Structured abstract

Background: While widely studied in traditional simulations, research on debriefing practices in educational escape rooms remains sparse. Escape rooms offer immersive, interactive environments that emphasize collaboration and quick decision-making, necessitating tailored debriefing strategies to optimize their educational potential.

Methods: 69 first-semester nursing students randomly participated in the study and were randomly grouped into 32 teams. Transcripts of facilitator-student interactions were coded using Dreifuerst's (2009) debriefing framework, expanded with new categories relevant to the escape room context. Sequential pattern mining was applied to identify patterns in the instructors' debriefing sequences.

Results: Demonstration (26.3%), reflection (21.6%), and prompting (20.1%) were the most frequent debriefing strategies, while emotion and assimilation were infrequent. Salient sequential patterns included [reflection → integration → prompting], emphasizing knowledge scaffolding and guided decision-making.

Conclusion: Educational escape rooms demand adaptive debriefing approaches that blend traditional and game-specific methods. The study findings inform the design of flexible debriefing frameworks to enhance learning outcomes in escape room simulations for nursing education.

Highlights (3-5 bullet points)

- Reflection consistently initiated debriefing, followed by instruction, integration, or reception to foster clinical reasoning.
- Immediate debriefing in the escape rooms helped bridge simulation activities with practical nursing skills.
- Escape rooms require unique debriefing methods to align with their dynamic, collaborative nature.

Key points (3 statements)

1. This study identified consistent debriefing patterns in nursing simulations, starting with reflection and progressing through instruction, integration, or reception to enhance clinical reasoning.
2. Tailoring debriefing strategies to simulation contexts and learner profiles can optimize learning outcomes, particularly in dynamic formats like escape rooms.
3. Future research should explore the unique role of debriefing in escape rooms and compare strategies across varied scenarios to inform evidence-based practices.

Keywords

educational escape room, debrief, prelicensure nursing students

Introduction

Debriefing is an essential component of clinical simulations, enabling students to critically reflect on their actions and thought processes. The National Council of State Boards of Nursing (NCSBN) emphasizes the effectiveness of simulation-based learning, demonstrating that up to 50 percent of traditional clinical experiences can be replaced with high-quality simulations that include structured debriefing sessions led by trained facilitators (Hayden et al., 2014). This is especially relevant given the increasing reliance on simulations in modern nursing education and the growing recognition of simulation's educational value (Cannon-Diehl, 2009; Duff et al., 2024). Facilitated debriefing is widely regarded as the most valuable part of simulation-based learning, with studies indicating that up to 94 percent of students find it the most beneficial component (Gordon & Buckley, 2009).

The International Nursing Association for Clinical Simulation and Learning (INACSL) has established Standards of Best Practice for Simulation, detailing guidelines for debriefing. These emphasize guided reflection, wherein facilitators help students bridge their experiences and understanding through reflective discussions (Decker et al., 2013). Debriefing differs from feedback and reflection by offering a structured process that reconstructs experiences, promotes pattern recognition, and fosters cognitive inference (Wotton et al., 2010). Facilitators engage students in discussing clinical scenarios, prompting them to evaluate reasoning, analyze actions, and build mental models, aligning with Fanning and Gaba's (2007) description of debriefing as a structured dialogue facilitating sense-making.

Despite its established importance, focused research on debriefing practices in nursing education remains mostly on the environment or the comparison among methods of debriefing (Dufrene & Young, 2014; Turner et al., 2024). For instance, Lee et al. (2020) highlighted the need for more nuanced studies to determine the effectiveness of specific debriefing methods across varied learning objectives, learner types, and contexts. While debriefing methods vary—from self-reflection to facilitator-led discussions—with more than 10 debriefing models in INACSL standards (INACSL Standards Committee, 2021), their application in escape rooms, an emerging learning experience design, requires further investigation. Extant research on educational escape room reported the usage of Promoting Excellence and Reflective Learning in Simulation (PEARLS) (Boggs et al., 2024; Choi et al., 2022; Sarage et al., 2021), modified Plus-Delta method (Connelly et al, 2018), INASCL guidelines and Debriefing for Meaningful Learning techniques (Reed & Ferdig, 2021), and the gather-analyze-summarize (GAS) model (Millsaps et al., 2022) without adaptation.

