

Interactive Narratives for Resilience: Designing a VR-Based Transmedia Learning Intervention for Earthquake Preparedness in Indonesian Schools

by M. Nabil



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Abstract. Indonesia faces recurring earthquakes, yet disaster education in schools often relies on lectures and drills that provide limited impact on preparedness and resilience. This paper presents the design phase of a virtual reality (VR) – based transmedia learning intervention for earthquake preparedness, developed in collaboration with Indonesian middle school students, teachers, and disaster risk reduction (DRR) practitioners. The intervention combines immersive VR scenarios with complementary classroom resources to create a multi-platform learning environment. Participatory co-design ensured cultural relevance, curriculum alignment, and practical usability, while addressing barriers such as limited infrastructure, device access, and teacher readiness. The paper details the project’s conceptual framework, narrative structure, and prototype assets, and positions the work within design-based research as an early stage in an iterative process. The planned evaluation will examine engagement, knowledge, and preparedness behaviors; however, the primary contribution lies in documenting the design rationale and strategies for integrating immersive narratives into disaster education. By highlighting lessons from this pre-production stage, the study offers guidance for researchers and practitioners seeking to adapt VR-based interventions to diverse educational and cultural contexts.

Keywords: virtual reality · transmedia learning · interactive narrative · disaster education

1 Introduction

Indonesia ¹ is one of the world’s most disaster-prone countries due to its position on the Pacific Ring of Fire and exposure to multiple tectonic boundaries. Earthquakes and tsunamis cause severe human, social, and economic impacts [1, 2]. Children are especially ² vulnerable, facing physical harm, disrupted schooling, and long-term trauma [3]. The Sendai Framework for Disaster Risk Reduction (2015–2030) emphasizes inclusive, child-centered preparedness, highlighting youth as active contributors to community resilience [4]. In response, Indonesia has introduced disaster education policies [5, 6], yet classroom implementation remains inconsistent.

Current practices—lectures, printed materials, and occasional evacuation drills—raise awareness but rarely build practical skills or sustained preparedness [7, 8]. Fewer than one-quarter of Indonesian middle school students can correctly demonstrate earthquake evacuation procedures [9]. Barriers include limited teacher training, scarce localized materials, and unequal access to resources in under-resourced schools [10]. These gaps indicate the need for innovative, engaging, and culturally relevant approaches.

Emerging technologies provide new opportunities. Virtual reality (VR) enables safe practice in realistic disaster scenarios, strengthening hazard awareness and decision-making [11, 12]. Studies show VR and serious games can surpass conventional methods in motivation, comprehension, and collaboration [13, 14]. Transmedia storytelling—distributing narrative elements across multiple platforms—has also proven effective in fostering engagement, agency, and preparedness when adapted to local contexts [15–17]. Combining VR and transmedia may help bridge the gap between knowledge and action in disaster education.

This paper reports on the design phase of a VR-based transmedia intervention for earthquake preparedness among Indonesian middle school students. The program integrates immersive VR simulations with classroom guides and story-based activities, creating multiple entry points for learning. Developed through participatory co-design with teachers, DRR practitioners, and students, it seeks cultural alignment and curricular relevance while addressing infrastructural limits. The focus on adolescents (ages 12–14) shows they are at a critical stage for developing independent reasoning and influencing community safety practices [18].

The project adopts a design-based research (DBR) framework, emphasizing iterative development, contextual adaptation, and stakeholder collaboration [19]. Rather than presenting outcomes, this paper shares design rationales, prototype assets, and identified challenges as a foundation for future classroom trials. This address concerns that early-stage projects risk speculation by clarifying their contribution: insights into strategies for resilience-focused interactive narratives.

Introducing VR into Indonesian schools raises equity concerns about cost, infrastructure, and teacher readiness. The intervention, therefore, runs on affordable, standalone headsets with offline functionality, supported by teacher guides and integration strategies. Addressing these barriers at the design stage aims to ensure accessibility beyond elite schools.

This paper addresses the urgent need for more effective disaster education in Indonesia. It contributes by (1) documenting the conceptual and design framework of the intervention, (2) presenting the narrative structure and prototype assets, and (3) identifying implementation challenges and adaptation strategies. These insights are intended for educators, researchers, and policymakers exploring immersive and narrative-driven approaches to disaster risk reduction.

