

***Designing an Educational Board Game Combined With Spherical Video Virtual Reality
Scaffolding Mechanism for Learning Inhaled Drug Therapy***

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Abstract

Inhalation therapy training encounters several challenges, primarily due to the intricate variety of drug types and methods of administration. These complexities often lead to cognitive overload and diminish student motivation. Moreover, there is a noticeable absence of effective contextual interaction and practical application scenarios within educational settings. To tackle these issues, this study introduces a tabletop educational game that incorporates Spherical Video Virtual Reality (SVVR) to authentically simulate clinical environments. The game involved 23 healthcare professionals, including physicians, pharmacists, respiratory therapists, specialized nurses, and medical students, who participated in the initial empirical evaluation. Participants were tasked with assessing and determining treatment regimens for two simulated patients concurrently, aiming to enhance their understanding of respiratory therapy medications and teamwork abilities. Results revealed that participants experienced high levels of flow, minimal anxiety, strong motivation, enjoyment, and expressed a desire to engage with the game again (all scores significantly above 3 on the 5-point Likert scale). Qualitative feedback also highlighted the effectiveness of the game relative to traditional courses in enhancing understanding of inhalation therapy concepts and clinical case evaluation.

Keywords: Educational Game, Board Game, Situated Learning, Scaffolding, Spherical Video Virtual Reality, Respiratory Therapy, Inhaled Therapy, Inhalation Drug Therapy

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Introduction

Experiential learning is a cyclical process encompassing four distinct stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). This model asserts that learning is achieved through experience and is characterized by its dynamic and continuous nature. In medical education, experiential learning strategies have been extensively implemented, with evidence suggesting that their application can significantly improve medical students' critical thinking abilities (Maudsley & Strivens, 2000). As the advantages of experiential learning become increasingly apparent, virtual reality (VR) has increasingly been incorporated into training methods. VR has been effectively utilized across diverse domains such as emergency responder training, medical training, interpersonal skills development, and educational instruction (Xie et al., 2021). Among the various VR approaches, spherical video virtual reality (SVVR) is particularly noted for its cost-effectiveness and its provision of a 360-degree panoramic view, offering a more immersive learning experience compared to traditional video-based methods (Hosseini & Swaminathan, 2016). From the standpoint of situative learning theory, SVVR presents a valuable educational environment that enhances both learning performance and motivation (Chang et al., 2022).

Among various digital training methods, game-based learning stands out as a trainee-centered approach that transcends time and space constraints. It enables trainees to engage in active learning within a safe environment while addressing clinical problems (Kim & Chun, 2022). According to Lampropoulos and Kinshuk (2024), incorporating virtual reality and gamification elements into education can significantly boost students' motivation, engagement, and learning outcomes. Board games serve as an excellent medium for educational purposes, offering high adaptability for teaching across different subjects (Cheng et al., 2019). One of the advantages of board games is their high level of interactivity; playing face-to-face allows students to actively explore concepts and share information with their peers (person-to-person interaction), while the game mechanisms can also provide feedback to players (interaction between players and the game) (Tsai et al., 2021).

This study has developed an educational board game called "Helps Quickly of Dyspnea," which integrates SVVR scaffolding mechanism for training in the use of respiratory therapy medications. The primary learning goals are to help students become familiar with different types of inhalable medications and to reduce their cognitive load. The game aims to enhance students' motivation to learn, reduce their resistance to learning, and develop essential clinical skills such as critical thinking, problem-solving, teamwork, communication, and collaboration.

Methods

This study explores the integration of a virtual environment scaffold mechanism into an educational board game. The participants included 23 healthcare professionals, such as physicians, pharmacists, respiratory therapists, specialized nurses, and medical students. We developed a board game titled *Helps Quickly of Dyspnea* (HQD), which incorporates the concept of inhaled medications into its gameplay. The game features three types of cards: Drug cards, Material cards, and Task cards, as illustrated in Figure 1. The drug cards represent various inhaled medications currently used in clinical practice in Taiwan, including different types and formulations. The material cards detail the components of these medications. The task cards, combined with the SVVR scaffold mechanism, simulate clinical scenarios in a three-dimensional space. This innovative approach merges SVVR technology with traditional board game elements, offering students an immersive learning platform. When players scan

the QR code on a task card, they enter a three-dimensional simulated clinical scenario that supports 360-degree panoramic exploration. This allows students to freely navigate the virtual environment, observe, and assess patient conditions, as depicted in Figure 2.

Players, divided into groups of 3-6, can engage in two gameplay modes. In the first mode, "Drug Development," players act as Clinical Research Associates (CRAs) and synthesize medications using the material cards they have. In the second mode, "Dyspnea Detection," players take on the roles of healthcare practitioners (doctors, pharmacists, respiratory therapists, or nurse specialists), and provide treatment recommendations after evaluating patients, thereby improving their clinical decision-making skills.

Combining SVVR scenarios with a board game brings distinct advantages and innovations. The virtual environment offers a highly realistic simulation platform, allowing students to practice and learn from mistakes without real-world risks. Additionally, the game maintains the social interaction typical of board games. In each round, players must evaluate two patients and decide whether to treat one or both, but with limited resources, they must communicate and strategize with other players to ensure that both patients receive treatment. Throughout the game, students can explore, interact, and collaborate, fostering a student-centered learning process that encourages independent thinking, strategic planning, value-based judgments, and decisive action.

