to a specific place and time, involving face-to-face interaction between instructors and students. These conventional methods are often seen as less effective, primarily because they promote passive learning through one-way communication, which can lead to disengagement and boredom among students (Hernon et al., 2023). It is crucial to incorporate appropriate and interactive learning media to enhance learning effectiveness (Sukmana et al., 2024).

In midwifery education, where practical skills are a core focus, learning often depends on video tutorials and simulation tools. However, these methods still present several limitations in effectively supporting hands-on skill development (Sukmana et al., 2024; Szara & Klukow, 2023). Following the pandemic, midwifery education programs have faced increasing pressure to adopt strategies that support the recovery and transformation of learning methods (Masrichah, 2023). This includes recommendations to revise curricula by integrating in-person and virtual learning environments to enhance flexibility and accessibility in education (Hossein et al., 2024). The core objective of midwifery education is to prepare competent midwives who demonstrate knowledge, clinical skills, and professional attitudes in accordance with both national and international standards. Reaching this goal requires learning models that are not only effective and innovative but also responsive to contemporary challenges. The use of educational technologies—such as e-learning platforms, Virtual Reality (VR), Artificial Intelligence (AI), and both synchronous and asynchronous formats—has become an increasingly viable approach to better integrate theoretical content with hands-on clinical training in midwifery education (Ladjar & Susanti, 2024).

Technological integration in medicine and scientific disciplines has become more prominent than ever before (Szara & Klukow, 2023). A strong and significant relationship has been identified between students' perceptions of contemporary learning methods and their engagement with e-learning platforms. Today's technology has made the shift from in-person education to remote learning easier, enabling seamless connectivity regardless of time or location (Maqfirah & Noviana, 2023). Moreover, educational technology offers valuable opportunities to bridge the gap between theoretical knowledge and practical application through digital simulations and virtual clinical experiences. This is particularly crucial in midwifery education, where the development of clinical skills and decision-making in real-life scenarios is essential. With technological support, students can continuously enhance their critical thinking and reflective abilities beyond the confines of the classroom. Therefore, the

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integration of technology in midwifery education is not merely a response to contemporary advancements but has become an essential component in shaping the competencies and professionalism of future midwives in the 21st century (Kiegaldie & Shaw, 2023).

Despite the numerous advantages that technology brings to midwifery education, its implementation is accompanied by several significant challenges that must be addressed. Among the most prominent obstacles are limited access to reliable internet services, which can hinder both students and educators from fully participating in digital learning activities. Additionally, many instructors face a lack of sufficient training and support to utilize new technological tools in their teaching practices effectively. There is also a notable disparity in digital infrastructure and resources among different educational institutions, creating an uneven playing field for students and faculty alike. Successfully adapting to and integrating emerging technologies requires comprehensive readiness that spans technical, administrative, and pedagogical aspects. Moreover, this transition demands robust support through government policies that prioritize and promote digital transformation within the education sector. Therefore, to ensure that technology can be effectively and sustainably embedded in midwifery education, carefully planned strategies that consider these challenges must be developed and implemented (Addae et al., 2022).

In addition, for technology to be successfully incorporated into the teaching and learning process, both teachers and students must actively participate. Educators must continuously enhance their digital competencies through training and professional development, while students should be motivated and supported to utilize technological tools effectively. An inclusive and collaborative approach among all stakeholders is also necessary to address both technical and non-technical challenges. Through such efforts, digital transformation in midwifery education can be implemented effectively and sustainably, ultimately producing well-prepared graduates to meet the demands of modern healthcare (Mestre et al., 2022). Several earlier studies have looked into how technology is being used in midwifery education and related fields. For example, research found that virtual reality simulations in nursing education can really help improve students' clinical skills and keep them engaged (Kiegaldie & Shaw, 2023).