2 Background and Rationale

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2.1 Disaster Risk Reduction (DRR) Education: Global and Indonesian Contexts

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DRR education has been a global priority since the Hyogo Framework (2005–2015) and the Sendai Framework (2015–2030) [7]. Both emphasize school-based education, recognizing children as highly vulnerable and key to spreading preparedness knowledge [53, 56]. However, in many countries, DRR education relies on lectures, manuals, or annual drills. These raise awareness but rarely build lasting knowledge or decision-making capacity [63, 67]. Passive methods seldom develop confidence, self-efficacy, or adaptive behavior—skills essential in emergencies [47, 71].

In Indonesia, these limitations are stark. Despite frequent earthquakes, tsunamis, and volcanic eruptions, fewer than one-quarter of middle school students can correctly perform evacuation procedures [75]. Although DRR is formally integrated into the national curriculum [8, 49], implementation is uneven. Many schools lack localized materials, trained teachers, or adequate infrastructure [52, 69]. Rural schools face additional disadvantages due to limited access to technology, deepening inequalities [26, 72]. These gaps highlight the need for approaches that move beyond awareness to build practical skills, emotional resilience, and context-specific preparedness while remaining adaptable across diverse school settings.

2.2 Transmedia Learning and the Role of Narrative

Narratives are a proven tool for education, making information memorable and emotionally resonant [60, 68]. In disaster contexts, locally grounded stories translate abstract risks into lived experience. The oral tradition of Smong in Aceh, for instance, preserved tsunami knowledge and saved lives in 2004 [61].

Transmedia learning expands narrative impact by distributing interconnected content across multiple media, with each medium adding a unique perspective to a broader storyworld [70, 74]. A game can simulate decisions, a video dramatize experiences, and printed materials support reflection, reinforcing learning through varied entry points [29].

Research shows transmedia approaches strengthen engagement and agency. Young people already use transmedia practices in informal learning [74]. Tombleson [76] highlights their potential for collaboration and critical thinking, while Dickinson-Delaporte et al. [20] report deeper engagement with complex topics in higher education. In Indonesian disaster education, transmedia interventions combining maps, board games, and storytelling have enhanced preparedness and encouraged peer-to-peer learning [31].

For resource-diverse settings, flexibility is a key advantage. High-tech tools such as VR or games can be paired with analog media, such as comics, posters, or oral storytelling, ensuring accessibility where technology is limited. By linking immersive simulations with classroom guides and peer activities, transmedia approaches overcome the weakness of standalone tools that often lack curricular integration [54].

2.3 Virtual Reality and Serious Games for Disaster Preparedness

VR offers immersive, risk-free environments for practicing disaster responses. Japan and New Zealand applications have improved hazard awareness, decision-making, and stress management [48, 62, 64]. However, many rely on costly equipment or strong internet connections, limiting use in low-resource schools [66]. Moreover, most focus on dramatic disaster response, neglecting preparedness behaviors, such as securing household objects or assembling kits, that reduce casualties and damage [77]. Designing accessible VR that emphasizes preparedness and response remains a critical need.

2.4 Defining Interactive, Immersive, and Transmedia Narratives

Combining interactive, immersive, and transmedia elements creates participatory, experiential, and scalable learning. Interactive structures foster agency, immersion supports embodied learning, and transmedia distribution allows adaptation across contexts. However, several gaps remain:

1. Cultural adaptation is limited. Many immersive projects are developed in high-resource contexts and transferred with minimal localization, reducing relevance in places like Indonesia, where local traditions and languages are vital [46].
2. Preparedness is underemphasized. VR applications often prioritize dramatic response scenarios, while proactive behaviors—arguably more actionable—receive little focus [55].
3. Curricular integration is weak. Many VR and game projects remain standalone, limiting sustainability without alignment to school practices and teacher capacity [54].

Together, these challenges underscore the need for disaster education strategies that integrate narrative, immersion, and transmedia distribution in ways that are culturally relevant, accessible, and embedded in curricula.

