



## Academic competence as a predictor of nursing students' readiness for artificial intelligence



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### ABSTRACT

Artificial intelligence (AI) is increasingly influencing nursing education and clinical practice worldwide; however, limited evidence exists on how academic and demographic factors affect nursing students' readiness to engage with AI in low- and middle-income countries. This study examined the relationship between academic competence and nursing students' attitudes toward AI, with academic seniority as a mediating variable and age and gender as moderating variables. A cross-sectional, multi-institutional survey was conducted among 550 undergraduate nursing students from six Egyptian universities during the 2024–2025 academic year. Data were collected using validated measures of academic competence and attitudes toward AI. Correlation, regression, mediation, and moderation analyses were applied to test the study hypotheses. The findings showed a significant positive association between academic competence and attitudes toward AI ( $r = 0.47, p < .001$ ). Academic seniority partially mediated this relationship ( $\beta = 0.04, p < .001$ ), while age ( $\beta = 0.08, p = .008$ ) and gender ( $\beta = 0.10, p = .013$ ) significantly moderated it, with stronger associations observed among older and female students. These results highlight the importance of competence-based educational approaches and inclusive curriculum design in supporting AI integration in nursing education. Providing targeted support for younger and less academically advanced students, along with enhancing faculty digital skills, may improve equitable AI readiness among nursing students.

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### 1. Introduction

True transformation in nursing education is not simply about digital adoption; it is about cultivating academic competence, digital awareness, and ethical intelligence to prepare future nurses for a technology-driven healthcare era. As [Ma et al. \(2025\)](#) explained, nursing education integrates foundational knowledge, clinical reasoning, and professional development to ensure graduates can respond to rapidly evolving healthcare systems. While digital transformation drives educational innovation globally, academic institutions in low- and middle-income countries face substantial barriers, including inadequate infrastructure, digital literacy gaps, and insufficient educator preparedness that fundamentally constrain pedagogical advancement ([Ndibalema, 2025](#)). Despite evidence demonstrating

the critical relationship between digital competence and pedagogical innovation, persistent systemic challenges create significant impediments to educational transformation in resource-constrained settings ([Asal et al., 2025](#)). These obstacles underscore the need for transformative models that develop both digital proficiency and reflective academic competence within nursing curricula ([López et al., 2022](#)).

Artificial intelligence (AI) represents one of the most profound and disruptive innovations in modern healthcare education. Its applications, ranging from predictive analytics and intelligent tutoring systems to adaptive simulations and AI chatbots, are redefining how nursing students learn, apply knowledge, and cultivate clinical judgment ([Doston et al., 2025](#)). AI has been shown to personalize learning experiences, provide real-time feedback, and foster cognitive engagement by adapting to learners' competencies and progress ([Yaseen et al., 2025](#)). Recent systematic reviews confirm that exposure to AI-integrated education enhances students' self-efficacy, critical thinking, and learning satisfaction, particularly in clinical training environments ([Ma et al., 2025; Sardi et al., 2025](#)).

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However, meaningful AI adoption also requires psychological readiness, especially positive attitudes, confidence, and ethical discernment among nursing students (Abuadas et al., 2025; Bozkurt et al., 2025).

Students' attitudes toward AI are therefore pivotal in determining whether technological integration translates into effective learning outcomes. Evidence suggests that perceived usefulness, ease of use, and digital self-efficacy, the core constructs of the Technology Acceptance Model (TAM), strongly predict willingness to engage with AI applications (Davis, 1989; Yan et al., 2025). Moreover, educational resilience and academic competence, as identified by Social Cognitive Theory (SCT), are critical mediating factors influencing this relationship (Shao and Kang, 2022). SCT posits that self-efficacy, the belief in one's ability to perform academic or task-related activities, directly affects motivation, learning persistence, and technology acceptance. Thus, nursing students with higher academic competence and self-efficacy are anticipated to hold more positive attitudes toward AI-supported learning environments (Varol, 2025).

Despite rapid advances in AI research, significant gaps persist regarding how academic competence interacts with demographic factors such as academic seniority, age, and gender to shape students' attitudes toward AI, particularly in LMICs (Balasa et al., 2025). Many prior studies have examined these variables independently, neglecting the interrelated nature of competence, readiness, and individual differences (Dermody et al., 2025). Furthermore, empirical research remains sparse within Egyptian nursing education, where national initiatives like the Artificial Intelligence Strategy 2025–2030 aim to advance digital inclusion, but disparities in access and faculty readiness remain pronounced (Buchanan et al., 2021; Hassan Mekawy et al., 2020).

