



ORIGINAL

## A Multidimensional Assessment of Generative AI Models in Theoretical and Clinical Nursing Education

### Evaluación multidimensional de los modelos generativos de IA en la enseñanza teórica y clínica de la enfermería

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#### ABSTRACT

Generative Artificial Intelligence (GAI) has rapidly emerged as an advanced technology with the potential to revolutionize various sectors, including education and healthcare. Despite the growing interest in applying GAI models to nursing education, there remains a lack of comprehensive research assessing their multidimensional impact. Research aims to determine the multifaceted impact of GAI on nursing education, focusing on its effectiveness and challenges. A mixed-methods approach was employed, combining qualitative interviews and focus groups with quantitative surveys and pre-and post-test assessments. Research involved nursing students, educators, and clinical practitioners from various institutions and healthcare settings, with a total of 820 participants gathered. Thematic analysis was employed to examine views, experiences, and issues pertaining to GAI in qualitative data. IBM SPSS software version 28 is used for the statistical analysis. Descriptive statistics were used to examine quantitative data to compile survey results and measures of academic achievement, while the findings of the pre- and post-tests were compared using paired t-tests to measure changes in knowledge and clinical skills. The GAI model is to increase student engagement (from 60 % to 80 %), improvement in personalized learning (from 65 % to 87 %), and an increase in theoretical knowledge retention (from 70 % to 95 %). The findings suggest that GAI enhances student engagement, offers personalized learning experiences, and improves theoretical knowledge retention. The research highlights the need for careful integration of GAI into nursing curricula and offers recommendations for addressing the ethical considerations and ensuring effective use in clinical training.

**Keywords:** Generative Artificial Intelligence (GAI); Clinical; Nursing Education; Student Engagement.

#### RESUMEN

La Inteligencia Artificial Generativa (IAG) ha emergido rápidamente como una tecnología avanzada con potencial para revolucionar diversos sectores, entre ellos la educación y la sanidad. A pesar del creciente interés en la aplicación de los modelos GAI a la educación de enfermería, sigue habiendo una falta de investigación exhaustiva que evalúe su impacto multidimensional. La investigación tiene como objetivo determinar el impacto multifacético de la GAI en la educación de enfermería, centrándose en su eficacia y desafíos. Se empleó un enfoque de métodos mixtos, combinando entrevistas cualitativas y grupos de discusión con encuestas cuantitativas y evaluaciones previas y posteriores a las pruebas. En la investigación participaron estudiantes de enfermería, educadores y profesionales clínicos de diversas instituciones

y entornos sanitarios, con un total de 820 participantes. Se empleó el análisis temático para examinar las opiniones, experiencias y cuestiones relativas a la GAI en los datos cualitativos. Para el análisis estadístico se utilizó el software IBM SPSS versión 28. Se utilizaron estadísticas descriptivas para examinar los datos cuantitativos con el fin de compilar los resultados de las encuestas y las medidas del rendimiento académico, mientras que los resultados de las pruebas previas y posteriores se compararon mediante pruebas t pareadas para medir los cambios en los conocimientos y las habilidades clínicas. El modelo GAI aumenta el compromiso de los estudiantes (del 60 % al 80 %), mejora el aprendizaje personalizado (del 65 % al 87 %) y aumenta la retención de conocimientos teóricos (del 70 % al 95 %). Los resultados sugieren que GAI aumenta el compromiso de los estudiantes, ofrece experiencias de aprendizaje personalizadas y mejora la retención de conocimientos teóricos. La investigación pone de relieve la necesidad de integrar cuidadosamente la GAI en los planes de estudios de enfermería y ofrece recomendaciones para abordar las consideraciones éticas y garantizar un uso eficaz en la formación clínica.

**Palabras clave:** Inteligencia Artificial Generativa (GAI); Clínica; Educación en Enfermería; Compromiso del Estudiante.

