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Integrating Generative AI into Escape Room-Based Learning: Effects on Nursing Students' Clinical Skills, Flow Experience, and Self-Efficacy

Intan SETIANI[a*], Ching Yi CHANG[b], Riska SAPUTRA[c] & Jie Chi YANG[a,d]
[a]*Graduate Institute of Network Learning Technology, National Central University, Taiwan*
[b]*School of Nursing, College of Nursing, Taipei Medical University, Taiwan*
[c]*Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan*
[d]*Research Center for Science and Technology for Learning, National Central University, Taiwan*
*intansetianis97@gmail.com

Abstract: This study investigates the impact of integrating Generative Artificial Intelligence (GenAI) into escape room-based learning on nursing students' clinical skills, flow experience, and self-efficacy. While escape rooms have proven effective in promoting collaboration and critical thinking in nursing education, their linear structure may limit personalized support. Conversely, GenAI tools such as ChatGPT offer adaptive feedback and individualized guidance but lack the immersive engagement of game-based learning. To address this, we designed a quasi-experimental study involving 47 first-year nursing students from a university in Taiwan. Participants were assigned to either an experimental group (AI-assisted escape room) or a control group (video-based learning). A four weeks, both groups engaged in sessions focused on breastfeeding skills, with pre- and post-intervention assessments administered using validated instruments. The results revealed statistically significant improvements in clinical performance, self-efficacy, and flow experience for the AI-assisted group compared to the control. These findings suggest that combining GenAI with escape room strategies creates a synergistic learning environment that enhances both cognitive and affective outcomes in nursing education. The study highlights the potential of AI-supported Escape Room learning to foster student-centered, competency-driven instructional models.

Keywords: Generative AI (GenAI), Escape Room, Clinical Skills, Nursing Education, Self-Efficacy, Flow Experience.

1. Introduction

In recent years, nursing education has undergone a paradigm shift towards more interactive, student-centred, and competency-based pedagogies. Among these, educational escape rooms have emerged as innovative game-based learning environments that promote collaboration, critical thinking, and motivation (Arrue et al., 2025; González-de laTorre, 2024). Unlike traditional case-based methods, escape rooms immerse learners in problem-solving scenarios under time constraints, fostering engagement and enhancing declarative knowledge. Nevertheless, such high-pressure environments can also elevate anxiety levels, and the direct correlation between enjoyment and knowledge acquisition remains ambiguous (Arrue et al., 2025).

Generative AI tools like ChatGPT are increasingly used in health education, offering adaptive, on-demand support for clarifying concepts, providing personalized feedback, and enhancing decision-making (El Arab et al., 2025; Han et al, 2025). Despite their growing utility, concerns regarding over-reliance, trust, and ethical considerations remain prevalent (Ramírez-Baraldes et al., 2025).

However, the integration of GenAI with escape room-based learning is still largely unexplored. Escape rooms foster motivation and knowledge acquisition but have fixed

learning paths, while GenAI offers personalized, real-time support without the immersive collaboration of physical spaces. Combining them could create a synergistic learning framework addressing cognitive, affective, and metacognitive aspects. Flow experience and self-efficacy are key to educational success, and enhancing AI-related self-efficacy requires not only AI literacy but also positive attitudes, practical application, and genuine interest in the technology. Bewersdorff et al. (2025) point out that to boost students' belief in their ability to use AI (self-efficacy), educational strategies must not only cover AI literacy but also concentrate on nurturing their attitudes towards AI, their practical application of it, and their overall interest in the technology.

This study aims to investigate the effects of integrating generative artificial intelligence (GenAI) into escape room-based learning on nursing students' clinical skills performance, flow experience, and self-efficacy, by comparing outcomes between an experimental group (escape room with GenAI support) and a control group (video-based learning). A quantitative approach using validated instruments will be employed to measure differences between the two groups.

