

Effectiveness Of A Structured Educational Program On Enhancing Nurses' Knowledge And Attitudes Toward Artificial Intelligence In Clinical Settings

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Abstract

Background: Artificial intelligence (AI) is rapidly transforming healthcare, yet nurses often lack the knowledge and positive attitudes needed to integrate AI effectively into clinical practice. The present study evaluates the effectiveness of a structured educational intervention on nurses' knowledge and attitudes toward AI. **Methods:** A quasi-experimental study was conducted in four teaching hospitals in Al-Najaf Governorate, Iraq. A total of 150 nurses were recruited using nonprobability convenience sampling and were equally allocated to the intervention (n = 75) and control (n = 75) groups, with baseline comparability confirmed prior to the intervention. Nurses in both groups completed a self-administered questionnaire at baseline and at post-intervention. **Results:** Before the intervention, the study group demonstrated predominantly moderate (56.00%) and poor (42.67%) knowledge, with only 1.33% achieving a good level (mean score = 0.37- 0.17). Following the educational program, knowledge improved markedly, with 98.67% of intervention group nurses classified at the good level. All nurses in both intervention groups demonstrated positive overall attitudes towards AI at both measurement points (100% classified as positive), while the control group showed no meaningful change in either outcome. **Conclusion:** The findings of this study demonstrate that the structured educational program significantly improved nursing's knowledge of and attitudes towards artificial intelligence in clinical settings. Healthcare institutions should prioritize the integration of AI education into mandatory continuing professional development curricula for nurses, thereby supporting safe, effective, and ethically grounded AI adoption in healthcare. Policymakers and nursing leaders should develop standardized, validated AI competency frameworks to guide nursing workforce development in the context of digital health transformation. This study provides evidence regarding the sustainability of educational impact and offers practical guidelines for AI adoption within nursing practice.

Keywords: Artificial Intelligence; Attitudes; Knowledge; Educational Program; Nurses.

1. Introduction

Artificial intelligence (AI) and information technology have been expanding rapidly across various disciplines, including healthcare. The healthcare sector is one of the fields most likely to benefit significantly from technological advancements, as sophisticated AI systems have the potential to improve multiple aspects of patient care. The growing volume and complexity of healthcare data are driving the adoption of AI applications, offering promising opportunities to enhance clinical efficiency and patient outcomes (Khalil & Yasir, 2025).

Technological integration in healthcare represents a prominent feature of the contemporary clinical landscape, presenting both advantages and challenges for nursing practice. AI technologies are regarded as disruptive innovations with the potential to improve healthcare quality, supporting rapid clinical decision-making, enabling remote monitoring, and generating actionable diagnostic data that can minimize medical errors and improve patient health outcomes (Oweidat et al., 2025).

Nurses, as core actors in clinical care and clinical data management, must possess adequate knowledge and positive attitudes toward AI to enable its effective implementation. However, evidence suggests that AI literacy varies across nursing populations. In the United States, studies have documented low knowledge levels among nurses alongside generally positive attitudes, while in Egypt, nurses similarly demonstrated favorable orientations toward AI (Sandanasamy et al., 2025). Understanding these knowledge-attitude dynamics is critical for designing targeted educational interventions.

The acceptance of AI among healthcare professionals is shaped by factors such as perceived usefulness, ease of

use, and familiarity with AI concepts (Jawad Kadhim & Lateef Alkhaqani, 2026). Despite broad awareness of AI technologies, many nurses remain uncertain about their underlying functions, conceptual frameworks, and ethical implications (Abd Al-Ridha, 2025). Structured educational programs represent a promising approach to bridging this gap.

The present study addresses this gap by implementing a structured educational intervention and evaluating its effects on nurses' knowledge and attitudes at two time points: pre-intervention and post-intervention. The study provides evidence regarding the sustainability of educational impact and offers practical guidelines for AI adoption within nursing practice.