Another research study also pointed out how new technologies like e-learning and digital simulations are helping nursing and midwifery students stay motivated and better understand both theory and practice (Szara & Klukow, 2023). One study researched the effectiveness of technology in midwifery education. It showed that tools like e-learning and video tutorials play a significant role in helping students build their clinical skills (Ladjar & Susanti, 2024). Keeping all this in mind, this review aims to take a broader look at how technology is applied in midwifery education by examining the available research. The main goal is to identify what types of technology are being used, how they benefit students' learning, and what obstacles schools encounter during implementation. Hopefully, this study will offer valuable insights to help improve midwifery education and make it more responsive to today's healthcare needs.

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LITERATURE REVIEW

Midwifery Education

Midwifery education is an academic process designed to develop professional midwives through the integration of theory, laboratory practice, and clinical practice. The midwifery curriculum in Indonesia is developed based on national standards and refers to international benchmarks, such as the Essential Competencies for Midwifery Practice from the International Confederation of Midwives. Its primary goal is to produce graduates capable of delivering safe, high-quality midwifery care that is responsive to the needs of women, newborns, and families across diverse social and cultural contexts (Nikmah & Wicaksono, 2021). The expected competencies include scientific knowledge, clinical skills, interpersonal communication, decision-making, and professional attitudes. This competency framework requires an integrative and contextualized learning process. Therefore, midwifery education emphasizes not only technical abilities but also the development of ethical values, empathy, and self-reflection. Students are expected to provide care both independently and collaboratively, applying evidence-based principles in all aspects of midwifery practice (Nugraheny et al., 2022).

In practice, the midwifery curriculum is implemented through a competency-based learning approach that integrates theoretical instruction, simulation, and field experience. Factors such as the quality of educators, availability of practical facilities, and partnerships with healthcare institutions are critical to support the achievement of these goals. Current transformations in midwifery education also demand adaptation to contemporary developments, including learning processes that incorporate technology. This involves not only the integration of technology in theoretical learning but also in practical skills training (Macad & Rocca-Ihenacho, 2025). The importance of strengthening the curriculum and professional competencies as the foundational pillars of midwifery education determines the direction for development and the technological innovations that must be integrated into the field. Thus, a robust curriculum and strong competencies will serve as the basis for the implementation of technology and other innovations in this contemporary era (Giltenane & Dowling, 2025).

Technology in Midwifery Education

It is now more important than ever to include technology in midwifery education, particularly in supporting students' understanding of complex topics. The effectiveness of digital innovations—such as web-based simulations and virtual reality—in enhancing students' grasp of midwifery content. These tools provide opportunities for learners to develop clinical skills in a risk-free, structured environment, thus improving their preparedness for real clinical settings. Nevertheless, recognizing that these tools are intended to supplement, not replace, traditional face-to-face learning and hands-on clinical experience. Effective integration of technology in midwifery education requires alignment with curricular goals and institutional readiness. When thoughtfully implemented, in order to prepare midwifery students for the changing demands of professional practice, technology might be a helpful tool (O'Connor et al., 2022). In reaction to worldwide issues such as the COVID-19 pandemic, technology has become a crucial tool for maintaining continuity in midwifery education.

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The pandemic forced educational institutions to transition to online learning modalities rapidly. Although this shift presented several difficulties, the integration of technology ensured that teaching and learning processes could proceed uninterrupted, allowing students to continue receiving high-quality education. This underscores the pivotal role of technology in enabling midwifery education to adapt effectively to worldwide disruptions and challenges (Lawes-Wickwar et al., 2023). Beyond online education, technologies such as computer-based simulations and VR are crucial components of midwifery training. These simulations provide students with the opportunity to practice handling diverse medical situations safely, without any risk to patients, thus enhancing their readiness for clinical challenges. Simulation effectively improves the practical abilities of midwifery students. Additionally, VR offers an engaging and immersive learning environment, enabling students to have a more thorough and useful comprehension of medical processes (Bigirwa et al., 2022).

