Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Effectiveness of an artificial intelligence-based microlearning chatbot for medical–surgical nursing: A quasi-experimental study

Eunmin Hong
Wonkwang University, South Korea
Sujin Shin
Ewha Womans University, South Korea
Minjae Lee
leemj1992@gmail.com

Ewha Womans University, South Korea
Miji Lee
Catholic University of Pusan, South Korea

Research Article

Keywords: artificial intelligence, education, generative artificial intelligence, students, nursing

Posted Date: April 30th, 2025

DOI: https://doi.org/10.21203/rs.3.rs-6187585/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background This study explored the development and implementation of an artificial intelligence (AI)-based microlearning chatbot (A-MINC) in nursing education and evaluated its impact on learning and learners' reactions. This study aimed to provide evidence supporting its effectiveness as an educational tool for nursing students.

Methods This quasi-experimental study was conducted with 49 nursing students an experimental group (n = 24) and a control group (n = 25). Self-directed learning and academic self-efficacy were assessed using self-reported questionnaires before and after a two-week A-MINC intervention. Additionally, a focus group interview was conducted with nine participants from the experimental group who consented to qualitative data collection to assess their experiences with the intervention. Homogeneity between the intervention and control groups was tested using χ^2, Fisher exact, and independent t-tests. To evaluate the effectiveness of the A-MINC, differences in academic self-efficacy and self-directed learning ability between groups were further examined using analysis of covariance.

Results The intervention group showed greater improvements in self-directed learning than the control group ($F = 14.727$, $p < 0.001$), whereas changes in academic self-efficacy were not statistically significant ($F = 1.808$, $p = 0.185$). A qualitative analysis of focus group interviews with nine participants revealed three key themes: (1) the benefits of A-MINC usage, including personalized learning and enhanced engagement; (2) potential applications highlighting its usefulness in clinical and theoretical nursing education; and, (3) areas for improvement, such as occasional errors, the need for case-based learning, and multimedia integration.

Conclusion An A-MINC can enhance self-directed learning in nursing students within a short intervention period. These findings highlight the potential of AI chatbots in nursing education and emphasize the need for longer interventions and further refinements, such as multimedia integration and content customization, to maximize their effectiveness.

1. Introduction

Artificial Intelligence (AI) enhances adaptive learning and personalizes educational experiences by utilizing deep and machine learning algorithms on online platforms, generating useful data, and supporting advancements in higher education [1]. These applications have also been extended to nursing education, where AI-driven technologies create realistic simulations that allow students to practice clinical skills, enhance critical thinking, and prepare for real-world patient care in a safe and controlled environment [2]. One prominent use of AI in education is in chatbots, which are automated conversational systems that employ natural language processing and machine learning techniques to communicate with users via text or voice input [3].

AI-chatbots utilize natural language processing, machine learning, and deep learning to simulate human conversations, allowing them to handle complex queries and follow-up discussions, unlike traditional

chatbots, which rely primarily on predefined rules and logic [4]. AI-chatbots have been employed in various nursing education settings to address specific learning objectives and improve student outcomes. For instance, Chang et al. [5] employed a mobile chatbot-based learning approach to teach obstetric vaccination and achieved significant improvements in nursing students' learning achievements and self-efficacy. Similarly, Han et al. [6] demonstrated that an AI chatbot-based program, effectively enhanced students' interest in education and self-directed learning abilities without causing any significant differences in knowledge, clinical reasoning, or confidence. Additionally, Shorey et al. [7] implemented a virtual counseling chatbot to train nursing students in communication skills, which led to enhanced learning attitudes and self-efficacy in nursing education.

Microlearning is a self-directed teaching approach that delivers concise, focused, and interactive content asynchronously through multimodal technologies, enabling learners to access it anytime and anywhere at their convenience [8]. Microlearning involves short learning content units, typically lasting 15–30 minutes, to enhance attention and motivation while leveraging easily accessible devices such as smartphones and tablets to improve learner satisfaction [9]. According to studies that apply microlearning, the structure typically consists of three phases: introduction, development, and conclusion. The introduction phase includes activities such as pre-diagnostic quizzes and confirmation of learning objectives to motivate learners. The development phase focuses on engaging learners with questions, discussions, quizzes, and assignments related to the learning topics. Finally, the conclusion phase serves as a wrap-up, consisting of a review of the learning content and guidance for further study [10].

With the advent of digital transformation, learner-centered education utilizing various technologies has been implemented in nursing education. However, little research has been conducted on the application of AI-based chatbots for microlearning and the evaluation of their validity in actual nursing education settings. This study aims to develop and implement an AI-based microlearning chatbot (A-MINC), evaluate its impact on learning and learners’ reactions, and assess its potential as an effective educational tool for nursing education. Furthermore, this study sought to provide evidence supporting its continued use in the nursing education.