Educational escape rooms, a novel form of clinical simulation, offer an interactive and immersive environment emphasizing collaboration, problem-solving, and time-sensitive decision-making (Kim et al., 2024; Seymour et al., 2023). These attributes mirror competencies required in clinical settings, such as teamwork, communication, and adaptability. However, research focused on debriefing practices in escape rooms is sparse, raising questions about whether the aforementioned debriefing models suffice or require adaptation to align with the unique dynamics of escape rooms.

The debriefing process in escape rooms is particularly important due to their game-like environment. Unlike traditional simulations, escape rooms involve interconnected tasks requiring quick thinking, adaptability, and teamwork. Immediate debriefing is highly valued in these scenarios, as the fresh memory of the activity enhances recall and engagement. Neil and Wotton (2011) found that students preferred immediate debriefing, which facilitated richer reflection and learning. Similarly, Cantrell's (2008) study showed that immediate debriefing allowed for more effective processing of events, indicating that timing significantly impacts the effectiveness of debriefing in escape rooms.

This study addresses two key questions: What debriefing strategies do instructors use in escape rooms, and how do these strategies sequentially work together to support students' learning in escape rooms? Sequential pattern mining on the dataset may reveal new insights into how escape rooms and immediate debrief can optimize learning outcomes. Such findings could inform the development of tailored debriefing methods that maximize the potential of escape rooms as a tool for nursing education.

Theoretical framework

As the importance of debriefing is widely recognized among clinical simulation educators, diverse approaches to guide debriefing have been explored. The Debriefing for Meaningful Learning© (DML) and the EIAG (Experience, Identify, Analyze, and Generalize) methods promote self-directed approaches that foster meaningful learning in the participants (Dreifuerst, 2010; Waznonis, 2014). The DML method also includes a student evaluation of performance in terms of clinical reasoning outcomes, with phases of explaining, elaboration, evaluation, and extending (Dreifuerst, 2015). On the other hand, The GREAT (Guidelines, Recommendations, Events, Analysis, and Transfer of knowledge to clinical practice) method is more instructor-led, with first two steps involving the instructor gathering evidence, policies, and recommended guidelines (Owen & Follows, 2006). Similarly, but more specific to nursing, the Outcome Present-State Test (OPT) model facilitates students to compare a client's present clinical state to the desired clinical outcome state, with a focus on identifying and examining nursing diagnoses, interventions, and clinical judgments made during the simulation experience (Kuiper et al., 2008). Considering both students' self-directed reflection aspect and instructors' guidance aspect of debriefing, Reed (2012) suggested Debriefing Experience Scale, which includes

analyzing thoughts and feelings, learning and making connections, facilitator skill in conducting debriefing, and appropriate facilitator guidance.

Notably, all these debriefing frameworks apply in typical situations where debriefing takes place instantly after a simulation, whereas in this study the debriefing occurred during the escape activities. The instructor's involvement was in and out throughout the whole simulation, not dedicated at the end of the escape room with structured questions. We chose such a form of debriefing as it gives the instructors the latitude to tailor the timing for first-semester students unfamiliar with simulation settings. This type of stop-and-go debriefing is known to be equivalently effective as typical post-scenario debriefing, as found by a randomized controlled trial by Schober et al. (2019). This unique context warrants a more flexible framework to investigate the implementation of the instructor-facilitated debriefing, such as those suggested by Dreifuerst (2009). In her work published in 2009, Dreifuerst defined six strategies of debriefing as reflection, emotion (emotional release), reception (openness to feedback), integration of the simulation experience, and assimilation (Dreifuerst, 2009, p. 111). These share some characteristics with The DML method and Debriefing Experience Scale in that they start with understanding the simulation scenario and expand into other situations where similar skills or knowledge can be applied. Yet, the Dreifuerst debriefing strategies (2009) are considered most suited for this study, where we were interested in understanding how the facilitator would lead debriefing when they stopped the escape room to guide the students.

In Dreifuerst (2009), reflection directs students to review their actions in the simulation, as an opportunity to reexamine the experience. Emotion or emotional release are related to students' significant emotional reaction when the simulation is mentally taxing (e.g., related to patient death). Reception, or openness to feedback, is a component that works mutually between the students and the instructor, where instructors facilitate formative feedback and coach the students to be open for feedback as well. Integration happens when the simulated scenario is framed with what the learners are familiar with, such as the nursing process or a piece of clinical knowledge they learned from didactics. As the ultimate goal of debriefing, assimilation expands the learners' experience to something they haven't encountered yet, usually through 'what if' questions. Considering or anticipating what could happen regarding the provided scenario is the metacognitive ability that distinguishes expert nurses from novices (Tanner, 2006). Dreifuerst (2009) emphasizes that all the attributes should exist and harmonize in the debriefing process to optimize the learning experience from the simulations.