Utilization of Technology in Midwifery Education in This Era

It has been demonstrated that integrating technology into midwifery education enhances students' learning outcomes and accessibility. Digital resources such as mobile apps and e-learning platforms allow students to engage with learning materials at any time and from any location. This proves especially advantageous for those residing in remote regions or facing time constraints. Furthermore, technology supports more interactive and engaging learning environments, which enhance student motivation and involvement in their educational journey (Nurhayati et al., 2025). The utilization of technology in contemporary midwifery education has brought about a significant transformation in teaching methods and student competency development. Through the digitalization of learning materials, students can access resources anytime in various formats such as videos, interactive modules, and e-books. Additionally, the implementation of both synchronous and asynchronous online learning methods offers flexibility in the educational process, enhancing time management skills and fostering self-directed learning (Azizah, 2024).

Technologies like VR are employed to provide realistic midwifery practice simulations without risk to patients. Clinical decision support systems are progressively using AI, offering a more personalized learning experience. In addition to boosting learning effectiveness, this technology integration equips students to handle the increasingly digitally driven needs of contemporary healthcare services (Azizah, 2024). The use of digital tools and simulations encourages students to actively cultivate their ability to think critically and solve problems in the midwifery area. This engagement enhances their participation in learning and strengthens their grasp of key midwifery principles. Problem-based learning supported by technology equips students to effectively manage complex clinical situations and provide high-quality care to mothers and infants. In this context, educational institutions are required to innovate instructional strategies, reinforce clinical skills through simulation, and integrate digital technologies to elevate the competence and societal relevance of their graduates within the national health system (Zhang et al., 2025).

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METHODS

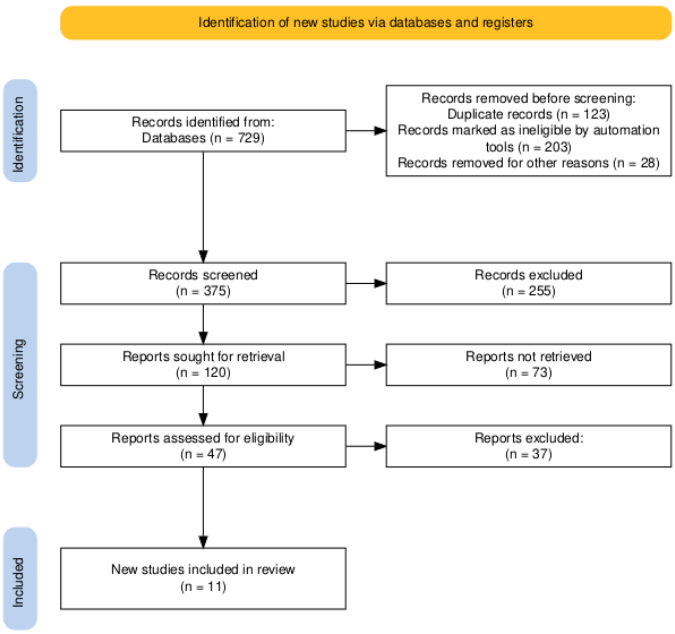
This study employs a scoping review approach to analyze the implementation of technology in midwifery education. **Table 1** shows this method is considered suitable for allowing the authors to explore the topic in depth using the Population, Exposure, and Outcome (PEO) framework. PEO is a framework commonly used in social and health research to assist in formulating clear and systematic research questions. It helps identify key elements of a research problem by focusing on the population studied (P), the exposure or condition examined (E), and the outcomes measured (O). This framework ensures that the research questions are more focused and relevant for in-depth analysis.

