

Evaluating Multiplayer Game-Based Training for Earthquake Evacuation: A Systematic Review

Berfin Deniz Çakmak¹ and Ahmet Gün^{1,2}

¹Department of Game and Interaction Technologies, Graduate School at Istanbul Technical University, Türkiye

²Faculty of Architecture, Istanbul Technical University, Türkiye

cakmak23@itu.edu.tr

ahmetgun@itu.edu.tr

Abstract: Earthquakes are the most devastating natural disasters, causing extensive loss of life and damage. Traditional methods, such as drills and instructional materials, focus on individual preparedness, overlooking group dynamics that shape real-world evacuations. In crowded settings like schools and hospitals, peer influence, leadership and collective decision-making significantly impact evacuation outcomes. Game-based learning offers an interactive approach to disaster preparedness, yet most serious games rely on single-player training or AI-driven simulations where non-player characters (NPCs) attempt to mimic human behavior. These models often fail to capture real-time social interactions, limiting their effectiveness in preparing individuals for group evacuations. This creates a critical research gap, as there is limited understanding of how multiplayer game-based training can improve collaborative decision-making and evacuation efficiency. This study conducts a systematic literature review using SCOPUS and Web of Science databases to examine the relationship between multiplayer game-based training and earthquake evacuation preparedness. The review aims to identify key findings, highlight existing research gaps and explore the role of multiplayer interaction in improving evacuation efficiency and adaptive decision-making. While previous studies have primarily focused on individual-centered evacuation training, few have examined the real-time impact of multiplayer interactions on group evacuation behavior and decision-making dynamics. Additionally, the influence of social factors—such as peer interactions, leadership roles and collective decision-making—on evacuation performance remains largely underexplored. Furthermore, the potential of multiplayer serious games to enhance engagement, situational awareness and collaborative problem-solving has received limited attention in existing research. Future studies should prioritize empirical investigations into the effectiveness of multiplayer serious games in enhancing group coordination, role differentiation and social influence during evacuations. Moreover, integrating multiplayer game-based training into official disaster preparedness programs could provide a more dynamic, interactive and socially realistic approach to emergency response education.

Keywords: Serious games, Game-based learning, Earthquake evacuation, Disaster preparedness, Emergency training, Human behaviour

1. Introduction

Earthquakes are one of the serious natural disasters in the world and it scales globally. Türkiye is located in a geographical area with important tectonic fault lines. In history, Türkiye witnessed 114 earthquakes greater than 5 and these earthquakes directly affected approximately 23.8 people and caused life loss for more than 144.000 people (EM-DAT, 2023). Researchers have some predictions about a major earthquake in the Marmara region with Mw 7.5. According to scenarios developed by the Kandilli Observatory and Earthquake Research Institute (2019), a possible earthquake with this magnitude could significantly affect this densely populated region. The spatial needs that may arise if these scenarios occur are determined.

Earthquake preparedness actions are divided into three classes: pre-earthquake, earthquake moment and post-earthquake stages. Learning and implementing basic safety measures during an earthquake is an effective and fundamental solution to prevent loss of life in this natural disaster (Rajabi et al., 2022). Given the complexity of human behavior during such disasters, especially in densely populated areas such as schools, hospitals and commercial facilities, traditional preparedness methods alone may not be sufficient. Training individuals for earthquake evacuation in public indoor spaces poses unique challenges, including panic management, route selection and coordinated decision-making. Traditional training methods, such as drills and instructional sessions often fail to adequately simulate the complexity of real-life scenarios. Game-based learning provides an alternative by immersing participants in virtual environments where they can practice responding to emergencies. Multiplayer serious games, in particular, add the element of collaborative behavior, which is critical during large-scale evacuations. Despite growing interest in serious games for safety training, the literature lacks comprehensive studies focusing on multiplayer systems for earthquake evacuation. This paper aims to review existing research from SCOPUS and Web of Science databases, investigate the potential and effectiveness of multiplayer serious games in earthquake evacuation preparedness, highlight gaps and propose future research directions.

The following section provides an overview about earthquake evacuation training and a comparison between traditional methods and game methods. The second section provides a comprehensive review of existing studies conducted at the intersection of earthquake evacuation and serious game methods. Last two sections summarize the key findings derived from these studies and future work suggestions.