2. Methods

This study aimed to develop and implement an A-MINC, evaluate its impact on learning and learners’ reactions, and assess its potential as an effective educational tool for nursing education.

2.1. Study Design

This quasi-experimental study employed a pretest–posttest design with a comparison group. The study design and methods were validated following the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines [11], which were utilized to improve the robustness and credibility of the study’s findings. Clinical trial number is not applicable.

2.2. Participants and setting

This study targeted fourth-year nursing students in South Korea. Students who had completed courses in medical–surgical nursing and owned smart devices capable of using chatbots were included. There were no exclusion criteria for this study. The dropout criteria included withdrawal during the pre- or post-survey, completion of the pre-survey without participating in the chatbot intervention, and participation in the pre-survey and chatbot intervention but failure to complete the post-survey. Participation in the study was voluntary. Convenience sampling was used for participant recruitment. Recruitment was conducted after obtaining approval from the Institutional Review Board (IRB) of the researcher's affiliated institution. The study recruitment notice and participation link were uploaded to an online community used by nursing students. Participants voluntarily consented to the study after reviewing the study information and provided their mobile phone numbers to enroll.

The required sample size was calculated using the G*Power 3.1.9.4 program, referencing a previous study [12] that developed and validated a microlearning chatbot for novice nurses. Based on an independent samples t-test (two-tailed) with an effect size of 0.8, a significance level of .05, and a statistical power of 0.8, the required sample size was determined to be 26 participants per group, totaling 52 participants. To account for a potential dropout rate of 10%, 29 participants were recruited from each group, resulting in a total of 58 participants. Participants were sequentially numbered based on their registration order, with participants 1 to 29 and 30 to 58 assigned to the intervention and control groups, respectively.

In the experimental group, five participants dropped out (withdrew from the study without notice), leaving data from 24 participants for analysis. In the control group, four participants withdrew from the study (withdrew from the study without notice), resulting in a final sample of 25 participants. The CONSORT diagram in Figure 1 illustrates the participant screening, enrollment, and follow-up processes. Participants were recruited between August 13 and September 20, 2024, and follow-up assessments were conducted until October 18, 2024.

2.3. A-MINC generation

The research team first created a structured, hierarchical outline of medical–surgical nursing concepts focusing on the cardiovascular, respiratory, and nervous systems and then crafted targeted prompts to guide generative pre-trained transformers (GPTs) in generating diverse item formats (multiple-choice, true-false, matching, short-answer, and fill-in-the-blank). This systematic approach ensured a comprehensive coverage of essential topics while grounding questions in an authoritative curriculum.

2.3.1. Development of an outline for medical-surgical nursing

This study used a structured hierarchical approach to generate various items for medical-surgical nursing, focusing on the cardiovascular, respiratory, and nervous systems. Content outlines were developed based on current medical–surgical nursing practices to ensure the accuracy and reliability of

the generated questions. By grounding the outlines in a trusted and authoritative source, this approach ensured that the generative AI did not rely on probabilistic guesswork but instead generated questions aligned with the established curriculum and key concepts. The knowledge was categorized into primary (general topics), secondary (subtopics), and tertiary (specific details) levels to ensure that the outlines comprehensively covered essential topics.

2.3.2. Development of prompts for item generation

Prompts were crafted and integrated into the GPTs to ensure the generation of accurate and contextually relevant assessment items. These prompts were written using clear and intuitive language to minimize ambiguity and enhance the AI's interpretative accuracy and output reliability [13]. GPTs, introduced as a new feature in ChatGPT in early November 2023, are customized chatbots designed by ChatGPT users for specific purposes. GPTs are guided by progressive prompts to generate various item types [14]. Initial prompts addressed general topics and gradually transitioned to more detailed queries on specific subtopics. This approach facilitated comprehensive coverage and alignment with the educational objectives. The generated items included multiple-choice questions (MCQs), true-false items, matching questions, short-answer items, and fill-in-the-blank questions, providing diverse and interactive learning experiences for nursing students.

The prompts are divided into three main sections. The first section, the Introduction, outlines the purpose and guidelines for the AI, requiring all responses to strictly adhere to the provided content and be delivered in Korean. It emphasizes the generation of five items simultaneously, each accompanied by explanations. At this stage, participants were allowed to select the body system they wanted to study from among the cardiovascular, respiratory, and nervous systems. The second section, item writing guidelines, specified rules for item creation, including alignment with content categories, randomization of item types, and a consistent format for presenting items, answers, and explanations. Finally, the operational instructions provided detailed guidelines for interaction, including feedback on the submitted answers, offering a retry for incorrect responses, and guiding learners through an iterative problem-solving process. The prompts were designed to provide feedback on the correctness of the participants' responses and deliver brief explanations when answers were submitted to the A-MINC. Furthermore, the prompts allowed participants to request additional items on other diseases or systems, more challenging problems, or alternative item types (e.g., true/false, matching, short answers). To support reflective learning, a feature was included in the prompts to summarize the participants' learning upon completing all the items.