## INTRODUCTION

Nursing education is always evolving to enhance both academic knowledge and clinical skills in response to the growing demand for healthcare workers.<sup>(1)</sup> A comprehensive assessment procedure ensures that nursing students have the theoretical knowledge and practical skills necessary to deliver exceptional patient care. Teachers can learn more about nursing students' competencies and highlight areas for development by evaluating using a variety of techniques, such as theoretical tests, clinical assessments, and practical models.<sup>(2)</sup> Nursing education is built on theoretical models, which provide frameworks for comprehending important ideas, including patient care, nursing ethics, and practice based on evidence. The development of nursing curricula is guided by these frameworks, which promote innovative thinking and the application of theoretical knowledge to practical applications.<sup>(3)</sup> Students' understanding of these frameworks is evaluated using a variety of instructional techniques, such as classes, conversations, and assignments, to overcome the gap between academic learning and practical application. Through practical learning experiences, clinical education enables students to apply their theoretical knowledge in authentic healthcare environments.<sup>(4)</sup> To produce qualified nurses who can deliver safe and efficient patient care, that aspect of nursing education is crucial. Through the utilization of clinical placements, simulations, and direct patient care under supervision, students can show their expertise in a dynamic controlled setting.<sup>(5)</sup> Assessing clinical performance scientifically guarantees that students are adequately prepared for the workforce and fulfill the requirements of professionalism. To guarantee the efficacy of training programs and the professional achievement of nursing students, a thorough multifaceted evaluation of nursing education techniques both theoretical and clinical is essential.<sup>(6)</sup> The objective of the research is to assess how well GAI approaches can be integrated and improve theoretical and clinical nursing education. The purpose of the investigation is to examine how GAI might change nursing education by evaluating its effects on learning outcomes, critical thinking, and practical skills.

The significance of resilience in nursing practice is becoming increasingly recognized among nurses. Increased resilience has been found to benefit nurses, according to research and integrative evaluations.<sup>(7)</sup> To more effectively prepare students for challenges in education and practice as nurses, the research proposes integrating resilience training into nursing education. Support, education, and introspection are key methods for implementing resilience training. The strategy could encourage conversations about potential instructional methods. To comprehend how theory is applied in research approaches and instruction, the literature on nursing education is examined. A thorough investigation of the nursing education literature's substantial growth and diversity possibilities. There is a great deal of room for growth and diversification in the scholarship of epistemology, discovery and exploration in addition to nursing, especially about teaching and learning.<sup>(8)</sup> The analysis identifies in which nursing educators might integrate more comprehensive philosophical, methodological, pedagogical, and theoretical perspectives to their instruction and techniques. To improve their education, nursing students' opinions on mobile technology use in clinical settings are essential. The benefits of mobile technology include less anxiety, increased knowledge and confidence, and faster access to educational resources.<sup>(9)</sup> Obstacles to the use of mobile learning in clinical nursing education include low-quality educational content, a negative perception of nursing staff, and inadequate Wi-Fi access. Determining the efficacy of mobile technologies in clinical practice requires more investigation.

The experiences of nursing students in clinical learning settings are examined in the investigation, with an emphasis on process-influencing variables. Five topics emerged from the data gathered from nursing students: how people affect clinical learning, the educational environment, the qualities of the students themselves,

the influence, and the student's perspectives on regarding clinical learning.<sup>(10)</sup> The results can serve as a guide for nurse educators as they develop interventions to help students during their clinical education. Clinical education is essential to nursing students' performance and professional readiness. The goal of the analysis is to highlight the issues with clinical nursing education, with a particular emphasis on ineffective educational design and the workplace performance environment.<sup>(11)</sup> Two major themes were identified through a qualitative content analysis of informal conversations with nursing educators, qualified nurses, and student nurses. Research examined the use of simulation education in nursing, emphasizing integration and competence development. It presents three novel ideas: using technology-enhanced boundary objects (TEBOs), reconsidering the theory-practice divide, and leveraging virtual clinical settings. These teaching strategies follow the constructivist-based clinical simulation education model.<sup>(12)</sup> With its animation and informative video content, the e-version helps nursing students, and seasoned instructors understand complicated educational concepts.