2. Traditional vs. Game-Based Training Methods

Traditional evacuation training methods such as instructional materials, drills, seminars and videos are standard preparation tools for preparing people for disasters in a long time. These traditional evacuation training methods aim to teach basic safety protocols and evacuation procedures to the people for reducing the effects of a disaster. However, their effectiveness is questioned because of the limitations in engagement, realism, adaptability and scalability.

Game-based learning (GBL) offers an alternative model with more realistic and interactive environments for simulating emergency conditions. Traditional methods are mostly passive and focus on individual behavior but serious games enable learners to actively participate in scenarios, make decisions and solve problems in a team collaboration. These features make Game-based learning (GBL) a powerful tool for enhancing preparedness in complex, high-stress scenarios like earthquake evacuations.

Nowadays, evacuation training is mainly conducted by using traditional methods like drills and written instructions. However, there are multiple factors that restrict how effective these methods can be. These limitations can negatively affect the process of preparing people for real emergency situations. The limitations of traditional evacuation training can be grouped under three groups:

- **Lack of Realism and Participation:** Traditional methods are not effective in simulating the unpredictability and complexity of real-life emergencies. This limitation makes it difficult for people to improve critical thinking and decision-making skills (Gwynne et al., 2020; Mitsuhashi et al., 2023). Additionally, traditional methods usually focus on specific scenarios and cannot properly direct participants to real disaster conditions (Capuano et al., 2015; Rahouti et al., 2017).
- **Limited Scope and Adaptability:** Traditional methods generally focus on specific scenarios and have difficulty about adapting different types of emergencies or personal behavior differences. Since these methods do not get attention to the decisions and behaviors of people during the evacuation process, deficiencies may occur during a real evacuation (Haghani, 2020; Li et al., 2022).
- **Restricted Educational Impact:** Traditional methods may not be effective in environments with vulnerable populations, such as hospitals or schools. These methods disrupt operations and offer limited educational value for vulnerable populations (Rahouti et al., 2017).

2.1 Conceptual and Theoretical Background: Serious Games in Evacuation Training

Serious games are not just about entertainment, their purpose is mostly about education and training. They use immersive storytelling, rule based systems and player agency to achieve specific learning outcomes. For disaster preparedness, serious games provide experiential learning environments that mimic real-life scenarios, promoting both knowledge acquisition and behavioral training.

Serious games serve several critical functions to apply evacuation training. They simulate the time-sensitive and high-pressure conditions of an emergency, allowing players to rehearse decision making, spatial navigation and collaborative actions. Unlike traditional simulations or paper-based learning, serious games allow real-time feedback and adjustment based on player choices, fostering deeper cognitive engagement. Multiplayer serious games further enhance this by simulating social dynamics, such as leadership, group cohesion and peer influence factors central to real-world evacuations in collective environments like schools or hospitals.

The theoretical foundation of serious games in this field is grounded in experiential learning (Kolb, 1984), which highlights the importance of context, interaction and reflection in effective education. These games also align with the principles of constructivist pedagogy, enabling learners to build knowledge through active participation and critical thinking within meaningful scenarios. Thus, serious games—especially in multiplayer formats—hold strong potential for improving disaster training by integrating behavioral realism, emotional engagement and social complexity into educational frameworks.

3. Methodology

This study adopts a systematic literature review methodology to investigate the effectiveness and potential of multiplayer serious games in enhancing earthquake evacuation preparedness. During the initial phase of the

literature search, it was observed that while numerous studies address serious games for disaster education and evacuation training, research specifically examining multiplayer dynamics in earthquake evacuation scenarios remains limited. For this reason, the keywords were expanded such as “Serious Game”, “Game-based Learning”, “Educational Game”, “Earthquake”, “Earthquake Evacuation”, “Earthquake Training” and not limited to just multiplayer. The review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines with the input of these keywords.