- To what extent does the integration of GenAI into escape room-based learning enhance clinical skills performance among nursing students compared to video-based learning?
- Does the use of GenAI within an escape room setting improve nursing students' self-efficacy more significantly than traditional video-based instruction?
- How does the flow experience differ between nursing students engaged in GenAI-assisted escape room learning and those in a video-based learning environment?

2. Methods

2.1 Participants

The study involved 47 first-year nursing students from a university in northern Taiwan, randomly assigned to an experimental group (n=24, AI-assisted escape room) or a control group (n=23, video-based learning). Ethical approval was granted by the university's Institutional Review Board (IRB). Using a quasi-experimental design within a structured four-week instructional period, pretests, posttests, and questionnaires were administered one week before and after the intervention. Both groups completed these assessments simultaneously and within the same intervals.

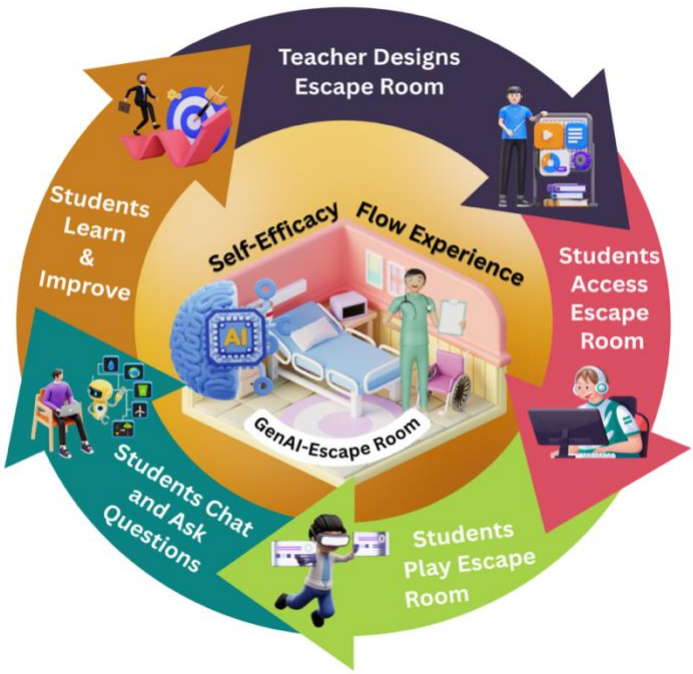

Figure 1. Experimental Design

2.2 Experimental Procedure

This study implemented a generative AI-assisted training intervention in a maternity nursing course through an Escape Room environment on the ZEP platform. The process began with the teacher designing a tailored escape room for nursing education, followed by students participating in the challenge. Generative AI was integrated to allow real-time interaction, enabling students to ask questions and receive clarification while solving puzzles and tasks. This combination aimed to enhance clinical skills, promote deep engagement or "flow," and increase self-efficacy. Before the intervention, the syllabus and learning goals were shared, and all participants completed a pretest along with self-efficacy and flow questionnaires. Participants were then randomly assigned to either the experimental group (AI-assisted Escape Room) or the control group (video-based learning).

The experimental group engaged in the AI-supported Escape Room, designed to foster learner independence and active participation, while the control group used traditional classroom methods, watching instructional videos and completing worksheets without AI or interactive tools. Both groups met once a week for four weeks, with each session lasting 100 minutes. After completing the sessions, participants took a post-test and repeated the questionnaires to measure any changes in clinical skills, self-efficacy, and flow experience. The study's main objective was to determine whether AI-supported Escape Rooms could yield greater improvements compared to traditional instruction.