2.4. A-MINC implementation and evaluation

2.4.1. Procedure

The A-MINC was implemented as an online intervention for the experimental group over a two-week period, with both the intervention and the pre- and post-assessments conducted online before and after the intervention. Following the pre-assessment, participants were provided with a structured study plan

to guide their self-directed learning using the chatbot for six sessions over two weeks, with each session lasting approximately 15–30 min. To ensure adherence to the study plan, the participants shared the completion link from the A-MINC with the researcher to confirm that the planned learning sessions were carried out. The A-MINC was accessed via a URL provided to the participants to enable them to engage in the learning sessions. After completing the two-week chatbot-based self-directed learning period, a post-assessment was conducted. To ensure higher fidelity in participants' engagement with the intervention, a video tutorial explaining how to use the A-MINC and documenting their learning progress was created and shared with the participants prior to the intervention. An example screen of the A-MINC is shown in Figure 2.

For the control group, a set of six online Google quizzes was provided, which were designed to allow approximately 15–30 min of learning per session. The learning content covered the cardiovascular, respiratory, and nervous systems, similar to the content of the A-MINC. The quizzes were accessible via a URL shared with participants. These quizzes provided feedback on correct and incorrect answers but did not offer further explanations. Participants were required to complete six sessions within a two-week period and share their quiz completion records with the researcher to confirm their participation. After a two-week self-directed learning period, a post-assessment was conducted. Following the post-assessment, the control group was given access to the chatbot to allow them to experience the chatbot-based learning process. To maintain blinding, the intervention and control groups were assigned different learning periods so that the participants were unaware of their group allocation. To ensure continuous engagement and intervention fidelity, all participants recorded their learning activities in a shared Google Sheet, which was monitored in real-time by the researcher to track adherence to the study protocol and verify that the intervention was delivered as intended.

2.4.2. Data collection

Data were collected to evaluate the validity of the A-MINC using the first two levels of Kirkpatrick’s four-level evaluation model [15]: reaction (level 1) and learning (level 2). Learners’ reactions (level 1) were assessed using qualitative data, including their satisfaction and experiences with the A-MINC. Qualitative data were gathered via focus group interviews (FGI) with nine participants who voluntarily expressed their willingness to participate in the post-intervention survey. Participants were divided into two groups of four and five individuals each. Focus group interviews were conducted online via Zoom in real-time, with each session lasting approximately 60 min. To ensure participants' convenience, they were instructed to join from a quiet and distraction-free environment. The interviews explored questions such as “What were your thoughts on using the chatbot?”, “What do you think are the strengths and weaknesses of the chatbot?” and “What impact do you think the chatbot had on your learning, and how could it be effectively utilized?” The interviews were recorded with the participants’ consent, and the audio files were transcribed for analysis.

The learning evaluation (level 2) assessed academic self-efficacy and self-directed learning ability. Data were collected using self-reported online surveys administered before and after the intervention.

Participants' demographic characteristics, including sex, age, region, and prior learning experience with AI, were also collected. Academic self-efficacy was measured using a 10-item tool developed by Ayres [16] and adapted to Korean by Park and Kweon [17], with each item rated on a 7-point Likert scale; higher scores indicated higher levels of academic self-efficacy. Park and Kweon [17] reported a Cronbach's α of .95, while it was .907 in this study. Self-directed learning ability was assessed using a 20-item tool developed by Cheng et al. [18] and adapted and validated in Korean by Kwak et al. [19], with each item rated on a 5-point Likert scale; higher scores indicated greater self-directed learning ability. Kwak et al. [19] reported a Cronbach's α of .90, while it was .924 in this study.

2.5. Data analysis

Quantitative data were analyzed using SPSS 29.0. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the participants' general characteristics, academic self-efficacy, and self-directed learning ability. Homogeneity between the intervention and control groups was tested using χ^2 tests, Fisher exact tests, and independent t-tests. To evaluate the effectiveness of the A-MINC, differences in academic self-efficacy and self-directed learning ability between groups were further examined using analysis of covariance (ANCOVA), with pre-test scores treated as covariates.

Qualitative data collected through focus group interviews to evaluate the participants' reactions to the chatbot were analyzed using the inductive approach of qualitative content analysis, as outlined by Elo and Kyngäs [20]. This involved iterative reading of the data, open coding, categorization, and abstraction to identify meaningful themes.