Table 1. PEO Framework Selection

Population	Exposure	Outcome
Midwifery students	Use of technology	Effectiveness in midwifery education

Source: Research, 2005

To identify relevant studies, a comprehensive literature search was conducted using PubMed, Google Scholar, and ScienceDirect databases following the guidelines in **Figure 1**. Articles published between 2020 and 2025 were collected from these databases, and duplicates were removed. The authors narrowed the scope by applying inclusion and exclusion criteria to ensure the review was focused and aligned with the research topic. The keywords used included implementation, technology, effectiveness, and midwifery education. The inclusion criteria for this study were: 1) research involving health students; 2) accredited international and national journals; 3) journal publications between 2020 and 2025; 4) study designs including quantitative, qualitative, and mixed methods; 5) articles written in English or Indonesian; 6) availability in full-text format. Exclusion criteria included: 1) articles in the form of books, conference proceedings, protocols, case reports, reviews, and theses/dissertations; 2) articles not accessible in full-text format.



Picture 1. Research Flow
Source: Research, 2025

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The authors screened the literature obtained from various search engines. The total number of articles retrieved from each source were 2 from PubMed, 38 from ScienceDirect, and 49 from Google Scholar. Articles that were not available in full text were excluded, leaving 42 articles from the three sources. The authors independently reviewed titles and abstracts to identify potentially relevant papers. Abstracts that did not meet the inclusion criteria were excluded. Abstract screening determined the eligibility of articles for full review, resulting in 11 articles selected for detailed analysis. The search flow for articles for this research can be seen in the following image in **Figure1**.

RESULTS AND DISCUSSION

Based on the screening results and eligibility assessment, 11 articles were deemed suitable for in-depth review. The findings of these studies are presented in **Table 2**.

Table 2. Charting Data

Journal Identity	Research Objective	Method	Sample	Research Findings
Hung et al., (2024). The evaluation of synchronous and asynchronous online learning: student experience, learning outcomes, and cognitive load	To evaluate students' learning experience, learning outcomes, and cognitive load in synchronous and asynchronous online learning.	Comparative quasi-experimental	170 medical students	Both synchronous and asynchronous methods improved post-test scores and retention.
Karawani et al., (2022). The Relationship between Synchronous and Asynchronous Learning and Self-Directed Learning in the Remote Teaching Environment.	To explore the relationship between synchronous and asynchronous learning and self-directed learning abilities in a remote learning environment during and after the pandemic.	Quantitative; survey + Structural Equation Modeling (SEM)	318 university students	A significant relationship was found between synchronous/asynchronous learning and self-directed learning abilities—particularly in self-management, self-monitoring, and motivation.
Ujoh, F. et al., (2024). Digital vs. conventional instructor-led midwifery training in Benue State, Nigeria: a randomized non-inferiority trial. Frontiers in Education	To examine whether digital midwifery training is equally effective as small-group face-to-face training in improving students' knowledge, critical thinking skills, and technical competencies.	Randomized non-inferiority trial	130 fifth-semester students	No significant difference was found in the improvement of knowledge and critical thinking skills between the digital and face-to-face methods.

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Journal Identity	Research Objective	Method	Sample	Research Findings
Dargahi et al., (2023). Learner satisfaction with synchronous and asynchronous virtual learning systems during the COVID-19 pandemic in Tehran University of Medical Sciences: A comparative analysis. BMC Medical Education	To compare student and staff satisfaction levels with synchronous and asynchronous virtual learning systems during the COVID-19 pandemic.	cross-sectional study	280 students and 500 staff members	Respondents reported moderate satisfaction with virtual learning.
Baidoo, K., & Adu, C. (2024). Virtual reality training to enhance clinical competence and student engagement in Ghana. British Journal of Midwifery	To evaluate the impact of virtual reality-based midwifery training compared to conventional methods on clinical competence and student engagement in Ghana.	Mixed methods: pre-post test + satisfaction survey	88 students	Students in the VR group had higher post-test and practicum scores, along with increased satisfaction, perceived effectiveness, and clinical confidence.
Ljungblad et al., (2025). Mixed reality for midwifery students: A qualitative study of the technology's perceived appropriateness in the classroom. BMC Medical Education	To assess how midwifery students perceive the appropriateness and usefulness of mixed reality in shaping meaningful learning experiences	Qualitative: demonstratio n + in-depth interviews	33 Master 's-level midwifery students	Students described mixed reality as an innovation that facilitates new understanding while reinforcing prior learning.
Georgieva et al., (2025). Application of Virtual Reality, Artificial Intelligence, and Other Innovative Technologies in Healthcare Education (Nursing and Midwifery Specialties): Challenges and Strategies. Education Sciences,	To evaluate the effectiveness of using technologies such as VR, AI, educational videos, and simulations in nursing and midwifery education, and to identify implementation challenges and strategies.	Experimental study with a quantitative approach using pre-test and post-test	Nursing and midwifery students	The experimental group showed significant improvements in clinical skills (injections), content understanding, and confidence compared to the control group.