The theory-practice divide in nursing education is examined with a particular emphasis on curriculum content reform and the development of clinical cultures. Emirati nursing students indicated that clinical training should take place in medical facilities, that clinical educators should experience less stress, and that classroom and lab instruction should be coordinated.<sup>(13)</sup> Additionally, the report recommends transitioning from a combined system to a block system, decreasing clinical training, and employing the same college staff to instruct both clinical and theoretical courses. The perspective of learning transfer to clinical practice is the main emphasis of the analysis, which investigated nursing students' experiences through simulation-based training.<sup>(14)</sup> Three main themes surfaced from focus group discussions: fostering self-confidence, enhancing clinical judgment and skills, and placing a strong emphasis on teamwork and communication. For long-lasting and deliberate educational results, the investigation emphasizes how crucial to prepare for and carry out simulation-based instruction for nursing education. Undergraduate nursing students' experiences and insufficient instruction are problems for Ghanaian nursing education.<sup>(15)</sup> The analysis discovered that students encountered complicated medical equipment, experienced isolation, and did not receive a proper physical examination from nursing professionals. These incidents demonstrate how nursing education needs enhanced organization and support. Medical and nursing students' attitudes regarding interprofessional education (IPE) are examined regarding professional identification and intergroup engagement. The students discovered that while medical students' attitudes about IPE decreased, nursing students' attitudes increased when they identified with their ingroup.<sup>(16)</sup> There was no discernible impact of intergroup contact. The results are predicated on status disparities among professional groupings and social identity theory.

### Research Gap

The importance of resilience in nursing practice and how difficult it is to integrate into nursing education is an under-researched area; there is less research on evidence-based strategies to teach resilience. The application of mobile technology in clinical environments has advantages and limitations that need to be further researched. The theory-practice gap in the design of clinical education affects the performance and readiness for professional practice of nursing students. More research is required to determine effective interventions for enhancing nursing education. Inadequate instruction and organizational support in nursing education must be addressed to maximize students' clinical experience.

### METHOD

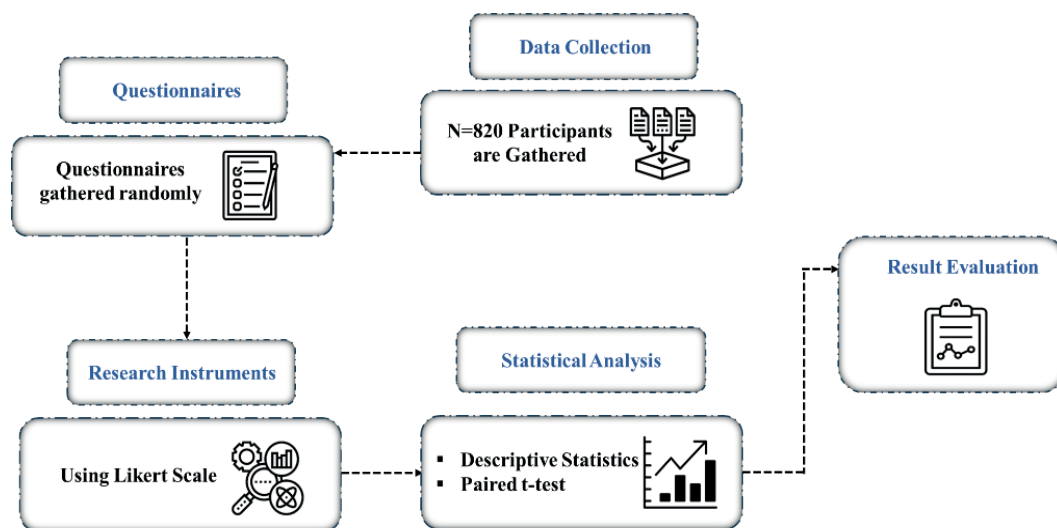


Figure 1. Flow of methodology

The influence of GAI on nursing education was evaluated in the investigation using questionnaires administered to a random sample of clinical practitioners, instructors, and nursing students. The Likert scale assessed information retention, individualized learning, and student involvement. Descriptive statistics and paired t-tests were among the statistical tools used to assess how theoretical knowledge and clinical competency had changed before and after GAI was incorporated into the instruction. Figure 1 shows the methodology flow.

### Data collection

There are 820 participants gathered randomly in the investigation, which included nursing students, instructors, and clinical professionals from different organizations and healthcare environments. Some questionnaires are also randomly gathered. Student engagement, personalized learning experiences, and improved theoretical knowledge retention are these factors used in theoretical and clinical nursing education.