2. Materials and Methods

Research Design: A pretest/posttest quasi-experimental design was employed to evaluate the effectiveness of a structured educational program on nurses' knowledge and attitudes toward AI in clinical practice. Participants were not randomly assigned; instead, allocation was based on hospital groupings to minimize contamination between groups.

Setting: The study was conducted across four teaching hospitals in Al-Najaf Governorate, Iraq: Al-Najaf Ashraf Teaching Hospital, Al-Sadr Teaching Hospital, Al-Hakeem Hospital, and Al-Furat Hospital.

Sample and Sample Size: A non-probability convenience sampling approach was used to enroll 150 nurses from different clinical departments. Participants were equally allocated to an intervention group ($n = 75$) and a control group ($n = 75$), with baseline comparability confirmed prior to intervention.

Sample size was calculated using the effect size formula: $n = [2 \times (Z_{1-\alpha/2} + Z_{1-\beta})^2] / d^2$, where $Z_{1-\alpha/2} = 1.96$, $Z_{1-\beta} = 0.84$, and $d = 0.5$, yielding a minimum of 63 participants per group (total = 126). To account for an anticipated attrition rate of 10–15%, the sample was increased to 75 participants per group, yielding a final sample of 150.

Study Instruments

Data were collected using two validated instruments:

1. **Artificial Intelligence Knowledge Questionnaire:** A researcher-developed structured questionnaire comprising 29 multiple-choice items assessing nurses' knowledge of AI concepts, clinical applications, ethical issues, and decision-support systems. One point was assigned for each correct response (total score range: 0–29). Content validity was established through expert review.
2. **Attitudes Toward Artificial Intelligence Questionnaire (ATAI):** A modified version of the General Attitudes towards Artificial Intelligence Scale (GAAIS; Schepman & Rodway, 2020, 2023) was adapted, translated into Arabic, and converted to a three-point Likert scale (Agree = 3, Somewhat Agree = 2, Disagree = 1). The scale comprised 19 items covering both positive and negative dimensions of attitudes toward AI. Higher mean scores indicated more positive attitudes.

Validity and Reliability: Face and content validity were established by a panel of 13 experts in nursing and clinical practice, ensuring clarity, relevance, and cultural appropriateness. Internal consistency reliability was confirmed using Cronbach's alpha: knowledge scale ($\alpha = 0.75$), attitude scale ($\alpha = 0.81$), and challenges scale ($\alpha = 0.75$).

Pilot Study: A pilot study was conducted with 15 nurses (10% of the total sample) to assess feasibility, clarity, and the time required for questionnaire completion. Completion time averaged 15–20 minutes. No modifications to the instruments were required. Pilot participants were excluded from the main study sample.

Educational Program: The educational program was developed following a comprehensive review of the literature on AI in healthcare and nursing practice. The intervention was delivered after baseline assessment of knowledge and attitudes. Participants were organized into small, interactive groups, and the program comprised three 75-minute structured sessions delivered on separate non-consecutive days. Teaching strategies included interactive lectures, group discussions, brainstorming activities, case-based learning, demonstrations, and hands-on exposure to AI tools (ChatGPT, DeepSeek, Gemini, Perplexity), supported by PowerPoint presentations and clinical case examples.

The program followed a four-phase implementation structure:

- **Phase I – Assessment:** Recruitment of participants following institutional approval, provision of study

objectives, and obtaining written informed consent.

- Phase II – Planning: Development of educational content guided by an extensive literature review; preparation of a self-learning illustrated booklet; coordination with hospital administration for training facilities.
- Phase III – Implementation: Program delivery over three months, with sessions scheduled according to nurses' work shifts to maximize participation.
- Phase IV – Evaluation: Post-intervention assessment conducted one month after program completion using the same validated instruments.

Sessions were structured progressively: Session 1 introduced AI concepts and their relevance to nursing, with a baseline assessment; Session 2 covered clinical applications, decision-support systems, and demonstrations of AI tools; Session 3 addressed ethical, legal, and organizational aspects, including barriers and implementation strategies. All sessions emphasized interactive, learner-centered engagement to enhance understanding and knowledge retention.