2.6. Ethical consideration

This study was approved by the IRB of the researchers' affiliated institutions. Participants who voluntarily agreed to take part were provided with a comprehensive explanation on the first page of the online survey. This explanation outlined the study objectives, participant eligibility, research content, methods of participation, utilization of results, potential risks and benefits, procedures for withdrawing consent, compensation for any potential harm, and measures for protecting and storing personal information. As a token of appreciation, participants were given a small reward for their involvement. The IRB granted an exemption from the requirement for written consent; instead, participants provided informed consent online before beginning the survey. Qualitative data recorded during the study were anonymized and coded to ensure confidentiality, and audio recordings were deleted immediately after transcription to eliminate any potential for identifying participants.

3. Results

3.1. Homogeneity test on general characteristics and dependent variables

The participants were predominantly women; the average age of the participants was 22.8 and 23.7 years in the intervention and control groups, respectively. Most respondents from both groups reported their academic achievement as medium. Approximately 70% of the participants had no experience using AI-based learning tools or experience learning with chatbots. Homogeneity tests of the participants' general characteristics revealed no significant differences between the intervention and control groups. Additionally, tests for the homogeneity of baseline scores revealed no significant differences between the two groups in terms of self-directed learning or academic self-efficacy, thus confirming the homogeneity of the dependent variables between the groups.

Table 1. Homogeneity test on general characteristics and dependent variables(N=49)

Variables	Exp. (n=24)		Cont. (n=25)		x^2 /t/Z	*p*
	n	(%) or Mean ± SD	n	(%) or Mean ± SD		
Gender						
Female	24	(100.0)	20	(80.0)		
Male	0	(0.0)	5	(20.0)		
Age (years)	22.75±1.40		23.36±2.06		-1.210	.232
Academic achievement						
High	8	(33.3)	10	(40.0)	3.346	.188
Medium	13	(54.2)	15	(60.0)		
Low	3	(12.5)	0	(0.0)		
Experience using AI-based learning tools						
Yes	6	(25.0)	8	(32.0)	0.294	.588
No	18	(75.0)	17	(68.0)		
Experience learning with chatbots						
Yes	6	(25.0)	9	(36.0)	0.698	.404
No	18	(75.0)	16	(64.0)		
Self-directed learning	79.96±8.77		79.28±6.70		0.305	.381
Academic self-efficacy	56.79±7.87		57.40±4.39		-0.336	.369
Exp.=experimental group; Cont.=control group						

3.2. Effects of A-MINC for Medical–Surgical Nursing

Following the intervention, both self-directed learning and academic self-efficacy improved compared with pre-intervention levels, with greater improvements observed in the intervention group than those in the control group. Pre- and post-intervention scores for self-directed learning were 80.0±8.8 and 86.7±8.3 for the intervention group, and 79.3±6.7 and 80.8±5.6 for the control group, respectively. For academic self-efficacy, scores were 56.8±7.9 and 63.8±6.1 for the intervention group, and 57.4±4.3 and 59.2±3.4 for the control group, respectively. Furthermore, there was a statistically significant difference in the change in self-directed learning scores between the two groups (F = 14.727, $p < 0.001$). However, the change in academic self-efficacy scores was not significantly different between the groups (F = 1.808, $p = 0.185$).

Table 2. Effects of AI-based Microlearning Chatbot for Medical-Surgical Nursing(N=49)

Variables	Groups	Pretest	Posttest	F(*p*)
		Mean ± SD		
Self-directed Learning	Exp. (n=24)	79.96±8.77	86.71±8.26	14.727(<.001)
	Cont. (n=25)	79.28±6.70	80.84±5.57	
Academic Self-efficacy	Exp. (n=24)	56.79±7.87	63.83±6.08	1.808(.185)
	Cont. (n=25)	57.40±4.29	59.20±3.44	
Exp.=experimental group; Cont.=control group				

3.3. Experience Using an A-MINC

This study involved nine nursing students who voluntarily expressed their willingness to participate in qualitative data collection during the post-intervention survey. Focus group interviews were conducted with these participants, who were divided into two groups comprising four and five individuals, to explore their experiences and perspectives on using A-MINC as a learning tool. The analysis revealed three main themes: the benefits of A-MINC usage, its potential applications, and areas for improvement.

Theme 1. Benefits of A-MINC Usage

The participants highlighted several advantages of using chatbots for learning. The chatbot provided customized explanations for incorrect answers, tailored items based on specific diseases, and allowed adjustments to item difficulty. It facilitated repetitive practice, focused on essential concepts, and offered unique questions not found in textbooks or workbooks.

“When I asked about a specific disease, it only focused on items related to that disease, which felt tailored to me.”

“It was helpful when I could ask for more difficult items or request easier ones if they felt too difficult.”

“The items often focused on important points, making it easier to organize key concepts.”

“Unlike textbooks or workbooks, it provided fresh, useful items I hadn't seen before.”

Theme 2. Potential Applications

The participants noted the potential of the A-MINC to enhance clinical and theoretical nursing education. They highlighted their ability to assist new nurses in prioritizing patient care, understanding clinical equipment, and identifying high-priority topics for exams.

