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The Effectiveness of Blended Learning Artificial Intelligence on Increasing Literacy of Midwifery Students at Mashhad University of Medical Sciences: A Semi-experimental Study

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Research Article

Keywords: Artificial Intelligence, Midwifery Education, Blended Learning, AI Literacy, Healthcare Technology, Nursing Informatics

Posted Date: July 17th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9823036/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Artificial Intelligence (AI) is increasingly shaping healthcare by enhancing clinical decision-making, medical data analysis, and patient management. However, AI literacy remains limited among midwifery students due to the absence of AI-focused courses in their curricula. Blended learning, combining in-person instruction with online and interactive methods, is a promising approach to improving AI education. This study aimed to evaluate the effectiveness of a blended learning course on AI literacy among midwifery students at Mashhad University of Medical Sciences.

Methods

A semi-experimental one-group pretest-posttest design was conducted among midwifery students. The intervention included two to three blended learning sessions covering AI fundamentals, machine learning, supervised and unsupervised learning, and AI applications in midwifery. The Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS-MS) and the Students' Attitude toward Artificial Intelligence (SATAI) tool were used to assess AI knowledge and attitudes before and after the intervention. Course effectiveness was evaluated using a structured Course Evaluation Questionnaire. Data were analyzed using paired t-tests and Wilcoxon signed-rank tests.

Results

A significant improvement was observed in students' AI knowledge (Pre-test: 12.5 ± 3.2, Post-test: 18.9 ± 2.8, $p < 0.001$) and attitudes across cognitive, affective, and behavioral domains ($p < 0.01$). Students expressed increased confidence in AI applications in midwifery and a higher willingness to integrate AI tools into clinical practice. The course received a high satisfaction rating (Mean score: 4.5 ± 0.6 out of 5), with students appreciating the interactive and case-based learning approach.

Conclusion

Blended learning effectively enhances AI literacy among midwifery students by improving their knowledge and attitudes. Given the rapid advancements in AI, incorporating structured AI education into midwifery curricula is essential for preparing future healthcare professionals. Further research should explore long-term knowledge retention and advanced AI topics in midwifery education.

Background

Artificial intelligence (AI) refers to the ability of computer technology or computer-controlled robots to "learn, reason, perceive, infer, communicate, and make decisions similar to or better than humans" (1).

This technology plays a crucial role in everyday life through devices like smartphones, smart TVs, and smartwatches, with its new capabilities rapidly emerging (2). In healthcare, artificial intelligence technologies (AIHTs) are instrumental in improving healthcare services, clinical decision-making, medical data analysis, and generating useful patterns and insights (3). These technologies have been widely integrated into disciplines such as radiology, pathology, and ophthalmology (4).

In the healthcare system, nurses and midwives form the largest group of healthcare professionals, accounting for nearly 50% of the workforce (5). It is anticipated that their roles and care models will significantly change in the future (6). These changes demand an update in their core competencies and educational requirements.

Midwifery students leverage knowledge from various fields, including biology, chemistry, social sciences, and behavioral sciences, to enhance their clinical knowledge and professional skills (7).Studies have shown that AI can bring fundamental changes to all functional areas of midwifery, including management, clinical care, education, policymaking, and research (8). These changes are particularly significant in education, which plays a vital role in preparing a professional workforce.

Research indicates that the use of AI in nursing and midwifery education is expanding (9). It is predicted that in the near future, advanced technologies such as humanoid robots and cyborgs will be integrated as simulation tools in clinical settings (10). These technologies can enhance students' clinical decision-making and improve the quality of education (11).

However, current medical curricula rarely address medical informatics or AI as part of their mandatory study programs (12, 13). In many countries, limitations imposed by educational regulations hinder the inclusion of AI-related courses in formal curricula (14). Meanwhile, medical and paramedical students express interest in learning about AI and identify the lack of related educational programs as a barrier to understanding this technology better (15–17).

Promoting "AI literacy" involves teaching the functioning of AI programs and understanding the opportunities and challenges associated with these technologies, without requiring technical details such as programming or mathematical modeling (18). Thus, designing and evaluating educational courses on this topic for midwifery students is essential.

One effective method to enhance students' knowledge and attitudes is blended learning. This approach combines face-to-face instruction, online learning, and self-study to improve the educational experience and allow students to better understand complex concepts such as AI (19). Interactive tools like group sessions, case studies, and practical exercises can be employed to teach these concepts (20).

Given the need to improve midwifery students' knowledge and preparedness in dealing with emerging technologies, this study aims to design and evaluate blended learning based on AI to enhance the knowledge and attitudes of midwifery students. This approach can lead to significant advancements in education and the application of AI in midwifery.