Statistical Analysis: All data were analyzed using SPSS version 26. Descriptive statistics (frequencies, percentages, means, and standard deviations) were calculated. Chi-square tests were used for categorical comparisons of demographic variables. Independent-samples t-tests, paired-samples t-tests, one-way ANOVA, and Pearson correlation coefficients were applied as appropriate. Statistical significance was set at $p \leq 0.05$.

Ethical Considerations: Ethical approval was obtained from the Ethics Committee of the Faculty of Nursing, University of Kufa, and official permissions were obtained from the Al-Najaf Health Directorate with reference number (44271dated 20 November 2025) and all participating hospitals. Participation was entirely voluntary. Written informed consent was obtained after participants were informed of the study objectives and their right to withdraw at any time without consequences. Confidentiality and anonymity were maintained throughout; no personal identifiers were collected, and all data were used exclusively for research purposes and stored securely.

3. Results

Table 1 presents the demographic characteristics of nurses in both groups ($n = 75$ each). The majority of participants in both groups fell within the 26–30 years age range, with no statistically significant difference ($\chi^2 = 2.473$, $p = 0.290$). Females constituted the majority in both groups (80% and 74.67%, respectively; $\chi^2 = 0.609$, $p = 0.435$). Most nurses held a nursing diploma (intervention group: 56%) or a bachelor's degree (control group: 49.33%), with no significant difference in educational level ($\chi^2 = 7.230$, $p = 0.065$). Most nurses had fewer than five years of experience in the intervention group (57.33%) and 5–10 years in the control group (50.67%), with no significant difference ($\chi^2 = 3.840$, $p = 0.147$). The majority reported no previous AI exposure (92% and 85.33%, respectively; $\chi^2 = 6.106$, $p = 0.191$), and most identified training courses as their primary source of AI-related knowledge ($\chi^2 = 7.754$, $p = 0.170$). All demographic variables were comparable between groups, supporting baseline equivalence.

Table 1. Distribution of Demographic Characteristics for study participants

Demographic Characteristic	Category	Intervention F.	Intervention %	Control F.	Control %	χ^2 (df)	p-value
Age (Years)	≤ 25	25	33.33	17	22.67	2.473 (2)	.290 NS
	26–30	41	54.67	50	66.67		
	≥ 31	9	12.00	8	10.67		
Sex	Female	60	80.00	56	74.67	0.609 (1)	.435 NS
	Male	15	20.00	19	25.33		
Education	High School	5	6.67	9	12.00	7.230 (3)	.065 NS

Demographic Characteristic	Category	Intervention F.	Intervention %	Control F.	Control %	χ^2 (df)	p-value
	Diploma	42	56.00	26	34.67		
	Bachelor	25	33.33	37	49.33		
	Master	3	4.00	3	4.00		
Experience (Years)	< 5	43	57.33	32	42.67	3.840 (2)	.147 NS
	5–10	30	40.00	38	50.67		
	> 10	2	2.67	5	6.67		
Department	Critical Care	47	62.67	36	48.00	3.264 (1)	.071 NS
	General Wards	28	37.33	39	52.00		
Prior AI Exposure	None	69	92.00	64	85.33	6.106 (4)	.191 NS
	Training/Workshop	1	1.33	7	9.33		
	AI Software	3	4.00	3	4.00		
	Self-learning	2	2.67	1	1.33		

NS = Not Significant; F. = Frequency; χ^2 = Chi-square statistic; df = degrees of freedom

Table 2 presents the overall assessment of nurses' AI knowledge at pre-test and post-test. Before the intervention, the intervention group demonstrated predominantly moderate (56.00%) and poor (42.67%) knowledge, with only 1.33% achieving a good level (mean score = 0.37 ± 0.17). Following the educational program, knowledge improved markedly, with 98.67% of intervention group nurses classified at the good level (mean score = 0.87 ± 0.09). In contrast, the control group showed no improvement; mean scores remained in the poor-to-moderate range across both time points (pre-test: 0.35 ± 0.14 ; post-test: 0.33 ± 0.12), with 52% categorized as having poor knowledge at post-test.