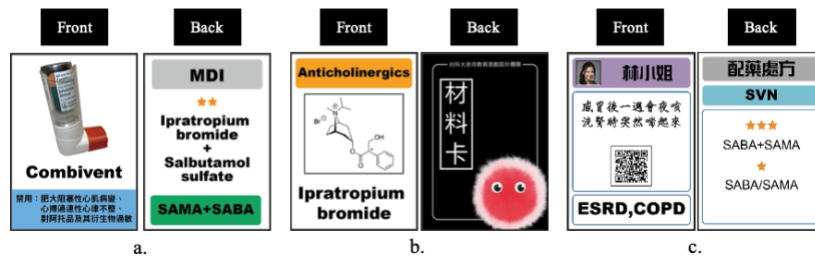


Figure 1: Playing Cards in the Board Game. (a) Drug Cards (b) Material Cards (c) Mission Cards



Figure 2: Spherical Video Virtual Reality Scaffolding Mechanism of Mission Card

Results and Discussion

"Helps Quickly of Dyspnea" (HQD) is an educational board game designed to teach respiratory therapy medications. In this game, learners engage in simulated patient assessments within a virtual environment using limited medical resources. They must collaborate with others to provide final treatment recommendations. Table 1 shows the descriptive statistics of the learners' flow state after playing the game. The overall flow state ($M=3.87$, $SD=0.42$) was significantly higher than the median score of 3 on a 5-point Likert scale. Both the flow antecedents ($M=3.66$, $SD=0.55$) and flow experience ($M=3.31$, $SD=0.41$) were also significantly higher than the median score. Sub-dimensions such as goals of an activity, unambiguous Feedback, and control in the flow antecedents were significantly higher than the median, indicating that learners understood the game's objectives and felt in control. The average scores for the challenge-skill balance (3.11 ± 1.10) and playability (3.26 ± 0.69) were not significantly higher than the median, suggesting that learners might have found the game challenging due to a lack of background knowledge about inhalation medications. Qualitative feedback from some participants described the game as "a bit difficult" and "challenging," with suggestions that prior instruction would make the game easier to understand and remember. Additionally, the average scores for concentration, time distortion, and autotelic experience were significantly higher than the median, implying that the game's integration of SVVR scaffolding deeply immersed the learners. Jong (2023) noted that SVVR can enhance students' immersion in the subject matter, thereby improving their flow and learning process.

Table 1: The Mean and Standard Deviation of Learners' Flow

	(N=23)			
	<i>M</i>	<i>SD</i>	<i>Z</i>	<i>Sig.</i>
Overall Flow	3.87	0.42	4.20***	0
Flow antecedents	3.66	0.55	3.83***	0
Challenge-skill balance	3.11	1.10	0.59	0.558
Goals of an activity	4.22	0.67	4.41***	0
Unambiguous Feedback	3.70	0.88	2.97**	0.003
Control	4.00	0.92	3.42***	0
Playability	3.26	0.69	1.65	0.098
Flow experience	3.31	0.41	3.05**	0.002
Concentration	4.43	0.58	4.17***	0
Time distortion	3.98	0.75	3.70**	0
Autotelic experience	4.30	0.71	4.08***	0
Loss of self-consciousness	2.83	1.07	-0.72	0.471

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2 presents the descriptive statistical analysis of learners' game anxiety, game feedback, and game elements. Overall anxiety ($M = 2.72$, $SD = 0.73$) was below the median score (3) on the scale but did not reach statistical significance. Conversely, overall game feedback ($M = 4.53$, $SD = 0.50$), game usefulness ($M = 4.60$, $SD = 0.50$), game ease of use ($M = 4.45$, $SD = 0.65$), and game elements ($M = 4.09$, $SD = 0.76$) were significantly higher than the median score of 3. The study indicates that good game elements can enhance learners' engagement, sense of achievement, and motivation (Hassan et al., 2021).

Table 2: The Mean and Standard Deviation of Learners' Game Anxiety, Game Feedback, and Game Elements

(N=23)				
	<i>M</i>	<i>SD</i>	<i>Z</i>	<i>Sig.</i>
Game Anxiety	2.72	0.73	-1.15	0.13
Game Feedback	4.53	0.50	4.223***	0
Game Usefulness	4.60	0.50	4.27***	0
Game Ease of Use	4.45	0.65	4.173***	0
Game elements	4.09	0.76	3.93***	0

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Conclusions and Limitations

"Helps Quickly of Dyspnea" (HQD) is a scenario-based game focused on "respiratory therapy medications," combining an online scaffolding system on mobile devices with a physical board game. Players can access real-time cognitive support through their mobile devices. Compared to traditional paper-based board games, mobile scaffolding is more dynamic and can integrate multimedia content (Hou et al., 2023). In summary, there are significant differences in flow performance, learning anxiety, game experience, and game elements. The preliminary results of this study suggest that combining clinical scenarios with a board game and SVVR scaffolding can maintain high flow states and increase learning motivation during the learning process. Future research could increase the sample size and further explore the effectiveness, realism, and practicality of the SVVR scaffolding mechanism for different learning groups (e.g., doctors, pharmacists, respiratory therapists).

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