Methods

Design of the study

This semi-experimental one-group pretest-posttest study was conducted on all midwifery students enrolled at Mashhad University of Medical Sciences during the study period.

Intervention

The educational intervention consisted of two to three blended learning sessions designed to introduce midwifery students to the fundamental concepts of artificial intelligence (AI). This blended learning approach combined in-person instruction, interactive discussions, self-study, group work, and hands-on exercises. The primary objectives of this teaching method were to enhance students' critical thinking, problem-solving abilities, engagement, and mastery of AI concepts and skills relevant to midwifery. The sessions were held on campus, utilizing the university's available educational facilities.

Training Content

The educational sessions covered the following topics: 1. Artificial Intelligence (AI): A brief introduction to AI. Discussions on AI applications and impacts in nursing and midwifery. 2. Machine Learning (ML): Introduction to the five main stages of ML: problem definition, data collection, data processing, model training, and reasoning and prediction. Practical guidance for implementing ML concepts, including image recognition tasks via online platforms.3. Supervised Learning: Explanation of regression and classification concepts. Practical examples of classification algorithms such as K-Nearest Neighbors (KNN) and decision trees, with real-world applications. 4. Unsupervised Learning: Introduction to unsupervised learning concepts. Case studies on clustering techniques, particularly K-means, and their applications in healthcare.

Each session included multimedia presentations, hands-on exercises, group discussions, and practical applications tailored to midwifery contexts.

Educational Resources

The course content was developed using both Persian and English resources, including: The book AI for everyone (21). Guidelines from the Organization for Economic Co-operation and Development (OECD) on AI (22). Curricula proposed by Tursky et al. (2019) (23).

Consultation with AI and medical informatics experts from Mashhad University of Medical Sciences further ensured content accuracy and relevance.

Evaluation Tools

Three validated tools were employed: 1. Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS-MS): This 22-item scale evaluated knowledge, abilities, perspectives, and ethical considerations regarding AI (24). Students' Attitude toward Artificial Intelligence (SATAI): This 26-item tool assessed cognitive, affective, and behavioral attitudes toward AI (25). Course Evaluation Questionnaire: A 29-item questionnaire developed by Pastor et al. (2020) to evaluate course structure, content, resources, instructors, and overall quality (26).

All tools were translated into Persian using the World Health Organization's standardized method, which included forward and backward translation, conceptual harmonization, and expert review for validity and reliability.

Study Population and Sampling

The study population included all midwifery students at the School of Nursing and Midwifery, Mashhad University of Medical Sciences. A convenience sampling method was used to recruit participants.

Data Collection and Analysis

Data were collected through pre- and post-intervention surveys to assess changes in students' knowledge and attitudes toward AI. Additionally, a final course evaluation survey was conducted to gather feedback on the program's quality and impact.

Data analysis was performed using IBM SPSS Statistics (version 28). The Shapiro-Wilk test was used to assess data normality. Parametric tests, such as the paired t-test, were applied for normally distributed data, while non-parametric tests, such as the Wilcoxon signed-rank test, were used for non-normally distributed data. Chi-square tests were conducted to analyze categorical data.

Results

The study results indicate a significant improvement in midwifery students' knowledge and attitudes toward artificial intelligence (AI) following the blended learning intervention.

Knowledge Improvement

A comparison of pre- and post-test scores using the Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS-MS) demonstrated a statistically significant increase in students' understanding of AI concepts. The mean post-test scores were significantly higher than the pre-test scores ($p < 0.001$), suggesting that the educational sessions effectively enhanced students' knowledge about AI, including its applications in healthcare and midwifery. (Table 1)

Table 1
Comparison of Pre-Test and Post- Test Scores in AI Knowledge and Attitudes among Midwifery Students

Variables	Pre-Test Mean ± SD	Post Test Mean ± SD	P-Value
AI Knowledge	12.5 ± 3.2	18.9 ± 2.8	≤ 0.001
Cognitive Attitude Toward AI	14.2 ± 3.8	19.5 ± 3.4	0.002
Affective Attitude Toward AI	13.8 ± 4.1	18.7 ± 3.6	0.004
Behavioral Attitude Toward AI	11.9 ± 3.5	17.3 ± 3.2	0.001
Course Satisfaction	-	4.5 ± 0.6 (out of 5)	-

Attitude Enhancement

Students' attitudes toward AI, assessed using the Students' Attitude toward Artificial Intelligence (SATAI) tool, also showed notable improvements. Scores increased across all three domains: cognitive, affective, and behavioral attitudes. Students expressed greater enthusiasm for learning AI-related concepts and showed increased confidence in applying AI-based technologies in their future practice. The paired t-test/Wilcoxon signed-rank test results confirmed a significant positive shift in students' perceptions of AI ($p < 0.01$, Table 1).