A comprehensive search was conducted in two major academic databases, Scopus and Web of Science, selected for their extensive coverage of peer-reviewed studies in disaster research, education and game-based learning. The initial search was restricted to articles published between 2015 and 2025 to ensure the inclusion of contemporary developments in serious game technologies and disaster education practices. The initial screening identified 71 records. After applying predefined inclusion and exclusion criteria, such as relevance to earthquake-related evacuation training, incorporation of serious game interventions and exclusion of studies focused on other disaster types (e.g., floods, hurricanes) or unrelated applications (e.g., engineering simulations without educational components), a total of 14 articles remained. (Figure 1)

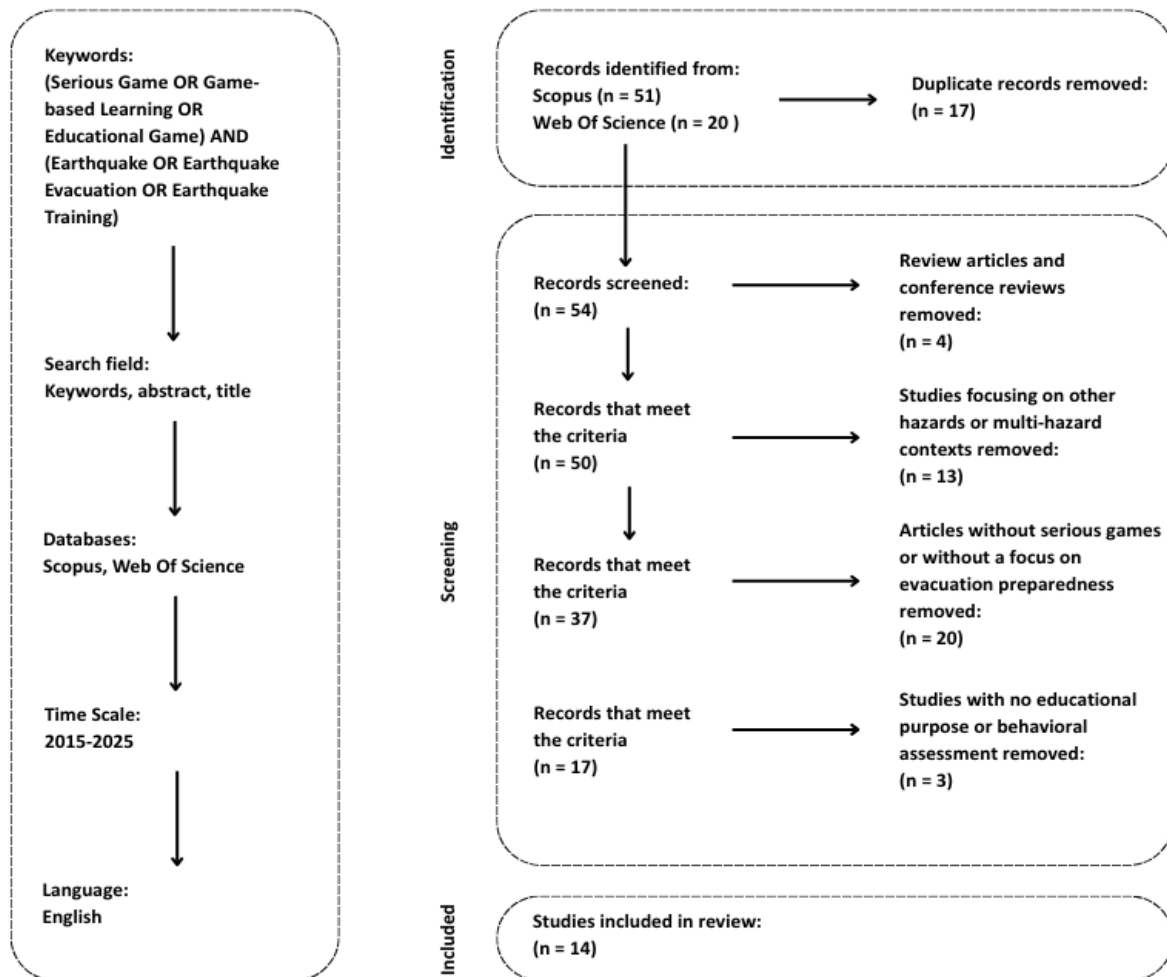


Figure 1: Literature search and screening based on PRISMA guidelines

Through further screening based on detailed eligibility criteria such as the presence of educational goals related to evacuation behavior 14 studies were finally included for final analysis. The table below shows the systematic review process of the selected resources. (Table 1)