Methods

Settings

The escape room scenario was themed around sepsis, requiring students to perform a head-to-toe assessment and make an appropriate clinical decision. The overview of the scenario is as follows:

> Joy Gladd, a 51-year-old Caucasian female, was admitted to the emergency care. You were called in to the bedside after getting the call. She appears very ill, with the initial vital signs BP 85/45. P 115. RR 28, O2 90%, Temp 102.5. The patient's Foley has 20ml of dark urine.

After assessing Joy Gladd, students report the results to the instructor, who will give them a key to open the first box. The students will find lap results in the box, which will also tell them to perform the full assessment again. The second assessment will result in different, more critical vital signs. When students report the new assessment results with worsened vital signs to the instructor, they will receive a key that opens the second box. The second box contains five action cards, including 'Perform a full assessment again,' 'Do CPR on the patient,' 'Ask for help,' 'Administer an IV push,' and 'Let the patient rest.' When students pick the right action card, 'ask for help,' and bring it to the game master, they escape the room. We defined debriefing as any utterance relevant to the topic the instructors spoke during the escape room process.

The escape room was physically set up with necessary equipment and a patient manikin, on which students were expected to perform a full assessment. Each team had 15 minutes to make the final clinical decision and escape the room. The course instructor, who has been teaching at the university for 15 years and leading the course for 3 years, monitored the overall process and provided debrief as necessary throughout the escape room.

Participants

The participants were 69 first-semester nursing students (82.6% female, 17.4% male, with an average age of

20.4 years, ranging from 18 to 24) taking a simulation-based introductory course at a public university in the southern United States. They were randomly grouped into teams of two or three to enter an escape room, which resulted in 32 teams. The participants represented diverse racial and ethnic backgrounds, with 64% identifying as White, 20% as African American, 10% as Hispanic/Latino, and 6% as Asian or other.

Data analysis

The conversations within the escape room activities of 32 teams were audio recorded, transcribed, and saved in a text data format. One researcher who is experienced in discourse analysis hand-coded speaker diarization with the assistance of Otter.AI, an AI-based transcription tool, and for this study only the utterances of the instructor were extracted into a single .csv file, where each row represented each utterance. There were 530 rows with 14,821 words.

Three researchers coded the first 50 rows according to Dreifuerst's (2009) five debriefing categories to examine the pattern of instructor-led debriefing. Initial Cohen's Kappa was 0.19 on average, indicating minimal agreement. The researchers discussed the conceptualizations of Dreifuerst's (2009) categories and coined three more categories: instruction, demonstration, and prompting. They agreed upon the need for the following new categories, considering the unique characteristics of escape room games and the participants: (1) instruction accounted for any utterance that explained the game rules, which is not related to the patient care, (2) demonstration accounted for direct explanations of the situation and desired actions, and (3) prompting accounted for any utterance that stimulated students' divergent thinking on the actions they can take or reflective thinking on the assessment process. The updated coding framework resulted in an interrater reliability of 0.42 on average. After resolving the disagreements through discussion and coding based on the final coding framework (see Table 1), the researchers achieved an interrater reliability of 0.88. Then, they coded the rest of the dataset individually. The coded transcripts were later analyzed to report descriptive statistics and mine sequential patterns in debriefing strategies using Prefixspan algorithm in Python.