This study investigates the relationship between academic competence and nursing students' attitudes toward AI, testing the mediating role of academic seniority and the moderating effects of age and gender in the Egyptian context. It uniquely integrates insights from SCT and TAM to build a comprehensive theoretical framework explaining how intrinsic and contextual factors converge to influence AI readiness. By addressing these multidimensional relationships, this study contributes to developing inclusive, competence-based frameworks for integrating artificial intelligence into nursing curricula across resource-limited educational settings.

## 2. Methodology

A cross-sectional analytical design examined relationships between academic competence and nursing students' attitudes toward artificial intelligence, with academic seniority tested as a mediator and gender and age as potential moderators.

The study was conducted during the 2024–2025 academic year across six Egyptian universities:

Helwan University, Misr University, Mansoura University, Assiut University, 6th of October University, and Badr University.

Sample size adequacy was determined using G\*Power version 3.1.9.7. The analysis indicated that a minimum of 304 nursing students was required to detect a moderate effect size ( $f^2 = 0.15$ ) with 95% statistical power at a significance level of  $\alpha = .001$ . The final sample comprised 550 participants, which exceeded the calculated requirement, thereby enhancing the study's statistical power and generalizability while accounting for potential nonresponse or incomplete data.

This study targeted undergraduate nursing students enrolled in BSN programs during 2024–2025 across six participating universities. Proportionate stratified random sampling was employed, with eligible populations stratified by academic year (first through fourth), ensuring balanced participation across academic levels and minimizing sampling bias. Within each stratum, participants were selected randomly using computer-generated numbers applied to enrollment lists provided by university registrars.

Eligible participants were full-time undergraduate nursing students enrolled in participating BSN programs who had completed at least one academic semester and provided informed consent. Students were excluded if they were on academic leave, not actively attending during the survey period, or enrolled in bridging or postgraduate nursing programs.

Demographic Questionnaire A researcher-developed questionnaire gathered background information, including age, gender, academic year, grade point average (GPA), and prior AI experience. These variables enabled comprehensive sample characterization and subgroup analyses examining factors influencing AI attitudes (Hughes et al., 2022; Kaya et al., 2024).

Academic Self-Concept Scale (ASCS) Academic competence was measured using the ASCS, a 20-item instrument developed by Liu and Wang (2005), comprising two subdomains: academic confidence (beliefs in intellectual abilities) and academic effort (diligence applied to academic tasks) (Liu and Wang, 2005). Responses used 7-point Likert scales (1 = "strongly disagree" to 7 = "strongly agree"), with higher scores indicating stronger academic self-concept. The ASCS demonstrates robust reliability across diverse cultural contexts (Cronbach's  $\alpha = 0.89$ –0.93) and exhibited excellent internal consistency in this study ( $\alpha = 0.91$ ).

Students' Attitudes Toward Artificial Intelligence (SATAI) Scale AI attitudes were assessed using the SATAI Scale, a validated 26-item instrument developed by Suh and Ahn (2022), evaluating attitudes across cognitive (beliefs about AI), affective (emotional responses), and behavioral (engagement intentions) dimensions. Items used 5-point Likert scales (1 = "strongly disagree" to 5 = "strongly agree"), with higher scores indicating more favorable AI attitudes (Suh and Ahn, 2022). The

SATAI shows strong psychometric properties across contexts ( $\alpha > 0.85$ ) (Derinalp and Ozyurt, 2025) and demonstrated high internal consistency in this study ( $\alpha = 0.89$ ).

Two validated tools, the Academic Self-Concept Scale (ASCS) and the Students' Attitudes Toward Artificial Intelligence Scale (SATAI), were adapted using a structured forward-backward translation protocol by bilingual experts to ensure semantic and conceptual accuracy. The ASCS showed excellent reliability ( $\alpha = 0.91$ ), and the SATAI demonstrated strong validity and consistency ( $\alpha > 0.85$ ), confirming both instruments' cultural suitability for Egyptian nursing students.

A pilot with 10% of the sample ( $n = 35$ ) confirmed clarity and feasibility; minor revisions were made, and pilot data were excluded from analysis.