Table 1: Literature review

N	Article Name	Year	Aim	Method	Findings
1	Improving post-earthquake evacuation preparedness for deaf and hard of hearing children: A conceptual framework	2021	Enhance evacuation preparedness for deaf and hard of hearing children using VR serious games	Systematic literature review	VR serious games should be adapted to deaf and hard of hearing needs within Disaster Risk Reduction frameworks
2	Exploring spiral narratives with immediate feedback in immersive virtual reality serious games for earthquake emergency training	2023	Investigate narrative structure and feedback impact in VR earthquake training games	Experimental VR game design and testing	Spiral narratives and immediate feedback improve learning outcomes
3	Instructional mechanisms in immersive virtual reality serious games: Earthquake emergency training for children	2020	Examine instructional strategies in VR games for earthquake training	Experimental study with children	Instructional scaffolding enhances preparedness learning
4	Mobile educational game for earthquake disaster preparedness in elementary school	2018	Develop a mobile game to teach earthquake mitigation to elementary students	Game development and pilot testing	Mobile games increased children's awareness and preparedness
5	An immersive virtual reality serious game to enhance earthquake behavioral responses and post-earthquake evacuation preparedness in buildings	2020	Create VR-based training to improve evacuation behaviors post-earthquake	Pilot study with hospital staff and visitors	VR training increased knowledge and self-efficacy significantly
6	Exploring the most effective feedback system for training people in Earthquake emergency preparedness using immersive virtual reality serious games	2024	Compare feedback types in VR earthquake training games	Controlled experimental study	Corrective feedback was most effective for behavior change
7	Educational Seismology through an Immersive Virtual Reality Game: Design, Development and Pilot Evaluation of User Experience	2023	Design a VR game for educational seismology and assess UX	Game design and pilot user evaluation	Positive usability and educational potential confirmed
8	Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study	2018	Develop VR training prototypes for hospital earthquake preparedness	Prototype development and stakeholder testing	VR improved staff readiness for evacuation scenarios
9	Towards a customizable immersive virtual reality serious game for earthquake emergency training	2020	Create a customizable VR serious game for earthquake response	Design-based research approach	Customizable scenarios increased relevance and engagement
10	Prototyping of an earthquake evacuation learning game with VR reproducing the environment that is familiar to learners	2019	Prototype a VR earthquake evacuation game in familiar environments	Prototype testing with students	Familiar settings enhanced learning and realism
11	Human behavior and decision-making in earthquake emergencies: insights from virtual reality and serious games	2024	Understand human decisions during earthquakes via VR games	Observational VR study	Social factors critically influence evacuation decisions

N	Article Name	Year	Aim	Method	Findings
12	Which training method is more effective in earthquake training: Digital game, drill or traditional training?	2022	Compare the effectiveness of digital games, drills and traditional education	Controlled experimental comparison	Games improved motivation and drills better for skills acquisition
13	Playing games for risk prevention: Design, implementation and testing of serious games in recent European projects UPStrat-MAFA and knowRISK	2021	Use serious games for risk prevention education	Game design and public testing	Serious games enhanced seismic risk awareness
14	Comparison of the digital game, drills and traditional education methods in terms of motivation in earthquake education	2022	Evaluate impact of different methods on motivation in earthquake education	Experimental study with elementary students	Games increased motivation and drills were more effective for behavior

Following the systematic review and selection process, the 14 retained studies were thematically clustered to identify the dominant research focuses and methodological tendencies. The reviewed literature reveals five major thematic clusters: (1) the use of immersive virtual reality environments for evacuation preparedness, (2) mobile-based serious games for early disaster education, (3) instructional mechanisms and feedback systems in serious game design, (4) behavioral decision-making during evacuation and (5) accessibility and inclusion in game-based training for vulnerable populations. These clusters provide a structured foundation to analyze the strengths, limitations and research gaps in the field. (Table 2).