“It seems like it could help new nurses learn to prioritize care while dealing with multiple choices.”

“When studying oxygen therapy, I asked about the types and benefits of different methods. The chatbot explained that commonly used clinical equipment would be useful for learning about new machines or tools.”

“New nurses often have many questions and find it challenging to search for answers in books. The chatbot allows for immediate inquiries, making it easier to understand and apply knowledge.”

“Having integrated questions that combine concepts into a single clinical scenario would be helpful for applying knowledge in practice.”

Theme 3. Areas for Improvement

Although participants found the A-MINC helpful, they also identified areas for improvement. These include occasional errors in marking incorrect answers as correct, limitations of the free version of GPTs’, and the need for case-based questions and multimedia integration.

“Sometimes incorrect answers were marked as correct, and I realized I could misunderstand concepts if I did not check the explanations carefully.”

“I wanted to summarize what I learned and review, but the free version ended before I could do that.”

“It would be great if it included more case-based items that simulate real-life scenarios, such as prioritization or identifying the most important assessment at a given moment.”

“Using videos or real photos can make studying more effective, especially with AI-based tools.”

4. Discussion

The implementation of the A-MINC significantly enhanced the self-directed learning abilities of senior nursing students without affecting their academic self-efficacy. Participants in the intervention group demonstrated improved learning outcomes compared to those in the control group, highlighting the chatbot's potential as an effective educational tool in nursing education. These findings suggest that integrating AI technology into nursing education can significantly improve students’ academic skills.

The A-MINC developed in this study effectively enhanced nursing students' self-directed learning abilities. This result is similar to that of a previous study [6] that found that self-directed learning abilities improved after providing educational programs to nursing students using an AI chatbot. The chatbot's ability to provide timely learning and respond immediately to diverse questions contributes to the enhancement of self-directed learning. This is further augmented by the flexibility it offers learners to study anytime and anywhere by utilizing various tools such as mobile devices or PCs [21]. Furthermore, the microlearning format enables short learning sessions of 15–30 min, which helps maintain focus and motivation, thereby enhancing the autonomy and flexibility of learning [9].

This platform, based on an AI chatbot, supports personalized learning through immediate responses and interactions, promoting self-directed learning [22]. The results of the FGI in this study also confirmed that the chatbot was helpful in improving self-directed learning abilities. Participants noted that the chatbot could be used easily without the need to memorize complex rules and could be used repeatedly for learning. They appreciated the customized explanations provided for incorrect answers and the opportunity to ask detailed follow-up questions if explanations were difficult to understand. Additionally, the chatbot allowed learners to adjust topics, item types, and difficulty levels, which were considered significant advantages. Learners could tackle new problems not commonly found in textbooks and ask questions freely, which is particularly useful in an online environment, where there may be less fear when asking questions. An AI-based chatbot also provides a comfortable environment for asking questions anytime and anywhere, thus reducing the psychological burden associated with asking questions online [23, 24]. These results suggest that chatbots effectively enhance self-directed learning abilities by providing a tailored learning environment and psychological comfort.

However, this study found no statistically significant effect of the A-MINC chatbot on academic self-efficacy. Self-efficacy is generally formed through successful experiences and does not change easily over a short period; it tends to develop gradually over time [25]. The intervention in this study was conducted over a period of two weeks, after which the effects were evaluated. Given the relatively short duration of the intervention and the focus on assessing only the short-term effects, further research is necessary to evaluate the long-term effects of A-MINC. Additionally, the results from the FGI indicated that, while using the free version of the chatbot, despite the desire to learn more, learning was limited owing to restrictions on the number of responses provided by the AI. Considering these issues, it is essential to provide learners with opportunities to learn as much as they want, at any time.

This study had several limitations that must be acknowledged while interpreting its findings. First, the intervention did not demonstrate a significant impact on the academic self-efficacy of nursing students, indicating a potential area for further refinement of the chatbot's capabilities. Additionally, the study had a relatively small sample size and lacked demographic diversity, which may limit the generalizability of the results to a broader nursing student population. Furthermore, learning outcomes were assessed shortly after the intervention, raising concerns about the long-term sustainability of the observed improvements in self-directed learning. Considering these findings, further research incorporating a larger and more demographically diverse sample is warranted to fully understand the potential benefits

across different populations. Enhancements to chatbots such as the integration of multimedia elements and content tailored to the specific tasks of novice nurses along with a broader range of case-based items could potentially amplify the effectiveness and applicability of AI-based learning tools in real-world nursing education settings. Case-based questions allow learners to engage in experiences that mirror actual nursing practice and foster their ability to anticipate and prevent patient issues by developing clinical judgment skills. These modifications aim to provide a more robust and immersive learning experience, thereby comprehensively supporting the development of critical nursing competencies.