3 Project Rationale and Design Objectives

3.1 Targeting User

The intervention is initially designed for junior secondary students (ages 12–14). This age group occupies a developmental stage where abstract reasoning, autonomy, and peer influence are expanding, enabling them to grasp complex risk concepts and apply preparedness behaviors independently (Ronan & Johnston, 2005). Adolescents also act as conduits of knowledge, sharing safety practices with families and peers, thereby extending impact beyond the classroom (Luciana et al., 2018).

Concerns that this focus might be overly narrow are addressed through modularity. The scenarios, vocabulary, and assessment tasks are parameterized to allow adjustment for younger or older learners. Transmedia components—such as teacher guides, story-based prompts, and printed resources—are adaptable across various literacy levels. Middle school students are thus the focal group for piloting, but the design anticipates broader age applicability.

3.2 Pedagogical Outcomes

The project identifies four outcomes aligned with disaster risk reduction (DRR) education and experiential learning theory [6, 21] below:

1. **Actionable knowledge:** equips students with usable understanding of earthquake risks and evacuation procedures [6].
2. **Procedural skills:** Reinforced through VR scenarios that train hazard recognition, prioritization, and response under time constraints [28].
3. **Psychosocial resilience** is supported by narrative, reflection, and group activities that strengthen coping and collective efficacy [33].
4. **Sustained engagement:** This aspect achieved through transmedia links between VR, classroom, and home, enabling transfer of learning into daily practice [42].

Outcomes are measured through knowledge tests, behavioral observations, and self-efficacy surveys.

3.3 The Implementation Gap in Indonesian Disaster Education for Children

The design responds to Indonesian school constraints and equity in access.

1. **Economic Accessibility:** Standalone offline headsets with short (10–15 min) sessions and rotating devices enable classroom use; paper role-play and tabletop activities extend reach.
2. **Physical Accessibility:** Gaze-based and single-controller modes support varied abilities; seated play reduces motion sickness; narration and captions enhance inclusion.
3. **Language and Cultural Fit:** Instructions in Bahasa Indonesia with regional options; environments mirror local homes and practices of mutual aid.
4. **Preparedness Emphasis:** Focus on securing furniture, emergency kits, and evacuation planning rather than dramatic response.
5. **Curricular Integration:** Teacher guides align with national DRR standards [3, 4], providing objectives, safety checks, and prompts for 40–45 min lessons.

3.4 Guiding Principles and Design Phase

Three design principles provide the framework:

1. **Inclusivity:** Anticipating socioeconomic, linguistic, and ability diversity through multimodal interfaces and structured classroom roles so all students can participate.
2. **Context Sensitivity:** Co-developing assets with teachers and DRR experts to reflect local environments, cultural practices, and risks, with configurable elements for regional adaptation.
3. **Participatory Co-Design:** involving educators, students, and professionals in ideation, prototyping, and testing to ensure transparency and build community ownership.

Commitments from the Design Phase:

1. Framing this paper within a design-based research process.
2. Ensuring adaptability across age groups while piloting with middle school students.
3. Prioritizing preparedness behaviors over spectacle-driven scenarios.
4. Embedding VR within a broader transmedia system for transfer and scalability.
5. Treating equity and accessibility as baseline conditions.

These objectives balance theoretical grounding and practical constraints, providing a foundation for evaluation and refinement.

4 Design and Development

4.1 Co-design with Teachers, DRR Experts, and Students

The intervention was developed as a VR-based transmedia learning system where content is distributed across media, with VR providing immersive and interactive environments [21, 35]. Interactive narratives enabled branching choices that fostered reflection, while VR supported presence, engagement, and experiential transfer [14, 59]. Following design-based and human-centered methods [18], three iterative cycles engaged teachers, DRR practitioners, and students (ages 12–14) in earthquake-prone districts, with safeguards for minors such as seated play and post-session check-ins.

1. Cycle 1 mapped routines and preparedness behaviors within classroom constraints. Cycle 2 co-specified scenarios, embedding decision points (securing electricity vs evacuating).
2. Cycle 3 refined prototypes through playtests, with errors triggering feedback and retries.