Table 2. Nurses' Knowledge About AI in Clinical Practice at Pre-test and Post-test.

Outcome	Intervention Pre-test		Intervention Post-test		Control Pre-test		Control Post-test	
	F. (%)	M $\pm$ SD	F. (%)	M $\pm$ SD	F. (%)	M $\pm$ SD	F. (%)	M $\pm$ SD
Poor	32 (42.67%)	0.37 ± 0.17	0 (0.00%)	0.87 ± 0.09	36 (48.00%)	0.35 ± 0.14	39 (52.00%)	0.33 ± 0.12
Moderate	42 (56.00%)		1 (1.33%)		38 (50.67%)		35 (46.67%)	
Good	1 (1.33%)		74 (98.67%)		1 (1.33%)		1 (1.33%)	

Poor: mean score ≤ 0.33 ; Moderate: 0.34–0.67; Good: ≥ 0.68 . F. = Frequency; M = Mean score; SD = Standard Deviation.

Table 3 presents attitude assessment findings. All nurses in both groups demonstrated positive overall attitudes toward AI at both measurement points (100% classified as positive). In the intervention group, mean attitude scores increased significantly from 2.19 ± 0.28 (pre-test) to 2.31 ± 0.26 (post-test), indicating improved positivity following the educational program ($t = 3.691$, $p < 0.001$). The control group showed no change, with mean scores remaining

stable at 2.10 ± 0.30 (pre-test) and 2.10 ± 0.22 (post-test).

Table 3. Overall Assessment of Nurses' Attitudes Toward AI in Clinical Practice at Pre-test and Post-test.

Outcome	Intervention Pre-test F. (%)	Intervention Pre-test M $\pm$ SD	Intervention Post-test F. (%)	Intervention Post-test M $\pm$ SD	Control Pre-test F. (%)	Control Pre-test M $\pm$ SD	Control Post-test F. (%)	Control Post-test M $\pm$ SD
Positive	75 (100%)	2.19 ± 0.28	75 (100%)	2.31 ± 0.26	75 (100%)	2.10 ± 0.30	75 (100%)	2.10 ± 0.22
Negative	0 (0%)		0 (0%)		0 (0%)		0 (0%)	

Negative: mean score ≤ 1.5 ; Positive: mean score > 1.5 . F. = Frequency; M = Mean score; SD = Standard Deviation.

4. Discussion

The nursing workforce in this study was predominantly young and female, consistent with global nursing workforce demographics (Mariano et al., 2025). This finding reflects the sustained feminization of the nursing profession and the increasing proportion of early-career nurses in clinical settings. The predominance of diploma and bachelor-prepared nurses aligns with reports indicating that nursing education in Iraq remains primarily practice-oriented, with limited postgraduate engagement (Sulaiman, 2025).

No statistically significant associations were found between demographic variables—including age, sex, educational level, years of experience, and prior AI exposure—and pre-intervention knowledge or attitude scores. This aligns with findings reported by Alruwaili et al. (2024), who similarly found no significant relationship between demographic factors and AI-related attitudes. These results suggest that structured educational programs may attenuate demographic influences by providing uniform learning opportunities. In contrast, Alrashedi et al. (2026) identified that greater clinical experience was associated with more favorable AI attitudes, suggesting that contextual and organizational factors may differentially shape AI perceptions across settings.

A central finding of this study is the statistically significant improvement in AI knowledge observed in the intervention group, with no comparable change in the control group. This demonstrates that structured, theory-based educational programs can effectively address knowledge gaps related to emerging technologies. These findings are consistent with prior evidence demonstrating that AI-focused educational interventions enhance clinical competencies and professional development (Hind Abdullah Mohamed, 2023; Sengul & Sarikose, 2025). Furthermore, the integration of interactive and technology-enhanced learning strategies has been shown to strengthen knowledge retention and clinical applicability (Agwu et al., 2025).