### Questionnaires

The use of questionnaires as a tool for multidimensional evaluation in theoretical and clinical nursing education is included in the declaration. Incorporating GAI into the data collection from several resources for nursing education, such as the standard of theoretical teachings, practical clinical experience, and the whole educational procedure is probably a component of this strategy. GAI can also support the instructors can gathering qualitative and quantitative input from students, teachers, and potentially patients by using questionnaires, which enables a thorough assessment. By identifying areas of strength and progress, nursing programs are more prepared to conform to professional and academic requirements. Table 1 shows the questionnaires for each factor.

Table 1. Questionnaires for each factor	
Factors	Questionnaires
Student engagement	To what extent do the person feel that the GAI model encourages their curiosity and interest in learning nursing theory and clinical practice? How motivated are you to complete assignments or engage with additional resources recommended by the GAI model?
Offers Personalized Learning Experiences	Do the person feel that the GAI model modifies the learning content to their specific needs and steps in nursing education? How well does the GAI model adapt to their preferred learning when providing nursing education content?
Improves theoretical knowledge retention	How effective do the participants think the GAI model is in helping the person remember nursing theories and concepts after completing the lessons? After interacting with the GAI model, how often do the participant find that can easily recollect and apply the theoretical nursing content in practical situations?

### Research Instruments

A Likert scale was used to evaluate how well clinical and theoretical nursing education improves student application of nursing principles, learning effectiveness, and student engagement. Participants were asked to elaborate on how they felt the combination of clinical experience and theoretical knowledge enhanced their comprehension, critical thinking, and nursing practical abilities, as supported by the GAI tool. ‘Strongly Disagree’ to ‘Strongly Agree’ were the five levels of the Likert scale. The evaluations assessed how well the participants engaged with the theoretical material and clinical experiences, how these components supported learning, and whether they felt equipped to use these ideas in actual medical environments.

### Statistical analysis

IBM SPSS software version 28 was used for the statistical analysis. The investigation utilized descriptive statistics and paired t-tests to determine the effect of GAI on nursing education. Descriptive statistics were utilized to report survey feedback and academic performance measures, summarizing student participation trends, knowledge retention, and clinical competency. Pre- and post-test results were analyzed using paired t-tests, quantifying changes in theoretical knowledge and clinical competency. These analyses sought to ascertain whether there were statistically significant differences in students’ learning outcomes after incorporating GAI to the nursing curriculum.

## RESULTS

The findings show that using GAI models in nursing education significantly increased student engagement, individualized learning, and retention of theoretical information. Increased scores across all assessed factors

demonstrated the benefits of the GAI model. When all factors are considered, the results demonstrate how well the approach works to improve learning outcomes in nursing education.

### Demographic Data Analysis

The analysis of the demographic data sheds light on the traits of the investigation's participants regarding generative AI models in nursing education. The proportion of females in the sample is greater than that of males. Although a sizable fraction of participants are the younger and older age groups, a significant majority of participants are in the middle age, indicating an appropriately balanced age distribution. Although the participants' educational backgrounds differ, the majority have bachelor's degrees, followed by associate's, master's, and doctoral degrees. Although there is a fair representation of people with more extensive professional experience throughout the various ranges, a significant portion of participants have less than five years of nursing experience. Table 2 and figure 2 show the outcome of the demographic data evaluation.

Demographic Variable	Category	Frequency (N=820)	Percentage (%)
Gender	Male	240	29,27
	Female	580	70,73
Age Group	18-30 years	150	18,29
	31-40 years	220	26,83
	41-50 years	240	29,27
	51+ years	210	25,61
Educational Level	Associate Degree	180	21,95
	Bachelor's Degree	460	56,10
	Master's Degree	140	17,07
	Doctoral Degree	40	4,88
Years of Nursing Experience	0-5 years	250	30,49
	6-10 years	200	24,39
	11-20 years	210	25,61
	21+ years	160	19,51