The process aligned DRR outcomes knowledge, skills, resilience, and transfer—with VR affordances of immersion, interactivity, and narrative branching, ensuring contextual and curricular relevance.

4.2 Narrative and Scenario Structure

The scenario adopts a preparedness-first approach, with immediate post-event checks to ensure completeness. To fit lesson length and support repeated practice, the experience is organised into two chapters:

- **Chapter 1: Preparedness.** Learners recognise hazards, secure interior risks, and assemble an emergency kit under timed constraints.
- **Chapter 2: Simulation and aftermath.** Learners take protective action during shaking, conduct post-event checks, and evacuate to an assembly point.

Progression is competency-based: later tasks unlock after prerequisite actions are completed. Missed steps trigger concise feedback and a short retry. Task selection follows BNPB school preparedness guidance and the Sekolah Aman Bencana (SPAB)

Table 1. Scene-level tasks and evidence captured

Chapter	Scene	Core task	Evidence captured (units/examples)
1	Emergency kit assembly	Select essential items; avoid unsuitable ones	Completion time (s); % correct; error type (missing/incorrect)
	Secure tall furniture	Move/anchor wardrobe, bookshelf to clear exit	Object state change; exit path clearance (yes/no) within time
	Safeguard fragile items	Lower glass/ceramics; relocate to safe corners	Count correctly repositioned; residual hazard score
	Prepare utilities	Identify mains panel; plan for shut-off	Identification latency (s); correct panel recognition (yes/no)
2	Protective action	Move to safer zone; drop-cover-hold	Time to safe posture (s); posture correctness; exposure events
	Post-event checks	Self/peer check; switch off mains	Sequence accuracy; omission errors
	Emergency signalling	Share status/location via device	Correct contact path; message completeness
	Evacuation	Follow signage to assembly point	Route efficiency; adherence to wayfinding cues

framework, prioritising actions that are feasible to rehearse in school and transferable to home routines (securing interiors, evacuation route planning, utility shut-off) [49] (Table 1).

Indicators such as time-to-safe-posture and sequence accuracy provide **construct-valid traces** of procedural skill; identification accuracy reflects actionable knowledge; signalling and evacuation behaviours align with school routines and intended transfer.

4.3 Mechanics: Multimodal Delivery, Focused Gamification, Constrained Branching

Multimodal delivery integrates icons, short text, cues, and brief voiceovers; physical actions mirror real tasks, supporting signalling and essential processing [21]. Focused gamification uses a countdown, readiness meter, and task-contingent feedback on what, why, and how, aiding transfer via cognitive load and formative feedback (Fig. 1).

The VR Earthquake Preparedness game starts when the player hears a siren, wakes up, and quickly grabs a bag to collect essential items before time runs out. Next, the