Table 2: Clustering of Articles

N	Thematic Clustering	Studies
1	Immersive VR for Earthquake Evacuation	5,7,8,9,14
2	Mobile-Based Disaster Education	4,13
3	Instructional Design & Feedback	2,3,6,12
4	Behavioral Decision-Making & Social Dynamics	11
5	Accessibility & Inclusive Design	1, 10

Several studies explored the use of immersive virtual reality (VR) environments to simulate earthquake scenarios and enhance behavioral preparedness. For instance, Feng et al. (2020) (Study 5), Lovreglio et al. (2018) (Study 8) (Figure 2) and Zhou et al. (2020) (Study 14) developed VR-based serious games to increase users' situational awareness and improve their evacuation responses through high-fidelity simulation. These applications often targeted adult populations such as hospital staff or university students and emphasized spatial realism and emotional engagement. Maragkou et al. (2023) (Study 7) focused on user experience within immersive systems, while another study by Feng et al. (2020) (Study 9) evaluated VR's role in reinforcing knowledge of evacuation procedures. Although these works highlight the value of VR in disaster training, they often lack consideration of multi-user dynamics and realistic social interactions.



Figure 2: A tester seated on the vibrating platform. (Lovreglio et al., 2018)

A smaller but significant group of studies examined mobile-based disaster education, particularly for younger learners. Winarni et al. (2018) (Study 4) developed an Android-based educational game to familiarize elementary students with earthquake preparedness through a multi-stage structure (before, during and after an earthquake). Similarly, Çoban and Göktaş (2022) (Study 13) compared digital games, traditional lessons and drills to assess their relative impact on motivation and learning. Both studies affirm the value of mobile serious games as accessible tools for early disaster education, though their behavioral complexity tends to be limited compared to immersive approaches.

Several studies emphasized instructional design and feedback mechanisms as core components of effective serious game-based learning. For example, Feng et al. (2023) (Study 2) investigated how spiral narratives and immediate feedback shaped users' understanding and performance. Another study by Feng et al. (2020) (Study 3) explored instructional scaffolding strategies in earthquake simulations. Yousefi et al. (2024) (Study 6) examined adaptive feedback systems and their impact on behavioral accuracy. Complementing these works, Çoban and Göktaş (2022) (Study 12) evaluated different instructional modalities and concluded that serious games can offer unique motivational advantages over traditional methods. Together, these studies suggest that pedagogical design elements are critical for shaping user engagement.



Figure 3: First training task. (Feng et al., 2023)

One study, Yousefi, Ahmadi and Ahmadi (2024) (Study 11), explored behavioral decision-making and social dynamics in simulated evacuation scenarios. This work investigated how individuals react to peer behavior, authority cues and spatial familiarity during earthquakes. The findings emphasize the importance of modeling realistic social interactions and behavioral variability in serious game environments—an area that remains underexplored in most existing training tools.

Finally, two studies focused on accessibility and inclusive design in evacuation training games. Abdulhalim et al. (2021) (Study 1) proposed a conceptual framework tailored to the needs of deaf and hard of hearing children, integrating visual cues and scenario-based learning to enhance preparedness. Yamamoto et al. (2019) (Study 10) stressed the importance of familiar spatial contexts in improving students' recognition and decision-making during VR-based training. These studies underscore the need for equity-oriented design approaches in serious game development to ensure that diverse populations can benefit from game-based disaster education.

4. Discussion and Conclusion

The findings of this review reveal that serious games have emerged as valuable tools for enhancing earthquake evacuation preparedness. Most of the reviewed studies demonstrated promising outcomes in terms of improving behavioral responses, increasing situational awareness and fostering disaster knowledge retention.

However, 3 critical gaps and limitations were consistently observed across the current body of research:

1. Limited Integration of Behavioral and Social Dynamics in VR Environments

A major limitation lies in the overreliance on architectural and environmental realism through immersive virtual reality (VR) technologies (Study 5, Study 7, Study 8, Study 9, Study 14). While these studies successfully employed high-fidelity VR environments to replicate post-earthquake conditions and stimulate emotional engagement, they often underexplored the behavioral and social dimensions of evacuation. Most simulations focused on spatial environments or individual responses, with limited incorporation of theoretical behavioral frameworks such as social influence theory, group coordination models or cognitive decision-making processes. The absence of a robust socio-cognitive layer in these game designs indicates a critical research gap, particularly in simulating complex human behavior during emergencies.

2. Lack of Multiplayer Functionality Reflecting Group-Based Evacuation Scenarios

All of the reviewed serious games were designed for single-player experiences. This widespread design choice neglects the essential role of peer interaction, leadership emergence and collective decision-making—elements that are fundamental to real-world evacuations. Earthquake response is inherently social and context-dependent, where individuals observe, follow or resist group behavior patterns. The lack of multiplayer mechanics results in a significant disconnect between the training environment and the reality of disaster scenarios. This suggests the urgent need for a paradigm shift toward multiplayer serious game formats that capture emergent group dynamics and foster collaborative learning experiences.