Data was collected electronically via structured, self-administered online surveys distributed through official university email systems. Participants received information sheets outlining the study purpose, methodology, voluntary participation, confidentiality assurances, and estimated completion time. Data collection occurred September-October 2024, with surveys completed in supervised settings including lecture halls, classrooms, and libraries during daytime hours (9:00 a.m.-2:00 p.m.), Sunday through Thursday. The electronic format reduced missing data and ensured secure, confidential response submission.

Data was analyzed using IBM SPSS Statistics version 26. Descriptive statistics (frequencies, percentages, means, standard deviations) summarize demographic characteristics and scale scores. Normality was examined via skewness and kurtosis values. Pearson correlations assessed associations between academic competence and AI attitudes. Linear regression tested predictive relationships, while mediation analysis using the PROCESS macro evaluated academic seniority's mediating role. Moderation analyses examined gender and age effects using interaction terms. Statistical significance was set at  $p < 0.05$  with 95% confidence intervals. Effect sizes were interpreted

using Cohen's conventions (small = 0.10, medium = 0.30, large = 0.50).

### 3. Result

**Table 1** demonstrates a well-distributed sample across gender, age, and academic year, enhancing the study's representativeness. Most participants were aged 19 < 21 (51.5%) and enrolled across all four academic years, supporting analysis of academic seniority. Device use showed high digital accessibility, with 49.5% using both PC and mobile devices relevant for AI integration.

**Table 1:** Demographic and academic profile of participants ( $n = 550$ )

| Variable       | Category          | n   | %     |
|----------------|-------------------|-----|-------|
| Gender         | Female            | 298 | 54.2% |
|                | Male              | 252 | 45.8% |
| Age            | < 19              | 26  | 4.7%  |
|                | 19 < 21           | 283 | 51.5% |
| Academic year  | 21 < 23           | 185 | 33.6% |
|                | ≥ 23              | 56  | 10.2% |
| Devices used   | First year        | 151 | 27.5% |
|                | Second year       | 117 | 21.3% |
| GPA (%)        | Third year        | 135 | 24.5% |
|                | Fourth year       | 147 | 26.7% |
| Used AI before | Laptop/PC         | 140 | 25.5% |
|                | Smartphone/tablet | 138 | 25.1% |
| Used AI before | Both              | 272 | 49.5% |
|                | 75 < 80           | 42  | 7.6%  |
| Used AI before | 80 < 85           | 128 | 23.3% |
|                | 85 < 90           | 152 | 27.6% |
| Used AI before | 90 < 95           | 139 | 25.3% |
|                | ≥ 95              | 89  | 16.2% |
| Used AI before | Yes               | 359 | 65.3% |
|                | No                | 191 | 34.7% |

**Table 2** reveals that nursing students exhibit high levels of academic competence ( $M = 84.9$ ) and favorable attitudes toward AI ( $M = 83.12$ ), with narrow standard deviations indicating consistent responses. Motivation and task management scored strongly among competence domains, while the cognitive component led among attitude dimensions. These results establish a solid basis for testing the hypothesized associations and suggest a generally receptive and academically capable sample for AI adoption.

**Table 2:** Descriptive statistics for academic competence and AI attitudes ( $n = 550$ )

| Variable                    | Items | Mean (M) | SD   | Min | Max |
|-----------------------------|-------|----------|------|-----|-----|
| Academic skills             | 9     | 14.12    | 2.45 | 7   | 18  |
| Motivation                  | 5     | 32.4     | 3.72 | 22  | 40  |
| Task management             | 6     | 37.25    | 4.1  | 24  | 48  |
| Total ACES score            | 20    | 84.9     | 7.3  | 60  | 105 |
| Cognitive attitude (SATAI)  | 4     | 38.23    | 5.12 | 18  | 52  |
| Emotional attitude (SATAI)  | 10    | 22.33    | 3.9  | 11  | 32  |
| Behavioral attitude (SATAI) | 12    | 26.01    | 4.5  | 14  | 36  |
| Total SATAI score           | 26    | 83.12    | 6.75 | 60  | 98  |

**Table 3** shows that all dimensions of academic competence are significantly positively associated with AI attitudes, with the total ASCS score demonstrating the strongest relationship ( $r = 0.47$ ,  $p < .001$ , large effect size). Linear regression confirmed academic competence as a significant predictor of AI attitudes ( $\beta = 0.47$ ,  $p < .001$ ), explaining 22% of

variance in AI attitudes, a substantial effect in educational research contexts. **Table 4** shows that Academic seniority partially mediates the relationship between academic competence and AI attitudes. The significant indirect effect ( $\beta = 0.04$ ,  $p < .001$ ) with confidence intervals excluding zero confirmed robust mediation. Both gender and age

significantly moderated the competence-attitude relationship, with effects being stronger among female students and older students, suggesting

demographic factors influence how academic competence translates to AI acceptance.