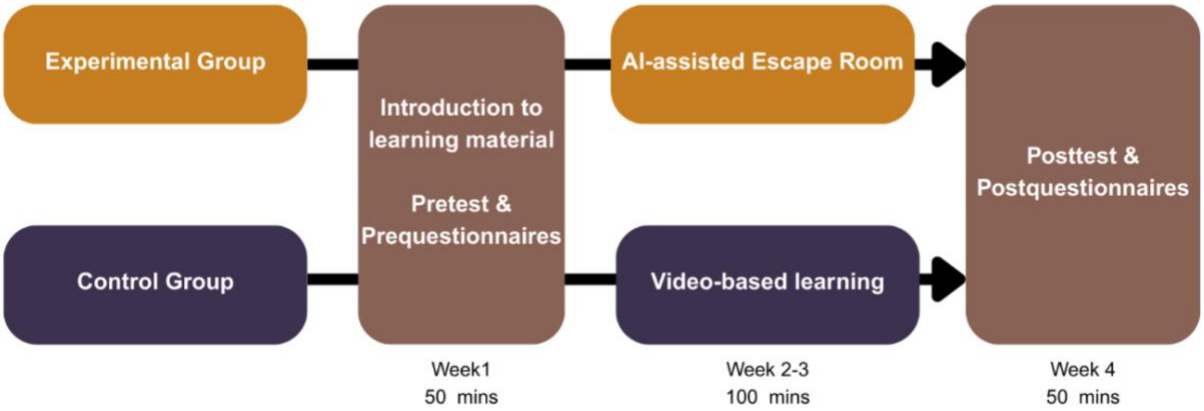

Figure 2. Experimental Procedure

2.3 Instruments and Data Analysis

In this study, we used 20-item multiple-choice clinical skills test, an eight-item self-efficacy questionnaire adapted from Pintrich et al. (1991), and an eight-item flow experience scale by Pearce et al. (2005). All items were rated on a 5-point Likert scale and demonstrated good reliability (Cronbach's alpha = .79–.88). Data analysis was performed in IBM SPSS 27 using descriptive statistics and nonparametric tests due to the small sample size. Mann–Whitney U tests compared pretest and posttest results for both groups. While no significant differences appeared at pretest, posttest results showed significant improvements in the experimental group's clinical skills, self-efficacy, and flow, confirming the effectiveness of the AI-assisted Escape Room intervention.

3. Results

3.1 Clinical Skills Achievement

The descriptive statistics showed that the AI-assisted Escape Room group had a pretest mean score of 78.96 (SD = 10.68) and a posttest mean score of 84.68 (SD = 8.43), while the video-based learning group had similar central tendencies. To compare the two groups, a Mann–Whitney U test was performed. The Mann–Whitney U test on the pretest scores for learning

achievement showed that there was no significant difference between the AI-assisted Escape Room (Mean rank = 25.58) and the video-based learning group (Mean rank = 22.35), U = 238.00, Z = −.821, p = .412. This indicates that both groups had comparable levels of achievement prior to the intervention. However, the posttest results revealed a statistically significant difference in learning achievement between the two groups. The AI-assisted Escape Room group (Mean rank = 29.85) significantly outperformed the video-based learning group (Mean rank = 17.89), U = 135.50, Z = −3.04, p < .01. These findings suggest that the use of AI-assisted Escape Room led to a significant improvement in students' post-intervention learning performance compared to the conventional video-based approach.

Table 1. *Mann-Whitney U test results for Clinical skills*

Variable	Groups	*N*	Mean rank	*Sum of ranks*	*U*	Z value
Clinical skills	Experimental group	24	29.85	716.50	135	-3.04**
	Control group	23	17.89	411.50		

p < .01**

3.2 Self-efficacy

Table 2. *Mann-Whitney U test results for self-efficacy*

Variable	Groups	*N*	Mean rank	*Sum of ranks*	*U*	Z value
Self-efficacy	Experimental group	24	30.83	740.00	112	-3.70***
	Control group	23	16.87	388.00		

p < .001***

The Mann–Whitney U test on the pretest scores for self-efficacy showed no significant difference between the AI-assisted Escape Room group (Mean rank = 24.94) and the video-based learning group (Mean rank = 23.02), U = 253.50, Z = −0.53, p = .599, indicating comparable self-efficacy levels before the intervention. In contrast, the posttest results revealed a statistically significant difference, with the AI-assisted Escape Room group (Mean rank = 30.83) scoring higher than the video-based learning group (Mean rank = 16.87), U = 112.00, Z = −3.70, p < .001. These findings demonstrate that integrating AI with Escape Room-based learning significantly enhanced students' self-efficacy in the experimental group.