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Journal Identity	Research Objective	Method	Sample	Research Findings
Frost et al., (2020). Exploring the application of mixed reality in nurse education. BMJ Simulation and Technology Enhanced Learning	To explore nursing students' experiences and perceptions of using mixed reality (MR) to enhance learning and the development of clinical judgment.	Observational and quality survey	Second-year students in a Bachelor of Nursing program	100% of students reported that MR was helpful for their learning.
Barnes et al., (2023). A non-invasive artificial intelligence approach for the prediction of pregnancy outcomes prior to embryo transfer (2023) - The Lancet Digital Health	To develop and implement a non-invasive AI method to predict pregnancy outcomes prior to embryo transfer in PGT-A.	Retrospective machine learning analysis of PGT-A cycle data and transfer outcomes	1,385 patients	The non-invasive AI method accurately predicted implantation and pregnancy outcomes, particularly in older patients.
Wen et al., (2022). Artificial intelligence model to predict pregnancy and multiple pregnancy risk following in vitro fertilization-embryo transfer (IVF-ET). Taiwan Journal of Obstetrics & Gynecology	To develop a machine learning-based AI model to predict pregnancy outcomes and the risk of multiple pregnancy in IVF-ET patients, particularly to support optimal embryo number selection.	Retrospective data analysis	949 embryo transfer cycles for the pregnancy prediction model; 380 cycles for the multiple pregnancy prediction model	XGBoost showed the best performance for pregnancy prediction.
Na et al., (2023). Learning-Based Longitudinal Prediction Models for Mortality Risk in Very-Low-Birth-Weight Infants: A Nationwide Cohort Study. Neonatology	To develop prediction models for mortality risk over different periods in very low birth weight (VLBW) infants during the perinatal and postnatal stages.	Cohort study	15,790 VLBW infants	The time-stratified MLP model demonstrated high accuracy, outperforming traditional machine learning methods

Source: Research, 2025

Asynchronous and Synchronous in Midwifery Education

Synchronous and asynchronous learning methods have proven to enhance learning outcomes among midwifery students. A 2024 study published in *BMC Medical Education* involved 170 students who took part in online classes using both approaches. The findings showed that students performed better on tests and had improved recall of materials after these sessions. They also expressed high levels of satisfaction—with average ratings of 4.6 for synchronous learning and 4.53 for asynchronous. Interestingly, students reported feeling less mentally burdened during synchronous sessions, likely due to the real-time interaction (Hung et al.,

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2024). This may be because synchronous learning offers a clear schedule and immediate feedback, which helps students stay on track. Synchronous learning—where instructors and students interact in real time, often through platforms like Zoom, Google Meet, or Microsoft Teams—creates a more dynamic learning environment. It allows for direct clarification, feedback, and the chance to build interpersonal connections. In midwifery education, this method has been beneficial for live demonstrations, interactive case discussions, and peer collaboration—activities that mirror real clinical settings (Ujoh et al., 2024). What makes this approach particularly valuable is that it goes beyond cognitive development. It helps students build communication and decision-making skills, both of which are crucial in real-world midwifery practice (Dargahi et al., 2023).