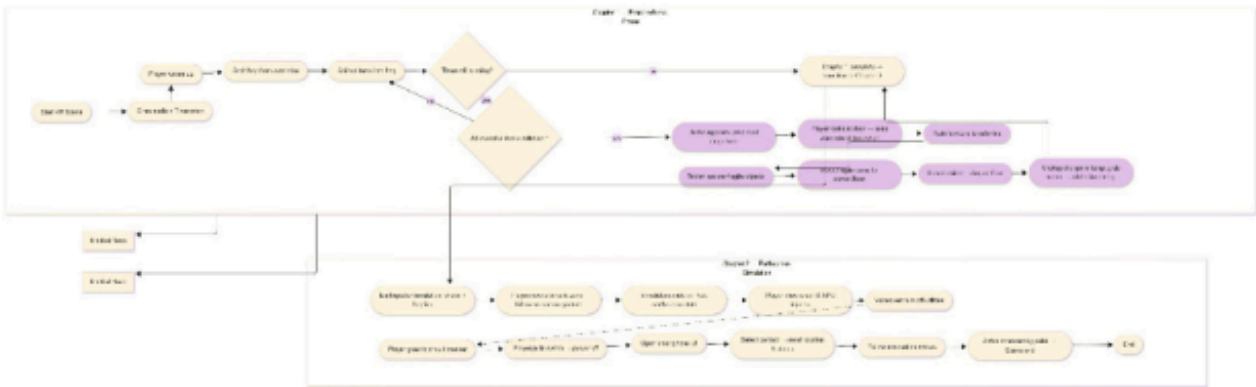


Fig. 1. Technical VR Mechanism

player secures tall furniture, moves fragile objects to a safe spot, lays down the mirror, and unplugs the lamp and charger while taking a water bottle with the emergency bag. After preparation, the earthquake simulation begins, and the player follows safety instructions to move to the safe zone. Once the shaking stops, the player checks for injuries, turns off the main power, sends an emergency signal through the smartphone, and finally follows the evacuation signs to the assembly point, where the scenario ends. Constrained branching shows visible consequences (hazards, missing kit) yet rejoins quickly, balancing agency with clarity [43, 44].

4.4 Asset Creation and Classroom Delivery

The interface applies high-contrast icons with labels, consistent prompts, and captions aligned with audio per XR accessibility guidance [W3C, 2019]. Semi-realistic, low-complexity 3D assets represent Indonesian homes/streets; interactables highlight preparedness items, budgeted for standalone headsets. Audio integrates spatial cues (sirens, ambience) and Indonesian voiceovers to reduce reading load, with captions retained; comfort is addressed via teleport, vignette, gaze-select, seated play, and single-controller options (Fig. 2).



Fig. 2. GUI Assets

Performance is kept smooth at 72–90 fps with foveated rendering and readability tests. Core variables—time limits, vocabulary, hints, signage, and item lists—are stored in configuration files, making scenarios easy to adjust. The 3D environment includes both preparedness objects and decoy assets (irrelevant items) to test focus. A typical 10 min session is structured as a short briefing, a single VR scenario where students interact with safety and decoy items, and a quick debrief to review decisions. This compact model

2. **Exclusions & Ethics:** Motion sickness, epilepsy, other contraindications; ethics approved; safeguards: ≤ 15 -min VR, seated play, stop-on-request, post-check-ins.
3. **Instruments:** UEQ, IMI, TAM, GEL, curriculum tests, structured observation, in-game analytics (hazard accuracy, safe-posture time, sequence, routes); reliability $\geq .70$, validated translations.
4. **Procedures:** T0 baseline + teacher sheets; T1 post-lesson (UEQ, IMI, GEL, TAM, fidelity, logs); T2 (3–4 weeks) follow-up with knowledge, GEL, preparedness, TAM; subsample observed/interviewed.
5. **Outcomes:** Engagement, knowledge, procedural behaviour, transfer; secondary: adoption & feasibility.
6. **Analysis:** Multilevel/ANCOVA, GLMM, reliability checks, imputation, thematic coding.

6 Implementation Challenges and Mitigation

School-level implementation faces constraints in infrastructure, cultural adaptation, and teacher readiness. Device access is uneven across districts, with issues of power stability, sanitation, and hardware maintenance; thus, delivery is designed for 1–3 headsets per class, seated play, rotation within 40–45 min, hygiene kits, and backup power solutions. Equity is addressed through pooling, booking rotas, and monitoring of implementation outcomes such as feasibility and sustainability [52]. Cultural and linguistic adaptation is ensured by providing prompts and audio in Bahasa Indonesia, configurable assets, and localisation briefs validated with DRR practitioners; content follows plain-language standards and reflects both urban and rural motifs while aligning with national DRR guidance [46, 55]. Teacher readiness is supported through a brief–rotate–debrief format, non-VR alternatives, structured guides, and short professional learning sessions. Adoption and fidelity are tracked through TAM indicators, observation, and teacher interviews, aligning with TPACK-based professional development [19, 21].

Outlook and Evaluation Link

Offline builds, short cycles, parameterised assets, and structured teacher support mitigate common barriers but do not eliminate systemic constraints. The evaluation will test acceptability, feasibility, fidelity, and adoption. Monitoring includes fidelity scores, teacher TAM, penetration/sustainability indicators, and learner outcomes (knowledge, readiness, transfer). Results will refine device governance, PD dosage, and localisation workflows for broader rollout.