Course Evaluation

The Course Evaluation Questionnaire indicated high levels of student satisfaction with the blended learning approach. The interactive teaching methods, including group discussions, case studies, and hands-on exercises, were particularly well received. Most students rated the course as effective in improving their understanding of AI (Mean score: 4.5 out of 5), with suggestions for additional sessions and more practical applications in future iterations. (Table 1)

Discussion

The findings highlight the effectiveness of blended learning in improving AI literacy among midwifery students. The significant increase in students' knowledge aligns with previous research emphasizing the importance of integrating AI education into healthcare curricula (19). Given that, traditional midwifery education lacks AI-focused courses (12, 13) this study underscores the need for formal AI training within midwifery programs.

The observed positive shift in attitudes supports the argument that structured AI education can reduce apprehension and resistance toward new technologies in healthcare (15–17). This is particularly relevant as AI is expected to play a crucial role in midwifery practice, influencing clinical decision-making, patient monitoring, and administrative tasks. The study results suggest that exposure to AI concepts in an educational setting can help students embrace technological advancements rather than perceive them as threats.

Moreover, the course evaluation results highlight the benefits of interactive and experiential learning. The integration of practical AI applications, such as machine learning demonstrations and case-based discussions, contributed to higher engagement and better comprehension. This supports prior studies suggesting that blended learning enhances students' ability to grasp complex concepts (20).

Limitations and Future Directions

While the study demonstrated positive outcomes, several limitations should be noted. First, the sample was limited to midwifery students at a single institution, which may affect the generalizability of the findings. Future studies should include a larger and more diverse student population. Second, the study measured short-term knowledge gains, but the long-term retention of AI concepts remains unknown. Future research should investigate whether periodic reinforcement of AI topics leads to sustained learning outcomes.

Additionally, students expressed interest in more extensive AI training, suggesting that future courses could incorporate advanced topics such as natural language processing, AI-based clinical decision support systems, and ethical considerations of AI in midwifery. The incorporation of virtual reality (VR) and simulation-based AI training may further enhance learning experiences.

Conclusions

This study provides compelling evidence that blended learning is an effective approach for integrating AI education into midwifery training. By improving knowledge and fostering positive attitudes, this educational intervention prepares future midwives to navigate an AI-driven healthcare landscape. Expanding AI education within midwifery curricula is essential to ensuring that midwifery professionals are equipped to leverage technological advancements for improved patient care.

Abbreviations

• **AI**
Artificial intelligence
• **AIHTs**
Artificial Intelligence Technologies
• **ML**
Machine Learning
• **KNN**
K-Nearest Neighbors
• **MAIRS-MS**
Medical Artificial Intelligence Readiness Scale for Medical Students
• **SATAI**
Students' Attitude toward Artificial

• **VBAC**
Vaginal Birth After Cesarean
• **NST**
Non-Stress Test
• **OECD**
Organization for Economic Co-operation and Development
• **VR**
Virtual Reality
• **MUMS**
Mashhad University of Medical Sciences

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board and the Ethics Committee of Mashhad University of Medical Sciences (Ethics Code: IR.MUMS.REC.1402.062). All methods were performed in accordance with the ethical standards of the Declaration of Helsinki. Prior to the intervention, the research goals, procedures, and the voluntary nature of participation were clearly explained to all midwifery students. Written informed consent was obtained from all participants. They were assured of the confidentiality of their personal information and their right to withdraw from the study at any stage without any negative impact on their academic standing.

Consent for publication

Not applicable.

Competing interests

The authors declare no conflict of interest related to this study.

Funding

Mashhad University of Medical Sciences, Mashhad, Iran, financially supported this research (Grant number: 4021159).

Author Contribution

All authors contributed to the study's conception and design. NJSh and SA were responsible for the study's conceptualization and coordination. SMT and MR designed the educational content and tools

related to artificial intelligence and medical informatics. MR and NJSh performed the material preparation and data collection. SMT and SA carried out the statistical analysis and data interpretation. The first draft of the manuscript was written by SA and NJSh, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Acknowledgement

The authors would like to express their sincere gratitude to the midwifery students of Mashhad University of Medical Sciences for their participation in this study. We also extend our appreciation to the AI and medical informatics experts who provided valuable insights during the course development. Special thanks to the university's educational staff for their support in facilitating the blended learning sessions.

Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to institutional regulations and to protect the privacy of the participating midwifery students. However, the data are available from the corresponding author (Somayeh Alirezaei) on reasonable request.

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