**Table 3:** Correlations, regression, and effect size analysis

| Analysis type | Predictor           | Outcome      | r / $\beta$    | p-value | 95% CI       | Effect size |
|---------------|---------------------|--------------|----------------|---------|--------------|-------------|
| Correlation   | Total ASCS          | SATAI        | 0.47           | < .001  | (0.40, 0.53) | Medium      |
|               | Academic skills     | SATAI        | 0.45           | < .001  | (0.38, 0.51) | Medium      |
|               | Motivation          | SATAI        | 0.44           | < .001  | (0.37, 0.50) | Medium      |
|               | Task management     | SATAI        | 0.36           | < .001  | (0.28, 0.43) | Medium      |
| Regression    | Academic competence | AI attitudes | $\beta = 0.47$ | < .001  | (0.33, 0.61) | Large       |

CI: Confidence interval; Effect size thresholds: small = 0.10, medium = 0.30, large = 0.50; Regression model  $R^2 = 0.22$  (simple linear regression)

**Table 4:** Mediation and moderation effects

| Analysis          | Pathway / Interaction                | $\beta$ | SE   | p-value | 95% CI       | Interpretation              |
|-------------------|--------------------------------------|---------|------|---------|--------------|-----------------------------|
| Mediation         | Competence $\rightarrow$ seniority   | 0.18    | 0.05 | < .001  | (0.09, 0.27) | Significant                 |
|                   | Seniority $\rightarrow$ AI attitudes | 0.22    | 0.06 | < .001  | (0.10, 0.34) | Significant                 |
|                   | Indirect effect                      | 0.04    | 0.01 | < .001  | (0.02, 0.06) | Partial mediation           |
| Gender moderation | Competence $\times$ gender           | 0.10    | 0.04 | .013    | (0.02, 0.18) | Stronger for females        |
|                   | Competence $\times$ age              | 0.08    | 0.03 | .008    | (0.02, 0.14) | Stronger for older students |

\*:  $p < .05$ ; \*\*:  $p < .01$ ; Gender coded: 0 = Male, 1 = Female

#### 4. Discussion

This study deepens understanding of AI integration in nursing education by showing that academic competence significantly influences students' attitudes toward AI, with gender and age as moderators and academic seniority as a mediator. Grounded in Social Cognitive Theory and the Technology Acceptance Model, it explains how self-efficacy shapes behavioral intentions toward educational technology. Extending prior studies on AI readiness (López et al., 2022), it offers a contextualized model demonstrating how competence and demographic factors jointly shape AI receptivity in a low- and middle-income country setting.

The strong positive association between academic competence and AI attitudes ( $r = .47$ ,  $p < .001$ ) aligns with SCT, which posits that self-efficacy fosters persistence, adaptability, and openness to innovation. Consistent with Davis's (1989) TAM, students with higher competence perceive AI as useful and manageable, strengthening their behavioral intentions toward AI use. These results align with Agaoglu et al. (2025), emphasizing the mediating role of digital literacy and the moderating impact of academic support on AI use and creativity among nursing students. Similarly, positive perceptions of AI tools have been documented among students, reinforcing a generally favorable disposition toward AI adoption in nursing education (Abou Hashish et al., 2025). In contrast, work by Prasoj et al. (2025) reported weaker associations among institutions with limited infrastructure, emphasizing that contextual constraints may moderate the competence-attitude relationship.

The partial mediation effect of academic seniority suggests that academic progression enhances AI

acceptance partly through increased competence development. This aligns with findings that senior nursing students typically display greater digital proficiency and more favorable AI attitudes (Abou Hashish and Alnajjar, 2024), indicating that sustained academic exposure contributes to technology acceptance.