7 Discussion

7.1 Design-Phase Insights and Lessons Learned

Across three cycles, several design choices proved consequential. Segmented tasks with immediate retries outperformed long narrative arcs for preparedness practice, consistent with cognitive load and segmenting principles. Constrained branching supported agency while preserving pacing and classroom oversight—an acceptable balance in the agency–coherence tension of interactive narrative. Multimodal signalling (high-contrast icons

plus concise text/voice) reduced errors more reliably than higher visual fidelity, aligning with signalling/modality guidance and the caution that presence alone does not ensure learning.

The readiness score aided debriefs when reported as components (timeliness, accuracy, and sequence adherence); transparency aligns with formative feedback guidance and avoids over-aggregation. Non-VR “mirrors”—aligned, low-tech rehearsals of the same steps—sustained whole-class participation and discussion, but are not equivalent to headset exposure; they mainly support near transfer and preparation for practice. The brief–rotate–debrief model remained workable only with explicit roles (observer, timer, recorder) and one-page checklists. These insights map to the project outcomes: fewer in-scene errors and faster time-to-safe-posture (procedural skill), more precise rule application (actionable knowledge), more confident debrief participation (psychosocial resilience), and reported household steps (transfer). Phases B/C will test these links using analytics, fidelity scores, and short-form scales.

7.2 Novelty of Participatory Transmedia and VR

Implementing VR for disaster risk reduction (DRR) in Indonesian schools requires addressing infrastructural, cultural, and pedagogical constraints. Device shortages, unstable power, and hygiene issues are managed through a rotation model with 1–3 headsets per class, ≤ 10 min seated turns, offline operation, and pooled resources [52]. Local adaptation is ensured by using Indonesian language, configurable signage and household assets, and validated terminology aligned with national DRR guidance [46, 55]. Teachers are supported with structured guides, objectives, and short professional learning aligned with TPACK (Technological Pedagogical Content Knowledge), enabling curricular integration and sustainable use [19, 21].

The project contributes by combining participatory co-design, preparedness-first content, and transmedia integration with teacher-led reflection. Storytelling within VR situates learners in familiar environments where interactive narratives promote agency, immersive cues foster presence, and culturally resonant tasks ground preparedness actions. Narrative debriefs extend learning through retrieval, elaboration, and social regulation, reinforcing coping strategies and self-efficacy. This approach contrasts with common spectacle-oriented disaster simulations by embedding VR as a teachable classroom component rather than a one-off novelty.

Scalability is supported by shared device pools, configurable assets, and low reading loads, while adaptability extends to multiple hazards and age groups. For policy, mapping tasks to curriculum standards, district-level procurement, and collaboration with DRR agencies ensure alignment, equity, and sustainability [52].

8 Conclusion

This paper documents the design phase of a VR-supported, transmedia intervention for earthquake preparedness in Indonesian schools. The contribution is a replicable design strategy—not summative effects—combining participatory co-design, a preparedness-first focus, and integration of headset practice with teacher-led, low-tech activities.

Design choices (segmented tasks, constrained branching, multimodal signalling, brief–rotate–debrief delivery, and readiness metrics) are aligned with four key outcomes: actionable knowledge, procedural skill, psychosocial resilience, and transfer beyond the classroom.

The work carries theoretical implications: (i) constrained branching as a pragmatic resolution of the agency–coherence tension in interactive narrative; (ii) segmenting and signalling as first-order principles for preparedness tasks in VR; and (iii) transmedia + debrief as a mechanism for retrieval, elaboration, and transfer.

Next steps proceed through staged pilots (A: formative refinement; B: feasibility and adoption; C: preregistered cluster-level outcomes). Scale-up will be contingent on pre-specified thresholds, including: fidelity (e.g., $\geq 80\%$ adherence with acceptable dosage/quality), penetration/sustainability across participating schools, minimum learning effects (e.g., a priori bands for knowledge and readiness components), and an adverse-event ceiling. Equity checks will include stratified results by school type and, where feasible, measurement invariance of key scales.

If evidence supports these criteria, policy integration will follow via curriculum mapping to BNPB/SPAB (and Sendai priorities), a repeatable 60–90-min teacher module, and district shared-device management for procurement, maintenance, and sanitation. To support reuse and review, we will provide a supplement containing the design log, configuration schema (for configurable content), teacher materials (session recipe, fidelity checklist, debrief prompts), and a summary of performance/comfort targets.