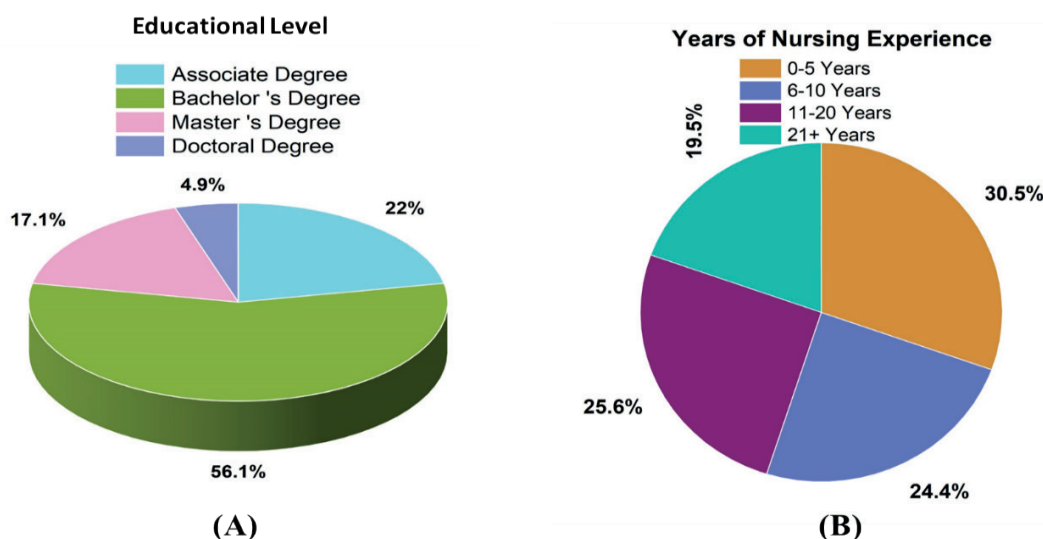


Figure 2. Outcome of demographic data evaluation (A) Educational Level, (B) Years of Nursing Experience

### Descriptive Statistics

Descriptive statistics are used to evaluate several aspects of GAI models in nursing education. The average score for student involvement was found to be reasonable, with a considerable standard deviation (SD) that indicates response variability. Involvement has a considerable impact on results, according to the statistical test. The GAI model's personalized learning experiences showed slightly higher averages, but the outcome



was not significantly different at the traditional threshold, indicating that this aspect may not have as much of an overall effect. A positive average score and a significant outcome for the GAI contribution to boosting students' memory of theoretical knowledge additionally suggest that the model successfully helps students maintain theoretical content. The model's potential to enhance learner engagement and information retention is highlighted by its overall result. Table 3 shows the evaluation of descriptive statistics.

$$T = \sqrt{\frac{\sum |w - \bar{w}|^2}{m-1}} \quad (1)$$

Equation (1),  $w$  represents the data value,  $\bar{w}$  is the average of the collected data,  $m-1$  is the quantity of sample values that has dropped, and  $|w - \bar{w}|^2$  symbolizes the departure from the sample mean.

Table 3. Descriptive statistics for theoretical and clinical nursing education using GAI models				
Factors	Mean	SD	t-value	p-value
Student engagement	3,8	0,75	2,35	0,02
Offers Personalized Learning Experiences	4,1	0,6	1,88	0,06
Improves theoretical knowledge retention	3,95	0,7	2,5	0,01

### Paired t-tests

The discrepancies between several categories of parameters pre and post the GAI models in nursing education are assessed using paired t-tests. After utilizing the GAI model, there is a noticeable change in the mean score and a high level of statistical significance, indicating a considerable boost in student involvement. With a considerable mean difference (MD) and an acceptable statistical outcome, the GAI approach is to individualized learning experiences likewise demonstrates a notable improvement. Furthermore, the model's capacity to enhance the retention of theoretical information shows a definite benefit, as evidenced by the notable rises in scores. These findings demonstrate the efficacy of GAI models in improving learning outcomes by showing that its application in nursing education resulted in significant improvements across all evaluated requirements. Table 4 and figure 3 show the outcome of the evaluation of the paired t-test.

$$S = \frac{\sum c}{\sqrt{\frac{m(\sum c^2) - (\sum c)^2}{m-1}}} \quad (2)$$

Where equation (2),  $c$  is the variation for each pair of values,  $m$  represents the several of data.