Effective communication is central to every patient encounter. Moreover, synchronous learning serves as an important form of instructional exposure that directly affects learning quality and professional readiness. Studies in this review show that synchronous sessions boost student engagement and foster a sense of connection—important elements in courses that demand ethical reflection and clinical reasoning. Of course, synchronous learning is not without its downsides. It requires stable internet and synchronized schedules, which can be a challenge—especially for students living in areas with poor digital infrastructure. That is why it is essential to apply the right strategies to ensure quality education without sacrificing accessibility or effectiveness. On the flip side, asynchronous learning gives students the freedom to access course materials anytime and work through them at their own pace. This flexibility is especially helpful for those in remote areas or dealing with unreliable internet—both common realities in Indonesia. Asynchronous learning encourages independent study and allows students to revisit complex materials like recorded lectures, interactive modules, and discussion boards. This format supports deeper learning and creates a less pressured study environment (Karawani, 2022).

That said, asynchronous learning comes with its challenges. Some students may struggle with time management and self-discipline. Without real-time feedback, misunderstandings can go unaddressed. Moreover, the lack of direct interaction may limit the development of soft skills like verbal communication and teamwork—skills that are vital in clinical practice. This is where blended learning comes in—an approach that combines the best of both worlds. By integrating synchronous and asynchronous methods, educators can create a more balanced and effective learning experience. However, success depends on several key factors: strong digital infrastructure, tech-savvy educators, and students who are ready to adapt. In the end, bringing together both modes of learning helps midwifery education move toward a more student-centered, flexible, and tech-supported model. The evidence is clear: when done right, synchronous and asynchronous learning not only improve academic performance but also equip students with the adaptability, digital literacy, and independent learning skills needed for today’s clinical environments.

Virtual Reality (VR) in Midwifery Education

The use of Virtual Reality (VR) in midwifery education has been shown to improve students' understanding of pelvic anatomy significantly. Studies reveal that students who use VR to study pelvic structures experience marked improvements in knowledge test scores. They also report better spatial comprehension compared to those learning through traditional

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methods. VR enables students to view and interact with anatomical structures in an immersive three-dimensional environment, making it easier to grasp complex midwifery concepts (Zhao et al., 2020). These findings suggest that VR enhances learning outcomes by supporting both the cognitive domain (knowledge acquisition) and the psychomotor domain (spatial reasoning)—critical for skills such as vaginal examinations, fetal positioning, and navigating the birth canal. Beyond anatomy, VR has also proven effective in simulating the entire childbirth process—from labor initiation to postpartum care. A student who participated in VR-based simulations felt more prepared to handle real-world clinical scenarios, particularly in managing the stages of labor, examining the placenta, and documenting medical records (Baidoo & Adu, 2024). Their study emphasizes that VR offers a safe, repeatable, and standardized clinical learning environment. This is particularly valuable in educational settings where direct clinical exposure may be limited, such as in rural institutions or those with constrained resources.

One of the standout benefits of VR implementation is the boost in students' confidence and clinical readiness (Georgieva-Tsaneva et al., 2025). Unlike conventional training, which often depends heavily on the availability of patients and instructors, VR allows students to practice critical procedures as often as needed without fear of causing harm (Frost et al., 2020). This repetitive and risk-free environment fosters not only technical competence but also emotional readiness—both essential for safe and effective midwifery practice. Students' responses to VR have been overwhelmingly positive. Research reported that learners found VR to be engaging and effective. Many appreciated the interactive nature of the simulations, saying it helped turn abstract concepts into more tangible, memorable experiences. However, the study also noted some mild side effects, such as dizziness and nausea among a few participants, highlighting the importance of careful and gradual implementation (Ljungblad et al., 2025).