References

1. Løvholt, F., et al.: Tsunami risk reduction—are we better prepared today than in 2004? *Int. J. Disaster Risk Reduct.* **10**, 127–142 (2014)
2. Badan Nasional Penanggulangan Bencana (BNPB): Data dan informasi bencana Indonesia (2014). <https://dibi.bnpb.go.id/>. Accessed 22 June 2025
3. Peek, L.: Children and disasters: Understanding vulnerability, developing capacities, and promoting resilience—an introduction. *Child. Youth Environ.* **18**(1), 1–29 (2008)
4. UNICEF: Adolescent and youth engagement in climate action in Indonesia (2021). <https://www.unicef.org/indonesia/reports/adolescent-and-youth-engagement-climate-action-indonesia>. Accessed 22 June 2025
5. Sakurai, A., Bisri, M.B.F., Oda, T., Oktari, R.S., Murayama, Y., Affan, M.: Exploring minimum essentials for sustainable school disaster preparedness: a case of elementary schools in Banda Aceh City, Indonesia. *Int. J. Disaster Risk Reduct.* **29**, 73–83 (2018)
6. Amri, A., Lassa, J.A., Tebe, Y., Hanifa, N.R., Kumar, J., Sagala, S.: Pathways to disaster risk reduction education integration in schools: insights from SPAB evaluation in Indonesia. *Int. J. Disaster Risk Reduct.* **73**, 102860 (2022)
7. United Nations Office for Disaster Risk Reduction (UNDRR): Sendai Framework for Disaster Risk Reduction 2015–2030 (2015). <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>. Accessed 22 June 2025
8. Kementerian Pendidikan dan Kebudayaan (Kemdikbud): Kemendikbudristek luncurkan kurikulum kebencanaan, 21 January 2022. <https://www.kemdikbud.go.id/main/blog/2022/01/kemendikbudristek-luncurkan-kurikulum-kebencanaan>. Accessed 22 June 2025
9. Sari, I.R., Purwati, N., Rosyida, A.F.: Disaster preparedness in children in Indonesia: a scoping review. *Jurnal Ners dan Kebidanan (Journal of Ners and Midwifery)* **10**(1), 102–111 (2023)