Despite the clear relevance of multiplayer dynamics in real-world earthquake evacuations, the reviewed literature mostly focused on single-player experiences. This trend may be attributed to several converging factors. From a technical perspective, implementing real-time multiplayer interactions in immersive environments—particularly VR—presents significant challenges, including synchronization of user behaviors, maintaining communication and preserving immersion across systems. Studies such as Lerner et al., (2020) and Freina et al., (2015) emphasize that multi-user VR systems demand advanced infrastructure and often encounter limitations in scalability and stability. Pedagogically, modeling collaborative decision-making and emergent group behavior under emergency conditions adds another layer of complexity, requiring interdisciplinary frameworks that integrate behavioral science, learning theory and interaction design. Consequently, many studies may have prioritized single-user designs for feasibility and experimental control, inadvertently reinforcing a gap in the literature. This disconnect between real-world social evacuation dynamics and current training game designs highlights the need for new approaches that can effectively integrate multiplayer capabilities into immersive serious games.

3. Limited Consideration of Role Allocation and Behavioral Pattern Formation

This limitation is not entirely independent; rather, it is closely interrelated with the two previously mentioned gaps. The limited consideration of dynamic aspects of evacuation behavior such as role allocation (e.g., leader, follower), timing of responses and behavioral pattern formation under stress further compounds the shortcomings of VR realism and single-player design (Study 11). While a few studies allude to the importance of

behavior adaptation during emergency conditions, the training scenarios rarely model the evolving interpersonal roles that naturally occur in evacuation settings. This gap is especially notable given that leadership, hesitation, following behavior or peer influence often determine the effectiveness of an evacuation. Role dynamics must be better represented in future game-based training tools particularly in multiplayer environments that can accommodate such complexity.

Based on these findings, future work should focus on designing a new generation of multiplayer serious games that integrate social behavioral theories, adaptive decision-making frameworks and dynamic evacuation modeling. Our next step will be to develop a prototype multiplayer serious game designed specifically for earthquake evacuation preparedness. This game will incorporate dynamic role differentiation, social influence mechanisms, and real-time group decision-making challenges. The design process will adopt an iterative development model involving continuous testing, player feedback collection, and refinement cycles to ensure both educational effectiveness and behavioral realism. By introducing this new multiplayer-focused approach, we aim to contribute to a paradigm shift in disaster preparedness training, bridging the current gap between environmental simulation and social behavior modeling in serious games.

Ethical Declaration: The ethical clearance was not required for this research as it involved a systematic review of published literature without direct involvement of human participants.

AI Declaration: AI tools (ChatGPT) were used during the preparation of this paper to assist with language refinement, content organization and academic writing support. All critical analysis, thematic synthesis and interpretations were conducted by the author.