Despite its benefits, integrating VR into midwifery education does come with challenges. High equipment costs, the need for technical support, and educator training are significant hurdles—especially in resource-limited settings. Moreover, for VR to be successfully integrated into the curriculum, it must align with learning objectives and institutional policies to ensure that it complements rather than replaces hands-on clinical practice. In summary, VR holds considerable promise in enhancing midwifery education by bridging the gap between theory and practice. It contributes directly to improved student learning, skill development, and readiness for clinical challenges. However, widespread and sustainable adoption requires thoughtful planning, infrastructure investment, and pedagogical alignment. Continued research is essential to evaluate the long-term impact of VR on clinical competence and professional behavior in real-world practice.

Artificial Intelligence (AI) in Midwifery Education

The use of Artificial Intelligence (AI) in midwifery education is rapidly expanding, driven by the growing demand for tech-savvy midwives who are equipped to navigate the challenges of the digital era. AI is now being applied to support clinical decision-making, enable data-driven simulations, and improve learning efficiency through adaptive learning systems. Midwifery education institutions need to begin integrating AI into their curricula so that students can become familiar with leveraging this technology in clinical practice. They also

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emphasize the need for faculty training to ensure educators can effectively deliver technology-enhanced instruction (Kranz & Abele, 2024). Current research highlights that AI is primarily used to power adaptive learning platforms, enhance the realism of clinical simulations, and provide data-driven decision support tools (Na et al., 2023). These functions directly support core competencies in midwifery—particularly clinical assessment, diagnostic accuracy, and personalized care planning. For instance, research has found that AI significantly improved students' ability to assess pregnancy accurately (Barnes et al., 2023).

By delivering real-time feedback and individualized learning pathways, AI facilitates a personalized learning approach aligned with constructivist and connectivist learning theories, where students actively build knowledge through interaction with digital tools and networks (Giaxi et al., 2025). This approach is especially valuable in health education, where critical thinking and situational awareness are key. Both students and educators have responded positively to AI integration, particularly in terms of improved efficiency and easier access to learning materials. Midwifery students report that AI-powered decision support systems help them better understand the clinical reasoning process (Wen et al., 2022). However, researchers also stress the importance of addressing ethical concerns, patient data privacy, and the limitations of technology use within both educational and clinical contexts (Bozyel et al., 2024). Their study warns against the uncritical adoption of AI without clear protocols for data governance, privacy protection, and algorithmic accountability. Given the sensitivity of patient-related data and the formative nature of health education, safeguards must be in place to prevent misuse or unintended harm. These concerns align with global discussions around ethical AI in education and healthcare, where trust, transparency, and fairness must underpin all digital innovations (Giltenane & Dowling, 2025).

Despite these promising developments, several critical challenges still hinder the sustainable and equitable implementation of AI in midwifery education. Studies point to a lack of adequate technological infrastructure in many educational institutions, particularly in low-resource settings (Liaw et al., 2022). Effective use of AI tools requires not only hardware and internet connectivity but also the presence of trained educators who can meaningfully integrate AI into the curriculum. One piece of research emphasizes that faculty readiness is just as important as student readiness, and without proper faculty development, AI integration risks being superficial or ineffective (Kranz & Abele,2024). In conclusion, integrating AI into midwifery education presents a substantial opportunity to enrich student learning, enhance diagnostic reasoning, and improve clinical preparedness. However, for implementation to be both effective and responsible, institutions must address infrastructure gaps, invest in faculty development, and establish clear ethical frameworks. As healthcare continues its digital transformation, preparing midwifery students to engage critically and competently with AI is not just a pedagogical innovation—it is an essential component of future-ready professional education.