5. Conclusion

This study provides preliminary evidence that an A-MINC can enhance self-directed learning among nursing students, although it does not significantly affect their academic self-efficacy within a short intervention period. These findings underscore the potential of AI chatbots in nursing education, particularly for promoting self-directed learning through interactive and personalized content. However, its limited impact on academic self-efficacy suggests that long-term interventions and further enhancements, such as multimedia integration and content customization, may be necessary to fully leverage the benefits of AI in educational settings. Future studies with extended durations and diverse demographic samples are essential to validate these findings and refine the chatbot's functionality to better meet the learning needs of nursing students.

Abbreviations

AI : Artificial Intelligence

A-MINC : artificial intelligence-based microlearning chatbot

FGI : focus group interviews

IRB : Institutional Review Board

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki. It was reviewed and approved by the Institutional Review Board of Ewha Womans University (approval number: ewha-202407-0014-01, dated July 16, 2024). All participants provided informed consent online before participating in the study, and the requirement for written consent was waived by the IRB.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2023R1A2C2006838).

Authors' contributions

EM performed conceptualization, data collection and analysis, writing, reviewing and editing. SJ performed the funding acquisition, project administration and supervision, reviewing and editing. MJ (Corresponding author) performed conceptualization, data collection and analysis, writing, reviewing and editing. MJ performed the data collection, reviewing and editing.

Acknowledgements

Not applicable

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. Bozkurt A, Karadeniz A, Baneres D, Guerrero-Roldán AE, Rodríguez ME. Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. Sustainability. 2021;13(2):800. https://doi.org/10.3390/su13020800.
2. De Gagne J. The state of artificial intelligence in nursing education: Past, present, and future directions. Int J Environ Res Public Health. 2023;20(6):4884. https://doi:10.3390/ijerph20064884.
3. Adamopoulou E, Moussiades L, Chatbots. History, technology, and applications. Mach Learn Appl. 2020;2:100006. https://doi.org/10.1016/j.mlwa.2020.100006.
4. Tam W, Huynh T, Tang A, Luong S, Khatri Y, Zhou W. Nursing education in the age of artificial intelligence powered Chatbots (AI-Chatbots): Are we ready yet? Nurse Educ Today. 2023;129:105917. https://doi.org/10.1016/j.nedt.2023.105917.
5. Chang CY, Hwang GJ, Gau ML. Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training. Br J Educ Technol. 2022;53(1):171–88. https://doi.org/10.1111/bjet.13158.
6. Han JW, Park J, Lee H. Analysis of the effect of an artificial intelligence chatbot educational program on non-face-to-face classes: A quasi-experimental study. BMC Med Educ. 2022;22(1):830.

https://doi.org/10.1186/s12909-022-03898-3.

7. Shorey S, Ang EN, Ng ED, Yap J, Lau LS, Chui CK, Chan YH. Evaluating a theory-based virtual counseling application in nursing education. CIN: Comput Inf Nurs. 2023;41(6):385–93. https://doi.org/10.1097/CIN.0000000000000999.
8. Cronin J, Durham ML, Microlearning. A concept analysis. CIN: Comput Inf Nurs. 2023;10:10–1097. https://doi.org/10.1097/CIN.0000000000001122.
9. Buchem I, Hamelmann H, Microlearning. A strategy for ongoing professional development. eLearning Papers. 2010;21(7):1–15.
10. Cho HJ, Kang K, Lee SH, Park KY. Application of microlearning to education: A systematic review. J Next-Gen Converg Technol Assoc. 2022;6(7):1243–55. https://doi.org/10.33097/JNCTA.2022.06.07.1243.
11. Des Jarlais DC, Lyles C, Crepaz N, Trend Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. Am J Public Health. 2004;94(3):361–6. https://doi.org/10.2105/ajph.94.3.361.
12. Kim AR, Park AY, Song S, Hong JH, Kim K. A microlearning-based self-directed learning chatbot on medication administration for new nurses: A feasibility study. CIN: Comput Inf Nurs. 2024;42(5):343–53. https://doi.org/10.1097/CIN.0000000000001119.
13. Choi J. Promplish [CAFA Training Module]. CAFA Laboratory, Inc.; 2024.
14. OpenAI, Introducing GPTs OAI. 2023 [cited 2024 Feb 7]. Available from: https://openai.com/index/introducing-gpts/
15. Kirkpatrick DL, Kirkpatrick JD. Evaluating Training Programs. Oakland (CA): Berrett-Koehler; 2006.
16. Ayres HW. Factors related to motivation to learn and motivation to transfer learning in a nursing population [Doctoral dissertation]. Raleigh (NC): North Carolina State University; 2005.
17. Park SY, Kweon YR. The effect of using standardized patients in psychiatric nursing practical training for nursing college students. J Korean Acad Psychiatr Ment Health Nurs. 2012;21(1):79–88.
18. Cheng SF, Kuo CL, Lin KC, Lee-Hsieh J. Development and preliminary testing of a self-rating instrument to measure self-directed learning ability of nursing students. Int J Nurs Stud. 2010;47(9):1152–8. https://doi.org/10.1016/j.ijnurstu.2010.02.002.
19. Kwak EM, Lee JY, Woo JJ. A study on the reliability and validity of the Korean version of self-directed learning instrument. Korean J Fundam Nurs. 2019;26(1):12–22. https://doi.org/10.7739/jkafn.2019.26.1.12.
20. Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs. 2008;62(1):107–15. https://doi.org/10.1111/j.1365-2648.2007.04569.x.
21. Hwang HS. Development of chatbot for elementary social studies micro-learning. Korean Soc Stud Assoc. 2021;60(3):81–104.
22. Chae J, Kim MY, Ryu K, You YM, Shin YH. Analysis of an AI-based chatbot platform for personalized learning. J Digit Contents Soc. 2024;25(4):1053–68.