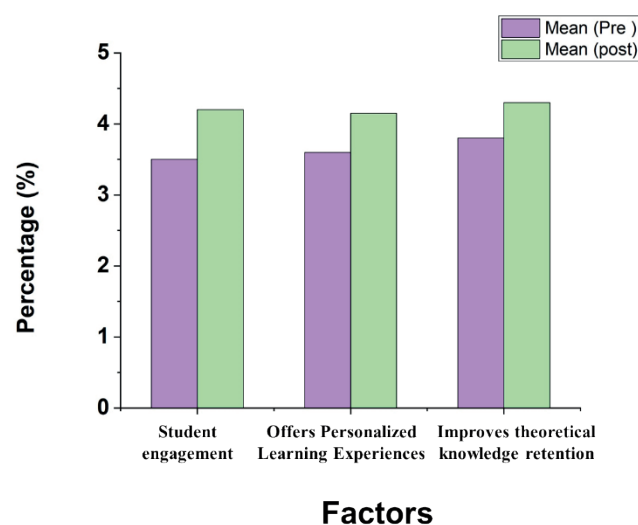


Figure 3. Outcome of paired t-test evaluation

**Table 4.** Paired t-test for theoretical and clinical nursing education using GAI models

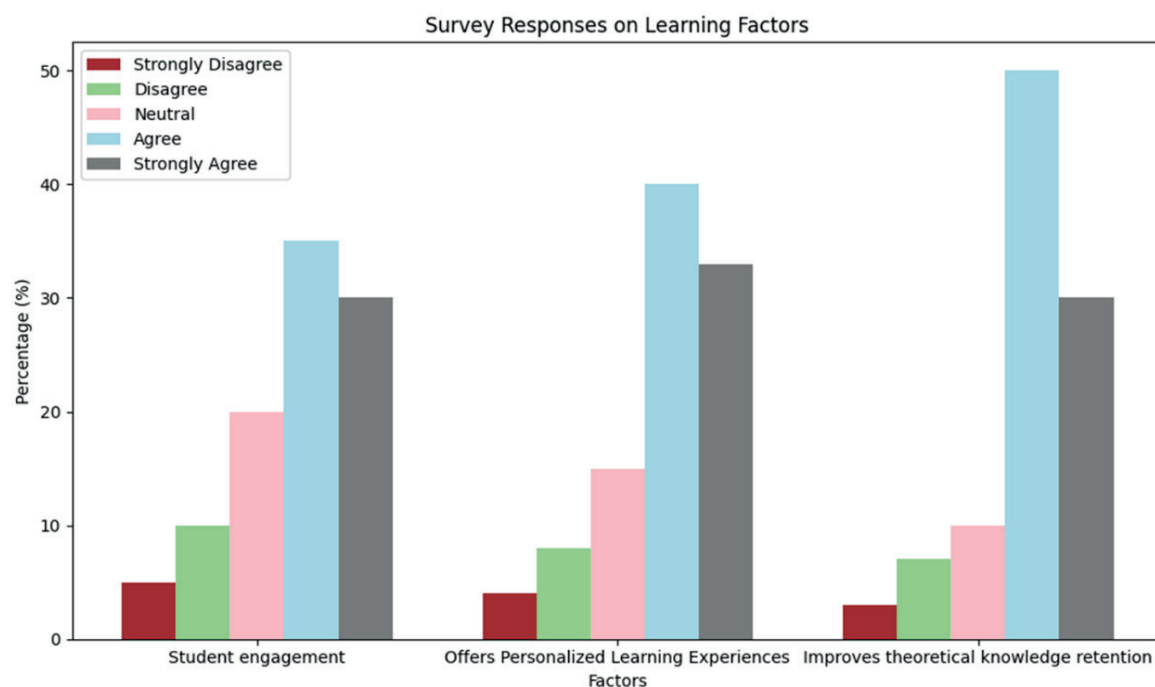
Factors	Mean (Pre)	Mean (Post)	MD	SD of Differences	t-value	Degrees of Freedom (df)	p-value
Student engagement	3,5	4,2	0,7	0,25	28	819	<0,001
Offers Personalized Learning Experiences	3,6	4,15	0,55	0,3	21,67	819	<0,001
Improves theoretical knowledge retention	3,8	4,3	0,5	0,2	35,36	819	<0,001

### Scale Analysis

The data from the Likert scale shows how participants responded to inquiries regarding GAI models in nursing education. Fewer respondents expressed disagreement or neutrality regarding student engagement, while the majority agree or strongly agree. A significant portion of participants agreed that the GAI model provides individualized learning experiences, indicating a strong positive response to this component. A lower percentage of individuals have indifferent or disagreeing opinions, and agrees that the GAI model develops improved theoretical knowledge acquisition. The comments generally indicate positive assessments of the GAI model's performance in these categories. Table 5 and figure 4 show the outcome of the Likert scale evaluation.