Table 1. *Coding Framework Adapted from Dreifuerst (2009)*

Codes	Definition	Examples
Reflection	The opportunity to reexamine the experience. It includes a **chronological review** or a summary of what the students have done so far.	"So, you just got an assessment.", "Did you do a full assessment?"
Emotion	Any utterance related to specific emotions or feelings, or facilitating the expression of emotion. It can be both positive and negative. Emotional release can redirect the attention of the learner to reflective learning.	"I'm a little concerned.", "Oh my goodness, look at his blood pressure, (it) is bottoming out. Oh my gosh."
Reception	Reception or openness to **feedback** is mutual between the learners and the facilitators. Coaching students to be open to feedback or guiding students' reflection to critique and correction can be included.	"You're right.", "Oh, okay. That's okay."
Integration	Any utterance that models framing (i.e., nursing process) and embeds the experience into scaffolding that connects knowledge and practice.	"So, your urine is dark and concentrated? Right? What does that mean?", "You just need to identify. That is a problem. What is the source of that problem most likely?"
Assimilation	Any utterance that transfers what students have learned and experienced from one situation to the next. It also involves anticipation. It can be modeled or facilitated using techniques like Socratic dialogue or 'what if' questions.	"Because just like when you're listening to a baby, you hear everything when you're trying to get a heart rate on a baby. You hear abdominal gurgling, you hear you hear everything. So you have to tune out to the blood pressure sound.", "This gives you a real (experience), this could actually happen."
Instruction	Any utterance that is not related to the patient assessment but the logistics of the game.	"Go ahead and turn over your card again.", "So, you lose two points for your vital signs."
Demonstration	Any utterance that is giving the answer as to what the facilitator would have done in such situations.	"You will call somebody for help, right? Because you can't manage this on your own.",

		"You wouldn't leave. You would just sit here and call someone."
Prompting	Any open-ended questions prompting the next actions of the students.	"Where else? You're missing the big one. Where, arm?", "What's wrong with that picture?"

As one of sequential pattern mining methods, PrefixSpan algorithm is a pattern-growth method based on projection (Saraf et al., 2015). Unlike other algorithms that rely on candidate generation, PrefixSpan adopts a projection-based strategy to reduce computational complexity. This efficient approach ensures that the mining process focuses on the relevant portions of the dataset, eliminating unnecessary scans. In this study, only sequential patterns of three codes with reasonable values of support, confidence, lift, and conviction are reported. While explaining the formula of them is beyond the scope of this paper, support, confidence, lift, and conviction are commonly used measures in associative rule mining (Kotsiantis & Kanellopoulos, 2006). Support shows how often the pattern emerged from the whole dataset. For example, ['reflection', 'reception', 'prompting'] was only 0.4% of the whole conversation. Confidence indicates the reliability of the rule. Confidence of 0.333 means, for example, that it was 33.3% that reflection and reception led to prompting, not other debriefing strategies. Lift tells if the combination is a coincidence or not. A lift value greater than 1 means the combination is stronger than random chance (Deora et al., 2013). Lastly, conviction focuses on how often the rule is wrong. If conviction is 1, the sequential pattern is no better than random chance (Deora et al., 2013).

Results

The coding process resulted in a total of 536 codes or coded events. Demonstration, where the instructor demonstrated what they would have done in the situation, was the most frequent code (n = 141, 26.3%). Reflection followed, as a chronological review of students' problem-solving process (n = 116, 21.6%). Next frequent code was Prompting, where the instructors prompted students' thoughts or next actions (n = 108, 20.1%). Integration, where instructors made connection between students' clinical knowledge and the scenario, was about 10% of the debrief (n = 62, 11.6%). Instruction, which was related to the rules of escape rooms, were similarly frequent (n = 55, 10.3%). Reception, where the instructor was open for students' thoughts or coached students to embrace the feedback, was less frequent (n = 28, 5.2%). Assimilation was second to the least frequent one (n = 24, 4.5%), which was emotion (n = 2, 0.4%) (See Table 2).

Table 2. *Frequencies of Learning Strategies*

Codes	Reflection	Emotion	Reception	Integration	Assimilation	Instruction	Demonstration	Prompting	Total
n	116	2	28	62	24	55	141	108	536
%	21.6	0.4	5.2	11.6	4.5	10.3	26.3	20.1	100

The subsequent sequential pattern mining revealed three salient sequences as listed in Table 3. Considering all the measures, they emerge as unique and meaningful sequences that instructor employed in their debriefing of escape rooms.

Table 3. *Frequent Sequential Patterns*

Patterns	Support	Confidence	Lift	Conviction
['reflection', 'reception', 'prompting']	0.004	0.333	1.251	1.100
['reflection', 'instruction', 'prompting']	0.006	0.429	1.608	1.284
['reflection', 'integration', 'prompting']	0.007	0.444	1.667	1.320