3.3 Flow-experience

The Mann–Whitney U test on pretest scores for flow experience indicated no significant difference between the AI-assisted Escape Room group (Mean rank = 23.35) and the video-based learning group (Mean rank = 24.67), U = 260.50, Z = −0.36, p = .723, confirming that both groups had comparable flow levels before the intervention. In contrast, posttest results revealed a significant difference, with the AI-assisted Escape Room group (Mean rank = 31.69) reporting higher flow experience than the video-based group (Mean rank = 15.98), U = 91.50, Z = −4.07, p < .001. These findings suggest that the AI-assisted Escape Room strategy effectively enhanced students' flow experience during learning.

Table 3. *Mann-Whitney U test results for flow-experience*

Variable	Groups	*N*	Mean rank	*Sum of ranks*	*U*	Z value
Flow-experience	Experimental group	24	31.70	760.50	91	-4.07***
	Control group	23	15.98	367.50		

p < .001***

4. Discussion and Conclusions

This study concludes that integrating Generative AI into Escape Room-based learning significantly enhances nursing students' clinical skills, flow experience, and self-efficacy. By

merging immersive, collaborative, real-time feedback, the AI-assisted Escape Room fosters deeper cognitive engagement and greater learner autonomy than traditional video-based instruction. This student-centered, competency-based approach supports both skill acquisition and confidence in clinical decision-making. The significant gains in clinical performance among students in the experimental group extend the findings of Aktaş et al. (2024) and Gómez-Urquiza (2022), demonstrating that Generative AI amplifies the educational benefits of Escape Rooms through personalized scaffolding and timely clarification.

Building on this, a particularly noteworthy finding is the enhancement of both self-efficacy and flow experience among students in the AI-assisted group. Generative AI tools, such as ChatGPT, enabled students to receive immediate, context-sensitive responses to their queries during problem-solving tasks, contributing to a sense of control, competence, and emotional engagement. This suggests that the integration of AI can help learners navigate complex clinical scenarios with increased confidence, particularly when traditional game-based learning lacks individualized support. These results align with the research of Bouriami et al. (2025), Chang et al. (2024), Chen et al. (2025), and Marinho et al. (2025), who highlight the importance of personalization, cognitive-emotional balance, and immersive challenge-based learning in developing learner motivation. Furthermore, the AI layer addresses a key limitation of traditional Escape Rooms—their fixed structure—by introducing adaptive pathways that maintain difficulty while preventing cognitive overload (Hong et al., 2025; Wang et al., 2025). Thus, the integration of GenAI does not diminish student agency; rather, it enhances it by offering just-in-time support that preserves critical thinking and collaboration.

Despite these promising outcomes, several considerations must be addressed for future implementation. A key concern is the potential over-reliance on AI, which may diminish students' independent reasoning and self-regulation over time. As cautioned by Fan et al. (2025) and Gerdes et al. (2025), treating AI as a shortcut rather than a supportive tool could undermine critical thinking skills. Thus, instructional design should balance assistance with cognitive challenge to ensure sustained student engagement, while educators play a vital role in fostering ethical and responsible AI use. Although the quasi-experimental design and validated instruments strengthen the study's internal validity, its generalizability is limited by the single-institution context and modest sample size. Future research should involve more diverse populations and examine long-term effects, such as knowledge retention, real-world skill transfer, and ethical AI literacy development.

Based on these results, nursing educators and curriculum developers are encouraged to incorporate Generative AI tools into interactive learning models such as Escape Rooms. Well-designed AI-enhanced environments can support both personalized learning and collaborative skill development. Future research should investigate how AI-assisted Escape Room influences clinical performance across diverse topics and settings, while also examining learners' ethical awareness, emotional resilience, and sustained engagement. This will help ensure that AI-integrated pedagogies enhance learning outcomes while preserving professional competence, autonomy, and ethical technology use in nursing education.

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