**Table 5.** Scale analysis for theoretical and clinical nursing education using GAI models

Factors	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Student engagement	5 %	10 %	20 %	35 %	30 %
Offers Personalized Learning Experiences	4 %	8 %	15 %	40 %	33 %
Improves theoretical knowledge retention	3 %	7 %	10 %	50 %	30 %

**Figure 4.** The outcome of the Likert scale evaluation

### Comparison of Before and After Efficiency for Nursing Education Using GAI Models

Comparing the efficiency of the GAI model before and after its implementation in nursing education shows improvements across all factors. There was an increase in student engagement from 60 % to 80 %, and offers of personalized learning experiences increased from 65 % to 87 % Improved theoretical knowledge retention increased from 70 % to 95 % after use of the GAI model. Presenting GAI models encouraged significant improvements in the engagement, personalized learning, and retention capabilities in nursing education. Table 6 and figure 5 show the outcome of the comparison of before and after efficiency for nursing education using GAI models.

Table 6. Comparison of Before and After Efficiency for Nursing Education Using GAI Models		
Factors	Before	After
Student engagement	60	80
Offers Personalized Learning Experiences	65	87
Improves theoretical knowledge retention	70	95

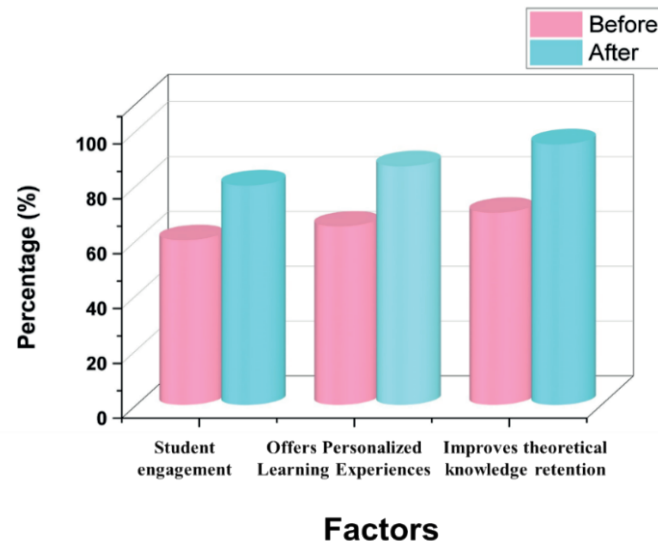


Figure 5. Outcome of comparison of before and after efficiency for nursing education using GAI models

## DISCUSSION

Evaluation of GAI techniques in theoretical and clinical nursing education from multidimensional evaluation. The findings show that GAI models have a major positive influence on nursing education, as evidenced by the interesting gains in student engagement, individualized learning, and theoretical knowledge retention. The paired t-tests' statistical importance demonstrates the data's strong support for GAI's contribution to improving the learning environments. The scale analysis supports the GAI model's favorable acceptance, especially in terms of supporting personalized learning and memory retention. These results highlight how GAI models can enhance nursing education outcomes, indicating the need for more research concerning their implementation. Prospective investigation should evaluate how GAI integration affects professional competency over a sustained period.

## CONCLUSIONS

A comprehensive evaluation of GAI models in theoretical and clinical nursing education assesses how well they promote theoretical comprehension, improve clinical abilities, and improve learning outcomes. It emphasizes how AI can be used to replicate real-world situations, offer tailored feedback, and stimulate critical thinking. The evaluation examined how AI is affecting nursing education's academic and practical components. The GAI model is to increase student engagement (from 60 % to 80 %), improvement in personalized learning (from 65 % to 87 %), and an increase in theoretical knowledge retention (from 70 % to 95 %). These enhancements demonstrate how well the GAI model performs to improve nursing education results. The drawback of the research is that it mostly concentrates on a limited amount of GAI models, which might not accurately reflect the variety of GAI technologies that are currently on the market. Furthermore, only theoretical and clinical nursing education is covered in the investigation, which means it might not be applicable to other fields. Future research should explore the use of GAI in personalized nursing education, its potential to enhance clinical decision-making and student engagement, its potential moral implications, and the extensive long-term analysis of its impact on nursing expertise and patient treatment.

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## FINANCING

None.

## CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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