Discussion and Conclusion

This study examined the debriefing practice in the escape rooms, an altered and emerging form of clinical simulations in nursing education (Vázquez-Calatayud et al., 2024). The results showed a relatively even distribution among all debrief strategies, with demonstration being the most common and emotion being the least. Sequential pattern mining revealed that when facilitating debriefing in nursing simulations, the instructors often began with reflection, by guiding students to review the information they gathered during patient assessments. This reflective phase set the foundation for the subsequent debriefing approaches: instruction,

integration, or reception, each fostering open-ended reasoning in distinct ways. Instruction often included game-related prompts, such as directing students to "turn over the card to see the lab results." These prompts typically occurred when students determined that the patient was seriously unwell and needed additional information to identify the symptoms. Integration involved connecting clinical observations to theoretical knowledge, such as explaining the physiological role of lactic acid, enabling students to apply classroom learning to authentic patient scenarios. Reception occurred when students proactively articulated their nursing processes, and instructors reacted to their reasoning, leading to further prompts that ensured thorough assessments.

These sequential patterns demonstrated a structured approach employed by the instructor to facilitating the mapping between theoretical knowledge and clinical practice. They provided a framework that nursing educators intentionally used to support student learning during brief, focused debriefing sessions. This is context adaptive since some elements of debriefing, such as the level of facilitation and specific approaches, are flexible and can be tailored to situational needs (Waznonis, 2014; Decker et al., 2013). Tailoring debriefing strategies in this way can help educators anticipate and overcome potential issues while optimizing learning outcomes.

Research emphasizes the value of structured debriefing in simulation-based education, linking it to improved performance, critical thinking, clinical reasoning, satisfaction, and problem-solving skills (Lee et al., 2020). However, the effectiveness of specific debriefing strategies, such as assimilation versus integration, remains uncertain. A meta-analysis of debriefing methods in nursing education found a non-significant total effect size of 0.31 ($p = 0.34$) (Lee et al., 2020), indicating that its impact may vary based on factors like course objectives, simulation context, and instructional design. This study highlights the importance of instructors' immediate debriefing process that is interactive and contextual by its nature.

However, the current study findings must be interpreted with caution. The dataset for this study was derived from the escape session for first-year nursing students that focused on foundational nursing skills, with limited emphasis on emotionally complex scenarios. This partially explains the low proportion of debriefing strategies related to emotion. Different debriefing patterns may emerge in simulations addressing areas such as mental healthcare or end-of-life care. Moreover, students' limited background knowledge and experience may have influenced the type of the instructor-led debriefing. As first-semester nursing students, they are just beginning their journey into the profession and are still akin to laypersons in the field. To help them grasp the simulation's events and their potential actions, the debriefing likely remained at a basic level, focusing on basic understanding (i.e., reflection, demonstration) rather than exploring the deeper clinical applications of their observations (i.e., integration, assimilation).

Students at a later phases of nursing program or nursing residents may require more integration or assimilation in the debriefing, which connects their simulation experience to clinical knowledge and extensive cases beyond what they observed in the scenario.

While debriefing is widely recognized as an integral part of learning in simulations, its role in escape rooms has been under-explored. Some studies on escape rooms omit detailed discussions of the debriefing process, which limits its applicability as clinical simulations. Given the unique, game-like nature of escape rooms, debriefing methods may need to evolve to align with their dynamic and playful elements. Future research could investigate how different debriefing strategies influence learning outcomes in varied contexts, including escape rooms. The patterns of immediate debriefing found in this study can be leveraged in designing virtual escape room experiences for simulating student-instructor interactions. By optimizing debriefing practices to the learner and simulation characteristics, nursing educators can further bridge the gap between theoretical knowledge and clinical application, enhancing the overall quality of simulation-based education.

Implications

This study draws attention to the underexplored role of debriefing in escape rooms, an alternative format of clinical simulations that demand unique approaches to align with its dynamic and collaborative nature. While focusing on the debriefing element of escape rooms in nursing education, this study highlights the potential of using data mining techniques, such as sequential pattern mining, to uncover meaningful insights into debriefing strategies used in nursing simulations. By analyzing how instructors guide clinical reasoning through different debriefing strategies to foster the connection between theoretical knowledge and practical application, the current study indicated the value of structured debriefing in simulation-based education, particularly in short, focused sessions where immediate feedback and cognitive reinforcement are critical, like escape rooms.

The results highlight the importance of tailoring debriefing strategies to the context and learning objectives of the simulation. Despite prior research, such as Waznonis (2014), Decker et al. (2013), and Lee et al. (2020), that affirms the significance of debriefing for enhancing various learning outcomes, gaps remain in understanding how specific methods impact these outcomes across different scenarios.

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