Discussion

The development of professional competencies that allow midwifery students to deliver safe, high-quality, evidence-based care in progressively complicated healthcare situations is the primary learning objective. To support this goal, the integration of technology plays a crucial role in transforming midwifery education. The adoption of digital innovations such as Virtual

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Reality (VR) and in addition to improving teaching strategies, artificial intelligence (AI) puts students at the center of the learning process. This fosters a more engaging and interactive learning atmosphere, enhancing both student motivation and academic outcomes. AI has emerged as one of the most transformative tools in education. In midwifery training, AI has been utilized to support the teaching of anatomy and physiology through visually rich and interactive platforms. For instance, AI-powered systems can simulate three-dimensional representations of the human body, displaying structures such as muscles, veins, and subcutaneous layers with precision—making it particularly useful for mastering injection techniques (Livesay et al., 2023). These tools not only deepen the learning experience but also enhance study efficiency and knowledge retention (Georgieva-Tsaneva et al., 2025).

However, the integration of technology is not without challenges. The broad use of online learning, including synchronous and asynchronous modes, was expedited by the COVID-19 pandemic. Although these methods encourage self-directed learning and provide flexibility, the shift from in-person to online learning has necessitated substantial adaptation on the part of both institutions and students. Key obstacles include insufficient technological infrastructure, limited digital literacy among both faculty and students, and inconsistent internet access (Mramel et al., 2024). Although students can control the pace and timing of their learning in online settings, gradual adaptation remains essential (Livesay et al., 2023). Prior research has emphasized difficulties in implementing distance education, highlighting the need for adequate infrastructure and institutional commitment as critical success factors. These findings underscore the urgency of improving digital infrastructure, particularly by ensuring stable internet connectivity and appropriate learning devices (Frost et al., 2020).

Meanwhile, Virtual Reality has proven to be a valuable tool in midwifery education by offering highly realistic simulations of clinical procedures. It allows students to practice repeatedly in a safe, risk-free environment. However, effective VR use requires initial technical training to help students navigate and interact within virtual environments. Developing motor accuracy and practical skills—such as picking up, moving, and placing virtual objects—is essential to maximize learning outcomes (Kusteja et al., 2024). This illustrates that technological advancement demands not only innovation but also readiness and skill development among all stakeholders. Ultimately, the effectiveness of e-learning and digital technologies in higher education is heavily dependent on the availability of reliable systems, robust infrastructure, and competent human resources. While e-learning offers various advantages over traditional methods—such as flexibility and broader access—its success hinges on how well institutions manage and support the digital learning environment (Khurshid et al., 2020). Therefore, the successful implementation of technology-enhanced midwifery education requires not just technological adoption, but a synergy between educational strategies, technological preparedness, and user adaptability.

CONCLUSION

This scoping review confirms that the incorporation of various technological innovations—including e-learning platforms, digital simulations, virtual reality, and mobile applications—has significantly enhanced the quality of midwifery education across cognitive, affective, and psychomotor domains. These tools facilitate flexible, interactive, and contextually relevant learning experiences, which are especially valuable in overcoming barriers such as limited

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clinical placement opportunities and scarce educational resources. However, despite these benefits, the implementation of technology in midwifery education continues to face substantial challenges. Key obstacles identified include insufficient infrastructure, limited digital competencies among educators, and disparities in institutional readiness to adopt and sustainably manage technology-enhanced learning systems. These challenges impede the equitable and effective digital transformation of midwifery education, particularly in resource-constrained settings. This review underscores the necessity of cross-sector collaboration involving educational institutions, policymakers, and technology providers to overcome these barriers. Prioritizing structured interventions—such as comprehensive faculty training programs, investment in digital infrastructure, and the integration of technology-responsive curricula—will be critical to developing an inclusive, sustainable, and adaptable learning ecosystem. Furthermore, future research should emphasize evaluative and longitudinal studies that measure the effectiveness of diverse educational technologies in achieving midwifery competencies. Such research is essential not only for assuring the quality of midwifery graduates but also for maintaining the relevance and responsiveness of midwifery education in the context of evolving healthcare demands.

AUTHOR'S NOTE

The author declares that there is no conflict of interest regarding the publication of this article and verifies that the data and content are free from plagiarism.

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