References

- Abdulhalim, I., Mutch, C., González, V.A. and Amor, R. (2021) 'Improving post-earthquake evacuation preparedness for deaf and hard of hearing children: A conceptual framework', *International Journal of Disaster Risk Reduction*, 62, 102360.
- Boğaziçi University Kandilli Observatory and Earthquake Research Institute (2019) 'Istanbul Province Possible Earthquake Loss Estimates Update Project', Istanbul Metropolitan Municipality, Earthquake and Ground Investigation Directorate.
- Capuano, N., Gaeta, M. and Ritrovato, P. (2015) 'Adaptive educational games for disaster preparedness training', *IEEE Transactions on Learning Technologies*, 8(2), pp. 173–185.
- Çoban, M. and Göktaş, Y. (2022) 'Comparison of the digital game, drills and traditional education methods in terms of motivation in earthquake education', *Education and Information Technologies*, 27(4), pp. 5235–5253.
- EM-DAT (2023) The International Disaster Database. Brussels: Centre for Research on the Epidemiology of Disasters (CRED).
- Feng, Z., González, V.A., Amor, R., Spearpoint, M., Thomas, J., Sacks, R., Lovreglio, R. and Cabrera-Guerrero, G. (2020) 'An immersive virtual reality serious game to enhance earthquake behavioral responses and post-earthquake evacuation preparedness in buildings', *Advanced Engineering Informatics*, 44, 1011.
- Feng, Z., González, V.A., Mutch, C., Amor, R. and Cabrera-Guerrero, G. (2023) 'Exploring spiral narratives with immediate feedback in immersive virtual reality serious games for earthquake emergency training', *Multimedia Tools and Applications*, 82(1), pp. 125–147.
- Feng, Z., González, V.A., Mutch, C., Amor, R. and Cabrera-Guerrero, G. (2020) 'Towards a customizable immersive virtual reality serious game for earthquake emergency training', *Advanced Engineering Informatics*, 44, 101134.
- Freina, L. and Ott, M. (2015) A literature review on immersive virtual reality in education: State of the art and perspectives', *eLearning and Software for Education (eLSE)*, pp. 133–141.
- Gwynne, S., Kuligowski, E.D., Reneke, P.A. and Peacock, R.D. (2020) A Review of the Methodologies Used in Evacuation Modeling. Gaithersburg, MD: National Institute of Standards and Technology.
- Haghani, M. (2020) 'Evacuation decision-making under stress: Insights from behavioral science', *Safety Science*, 129, 104800.
- Kolb, D.A. (1984) *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice-Hall.
- Lerner, D., Mohr, S., Schild, J., Göring, M., Luiz, T. (2020) 'An immersive multi-user virtual reality for emergency simulation training: Usability study', *JMIR Serious Games*, 8(3), e18822.
- Li, Y., Lu, L., Zhang, C. and Chen, Z. (2022) 'Modelling crowd evacuation behavior with personality traits and real-time stress', *Physica A: Statistical Mechanics and its Applications*, 588, 126527.
- Lovreglio, R., González, V.A., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M. and Sacks, R. (2018) 'Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study', *Advanced Engineering Informatics*, 38, pp. 670–682.
- Maragkou, V., Rangoussi, M., Kalogeras, I. and Melis, N.S. (2023) 'Educational Seismology through an Immersive Virtual Reality Game: Design, Development and Pilot Evaluation of User Experience', *Education Sciences*, 13(11), 1088.
- Mitsuhara, H., Hirata, Y., Ochi, Y. and Shishibori, M. (2023) 'Evacuation training using VR games: Effects on behavioral decision-making in disasters', *Simulation & Gaming*, 54(1), pp. 31–51.

- Rajabi, A., Abbasi, A., Mohammadi, A. and Malekian, A. (2022) 'Improving public preparedness for earthquakes using simulation-based training', *International Journal of Disaster Risk Reduction*, 74, 102879.
- Rahouti, M., Salim, R., Nasiri, M. and Amini, F. (2017) 'Challenges of traditional disaster education in vulnerable settings', *Journal of Contingencies and Crisis Management*, 25(4), pp. 292–302.
- Solarino, S., Amaral Ferreira, M., Musacchio, G. and Eva, E. (2021) 'Playing games for risk prevention: Design, implementation and testing of serious games in recent European projects UPStrat-MAFA and KnowRISK', *Annals of Geophysics*, 64(3), SE327.
- Winarni, E.W., Purwandari, E.P. and Hervianti, Y. (2018) 'Mobile educational game for earthquake disaster preparedness in elementary school', *ARPN Journal of Engineering and Applied Sciences*, 13(7), pp. 2612–2618.
- Yamamoto, R., Kitaoka, A. and Inoue, K. (2019) 'Prototyping of an earthquake evacuation learning game with VR reproducing the environment that is familiar to learners', *Proceedings of the 27th International Conference on Computers in Education*, pp. 573–578.
- Yousefi, S., Ahmadi, M. and Ahmadi, A. (2024) 'Exploring the most effective feedback system for training people in earthquake emergency preparedness using immersive virtual reality serious games', *International Journal of Disaster Risk Reduction*, 89, 104630
- Yousefi, S., Ahmadi, M. and Ahmadi, A. (2024) 'Human behavior and decision-making in earthquake emergencies: insights from virtual reality and serious games', *International Journal of Construction Management*.
- Yüksel, G. and Çoban, M. (2022) 'Which training method is more effective in earthquake training: Digital game, drill or traditional training?', *Smart Learning Environments*, 9(1), 4.