Notably, most participants reported no prior AI exposure yet demonstrated substantial knowledge improvements post-intervention. This indicates that baseline AI familiarity is not a prerequisite for competence development when well-structured educational frameworks are implemented. This finding is supported by El-Banna et al. (2025), who demonstrated that AI literacy can be effectively developed through targeted educational interventions, irrespective of prior experience. Khalil and Yasir (2025) similarly found that nurses who received AI training demonstrated higher knowledge levels, underscoring the transformative role of structured education.

Regarding attitudes, the intervention group demonstrated a statistically significant improvement following the educational program, reflecting increased acceptance and willingness to integrate AI into clinical practice. Recent literature reports generally positive nursing attitudes toward AI, particularly when supported by adequate training and institutional readiness (El Arab et al., 2025; Seven et al., 2025). Namdar Areshtanab et al. (2025) further reported that positive attitudes toward AI may exist independently of knowledge level, supporting the current finding that attitude enhancement can occur alongside knowledge improvement.

Psychological readiness also emerged as a relevant factor; Nirgiz et al. (2026) demonstrated that lower anxiety levels

were associated with more positive AI attitudes, highlighting the importance of addressing emotional and cognitive readiness alongside technical training. Despite the overall positive attitudes observed, concerns regarding AI ethics, patient safety, and the potential erosion of human interaction in care delivery persist (Yerkoy Ates & Cetin, 2025). These concerns underscore the need for a balanced approach to AI integration, positioning AI as a complementary tool that augments rather than replaces human clinical judgment, within established ethical frameworks.

Limitations

This study has several limitations. First, the use of convenience sampling from hospitals in a single Iraqi governorate limits the generalizability of findings to other settings and populations. Second, the quasi-experimental design without full randomization may introduce selection bias, despite baseline comparability. Third, the follow-up assessment was conducted only one-month post-intervention; longer-term follow-up would better capture the sustainability of educational impact. Fourth, social desirability bias may have influenced self-reported attitude scores. Future studies should employ randomized controlled designs, larger and more geographically diverse samples, and extended follow-up periods.

Future Scope

Future research should explore the long-term sustainability of AI knowledge and attitude improvements following structured educational programs, with follow-up assessments at six- and twelve-months post-intervention. Studies incorporating randomized controlled designs and multi-institutional samples across different healthcare settings and countries would strengthen the evidence base. Additionally, research examining the impact of AI education on actual clinical practice behaviors, patient outcomes, and institutional AI adoption rates would provide valuable insights. The development and testing of standardized AI competency frameworks for nurses—integrated into undergraduate curricula and continuing professional development programs—represents a critical direction for the field.

5. Conclusion

The findings of this study demonstrate that a structured educational program significantly improved nurses' knowledge of and attitudes toward artificial intelligence in clinical settings. The substantial knowledge gains observed in the intervention group, in contrast to the stagnation in the control group, provide compelling evidence for the effectiveness of targeted AI education. Positive attitudes toward AI were prevalent at baseline and further strengthened following the intervention. Healthcare institutions should prioritize the integration of AI education into continuing professional development programs to prepare nurses for the increasing presence of AI in clinical environments, thereby supporting safe, effective, and ethically grounded AI adoption in healthcare.

CRedit authorship contribution statement

Reven Riadh Gani: Conceptualization, Methodology, Data Collection, Formal Analysis, Writing – Original Draft. Jihad Jawad Kadhim: Supervision, Writing – Review & Editing, Validation.

AI Assistance Declaration

The authors used AI-assisted tools for language enhancement, grammar correction, and structural refinement of the manuscript. All AI-generated suggestions were critically reviewed and revised by the authors, who take full responsibility for the accuracy, integrity, and content of the final manuscript.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise, related to this study.

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