23. Munangatire T, Indjamba L. Learning engagement; nursing students' experiences in an online environment at a university. Nurs Open. 2023;10(5):3145–52. https://doi.org/10.1002/nop2.1564.
24. O'Connor S. Nursing students' engagement in online learning. Br J Nurs. 2024;33(13):630–4. https://doi.org/10.12968/bjon.2023.0161.
25. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychol Rev. 1977;84(2):191–215. https://doi.org/10.1037/0033-295X.84.2.191.

Figures

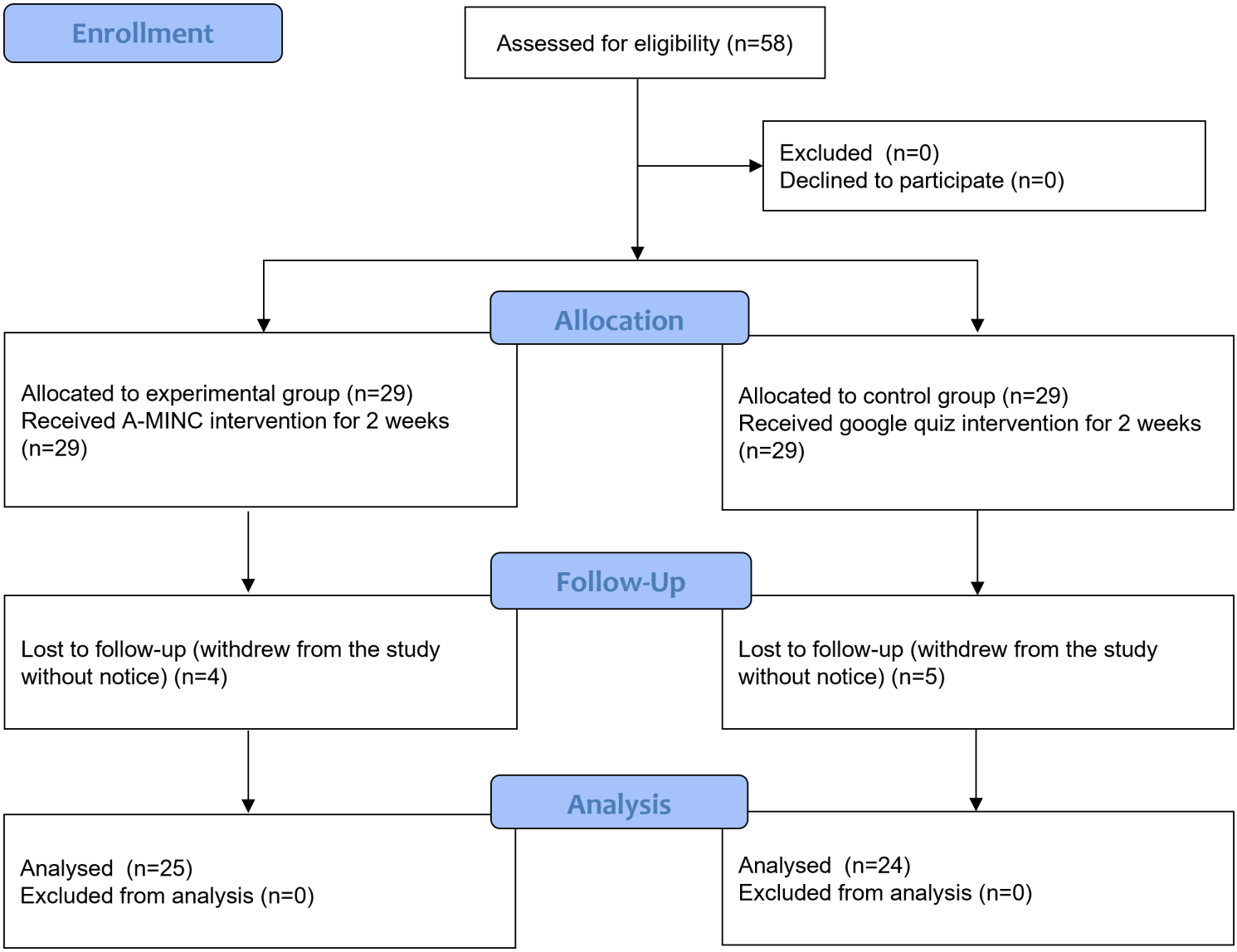


Figure 1

Study flow diagram

Abbreviation: A-MINC, artificial intelligence-based microlearning chatbot

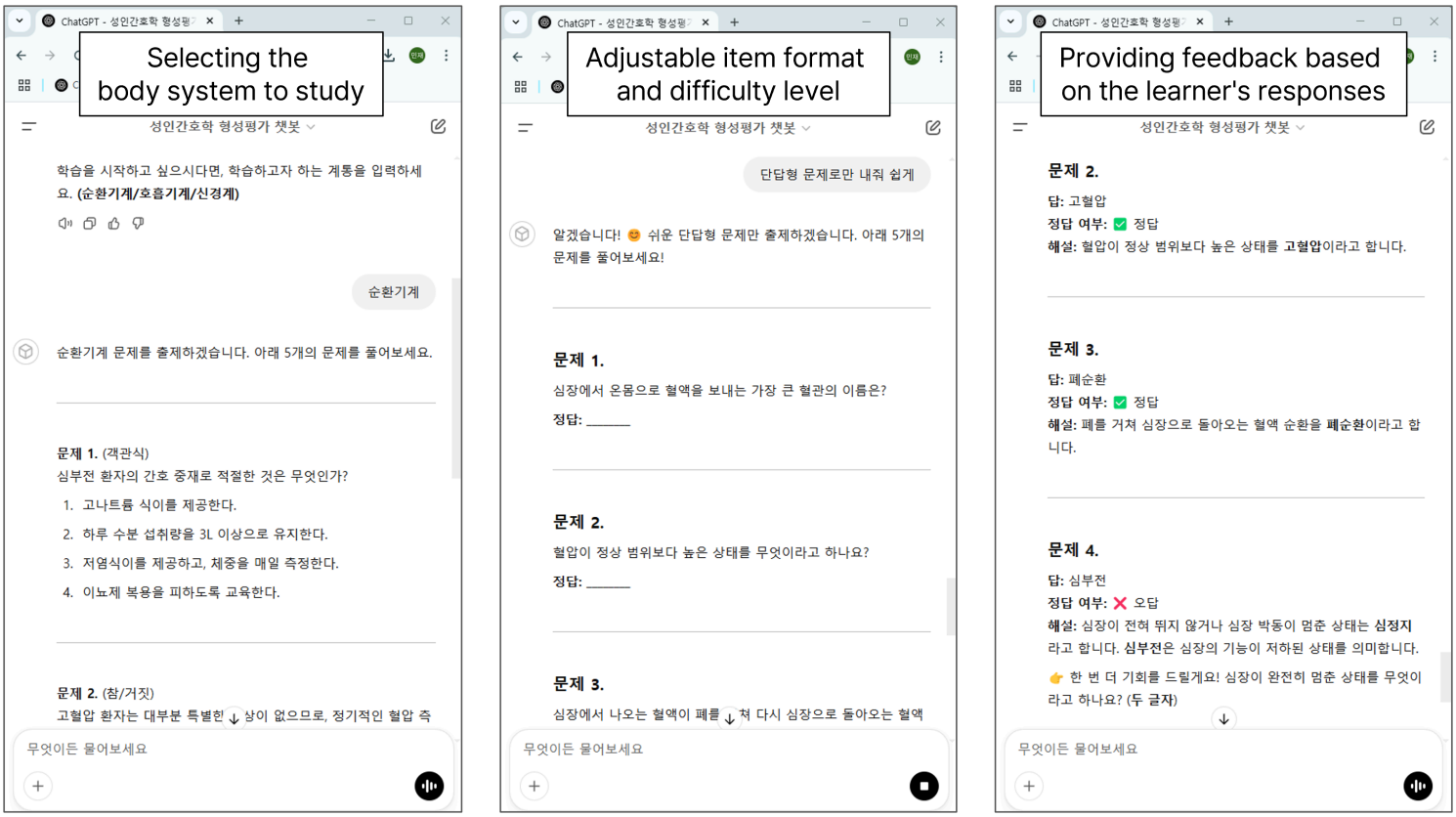


Figure 2

Screen example of artificial intelligence-based microlearning chatbot