The significant gender moderation effect, with stronger competence-attitude relationships among female students, aligns with Salameh et al. (2025), who observed gender differences favoring females in AI receptivity. In contrast, Sandanasamy et al. (2025) noted a significant relationship between male gender and positive AI attitudes.

The age moderation effect, showing stronger competence-attitude associations among older students, challenges assumptions about younger students' inherent technology affinity. These findings suggest that maturity and accumulated academic experience may enhance the translation of competence into AI acceptance, possibly through greater appreciation of technology's practical utility or more developed critical thinking skills for evaluating AI applications, consistent with Abou Hashish and Alnajjar (2024).

Overall, this study substantiates the central role of academic competence in promoting positive attitudes toward AI among nursing students, both directly and indirectly through academic seniority. The moderating influences of gender and age highlight the importance of considering demographic diversity when designing AI-related curricula. These insights offer valuable guidance for nursing educators and policymakers to develop inclusive, competency-based educational frameworks that effectively prepare diverse learner profiles for the evolving AI-enabled healthcare environment.

## 5. Limitations

Several limitations should be acknowledged. Cross-sectional design prevents causal inferences; relationships identified reflect associations rather than causal pathways. Self-reported data may introduce recall and social desirability bias, particularly for sensitive topics like academic competence and technological attitudes. Unmeasured contextual factors such as digital infrastructure quality, faculty engagement levels, and institutional AI policies may have influenced results but were not captured in this study.

The single-country focus, while providing valuable LMIC insights, limits generalizability to other cultural and educational contexts. Future research should employ longitudinal designs to establish temporal relationships and incorporate objective measures of academic performance and AI engagement behaviors.

## 6. Conclusions

This study demonstrates that academic competence serves as a significant predictor of nursing students' attitudes toward artificial intelligence, with academic seniority partially mediating this relationship and gender and age serving as important moderators. These findings provide evidence-based guidance for developing inclusive, competency-based approaches to AI integration in nursing education, particularly within LMIC contexts.

### 6.1. Implications for nursing practice and education

Nursing education programs should systematically integrate AI-related competencies across all academic levels, emphasizing clinical application, ethical considerations, and critical evaluation of AI outputs. Faculty development initiatives must enhance educators' digital literacy and pedagogical capacity for AI-based instruction while ensuring sustainable implementation within resource constraints.

Targeted support mechanisms are recommended for younger and male students to address disparities in digital readiness and ensure equitable engagement. Curricular strategies should prioritize inclusivity, accounting for demographic factors that shape technology acceptance patterns.

### 6.2. Future research directions

Future investigations should employ longitudinal and experimental designs to evaluate the long-term impact of AI education on nursing students' clinical competence, patient care outcomes, and professional identity development. A mixed methods approach incorporating qualitative insights into student

experiences and contextual factors would provide a deeper understanding of AI adoption processes.

Cross-cultural research examining these relationships across diverse LMIC contexts would enhance generalizability and inform region-specific implementation strategies. Additionally, research examining the effectiveness of targeted interventions for different demographic groups would provide practical guidance for optimizing AI integration approaches.

## List of abbreviations

|          |  |
|----------|--|
| AI       | Artificial intelligence                            |
| ASCS     | Academic self-concept scale                        |
| BSN      | Bachelor of science in nursing                     |
| CI       | Confidence interval                                |
| DHL      | Digital health literacy                            |
| $f^2$    | Effect size measure (Cohen's f squared)            |
| GPA      | Grade point average                                |
| LMICs    | Low- and middle-income countries                   |
| M        | Mean   |
| MIS      | Management Information Systems                     |
| n        | Number of participants                             |
| PC       | Personal computer                                  |
| PROCESS  | A macro for mediation and moderation analysis      |
| r        | Pearson correlation coefficient                    |
| SCT      | Social cognitive theory                            |
| SD       | Standard deviation                                 |
| SE       | Standard error                                     |
| SPSS     | Statistical package for the social sciences        |
| SATAI    | Students' attitudes toward artificial intelligence |
| TAM      | Technology acceptance model                        |
| $\alpha$ | Cronbach's alpha                                   |
| $\beta$  | Standardized regression coefficient                |

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## Compliance with ethical standards

### Ethical considerations

Ethical approval was obtained from the Research Ethics Committee, Faculty of Nursing, Helwan University (Reference No. HUNURSERC 2024/07/52/85). The study complied with the Declaration of Helsinki, and electronic informed consent was secured from all participants.

### Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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