10. Wulansari, P., Subroto, E., Utomo, D.B.: Knowledge and preparedness of disaster mitigation for students in Indonesia. *J. Vocation. Health Stud.* **6**(3), 209–216 (2022)
11. Fitriani, D., Pratiwi, D.: Effectiveness of disaster preparedness education on disaster preparedness knowledge and attitude in school-age children in Indonesia: a systematic review. *Jurnal Keperawatan Sriwijaya* **10**(1), 16–25 (2023)
12. Shaw, R., Shiwaku, K., Takeuchi, Y. (eds.) *Disaster Education*. Emerald Group Publishing (2011)
13. Johnson, V.A., Ronan, K.R., Johnston, D.M., Peace, R.: Evaluations of a child-centered disaster risk reduction education program in a low-to-moderate hazard risk country. *Int. J. Disaster Risk Reduct.* **9**, 107–123 (2014)
14. Huang, Y.M., Chen, C.H., Hwang, G.J.: An investigation of effectiveness and engaging effects of virtual reality-based disaster education. *Interact. Learn. Environ.* **28**(7), 912–925 (2020)
15. Radianti, J., Majchrzak, T.A., Fromm, J., Wohlgenannt, I.: A systematic review of immersive virtual reality applications for higher education: design elements, lessons learned, and research agenda. *Comput. Educ.* **147**, 103778 (2020)
16. Slater, M., Sanchez-Vives, M.V.: Enhancing our lives with immersive virtual reality. *Front. Robot. AI* **3**, Article 74 (2016)
17. Götz, M.: Transmedia learning: the role of narrative in educational media. International Central Institute for Youth and Educational Television (2012)
18. Djalante, R., Holley, C., Thomalla, F., Carnegie, M.: Pathways for adaptive and integrated disaster resilience. *Nat. Hazards* **69**(3), 2105–2135 (2013)
19. Alper, M., Herr-Stephenson, R.: Transmedia play: literacy across media. *J. Media Literacy Educ.* **5**(2), 366–374 (2013)
20. Dickinson-Delaporte, S., Gunness, A., McNair, H.: Engaging higher education learners with transmedia play. *J. Mark. Educ.* **42**(2), 123–133 (2020)
21. Mayer, R.E.: Principles for managing essential processing in multimedia learning. In: Mayer, R.E. (ed.) *The Cambridge Handbook of Multimedia Learning*, 2nd edn., pp. 165–182. Cambridge University Press (2014)
22. Immordino-Yang, M.H., Damasio, A.: We feel, therefore we learn: the relevance of affective and social neuroscience to education. *LEARNing Landsc.* **5**(1), 115–131 (2011)
23. Glenberg, A.M., Gallese, V.: Action-based language: a theory of language comprehension. *Cortex* **48**(7), 905–918 (2012)
24. Apostolakis, K.C., et al.: Path of trust: a prosocial co-op game for building up trustworthiness and teamwork. In: De Gloria, A., Veltkamp, R. (eds.) *GALA 2015. LNCS*, vol. 9599, pp. 80–89. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-40216-1_9
25. Fischer, R., et al.: Cultural challenges for adapting behavioral intervention frameworks: a critical examination from a cultural psychology perspective. *Clin. Psychol. Rev.* **110**, 102425 (2024)
26. Asosiasi Penyelenggara Jasa Internet Indonesia (APJII): *Survei penetrasi internet Indonesia 2023* (2023). <https://apjii.or.id/survei>. Accessed 22 June 2025
27. IDEO: *The field guide to human-centered design*. IDEO (2015)
28. Scolari, C.A., Masanet, M.J., Guerrero-Pico, M., Establés, M.J.: Transmedia literacy in the new media ecology: teens' transmedia skills and informal learning strategies. *Profesional de la Información* **27**(4), 801–812 (2018)
29. Tombleson, B.: Transmedia learning: a literature review. *Technol. Pedagog. Educ.* **33**(2), 255–269 (2024)
30. Hancox, D.: From subject to collaborator: transmedia storytelling and social research. *Convergence* **23**(1), 49–60 (2017)
31. Satyagraha, A., Hutapea, G.: Transmedia learning map: disaster risk reduction education content for primary school students in Indonesia. In: Martyastadi, Y.S., et al. (eds.) *IMDES 2023*.

- LNCS, vol. 790, pp. 3–12. Springer, Cham (2023). https://doi.org/10.2991/978-2-38476-136-4_2
32. Clandinin, D.J., Caine, V.: Narrative inquiry. In: *Handbook of Qualitative Research in Education*, 2nd edn. pp. 165–177. SAGE Publications (2013)
 33. Lavoie, M.: Walking alongside: relational research spaces in visual narrative inquiry. *Int. J. Qual. Methods* **20** (2021)
 34. Naul, E., Liu, M.: Why story matters: a review of narrative in serious games. *J. Educ. Comput. Res.* **58**(3), 687–707 (2020)
 35. Anderson, T., Shattuck, J.: Design-based research: a decade of progress in education research? *Educ. Res.* **41**(1), 16–25 (2012)
 36. Raybourn, E.M.: A new paradigm for serious games: transmedia learning for more effective training and education. *J. Comput. Sci.* **5**(3), 471–481 (2014)
 37. Behnke, K., Bennett, E.: Serious games for resilience: evaluating disaster risk education for children. *Int. J. Disaster Risk Reduct.* **65**, 102553 (2021)
 38. Edmondson, L., Pearce, J.M.: Disaster education: a critical review. *Int. J. Disaster Risk Sci.* **10**(3), 384–399 (2019)
 39. Pinasthika, L.T.: “Keep it interesting for generation Z”: evaluating immersive factors in recreational reading activity. In: *Proceedings of the 2nd International Conference of Innovation in Media and Visual Design (IMDES 2023)*, pp. 33–46. Atlantis Press (2023)
 40. Wouters, P., van Nimwegen, C., van Oostendorp, H., van der Spek, E.D.: A meta-analysis of the cognitive and motivational effects of serious games. *J. Educ. Psychol.* **105**(2), 249–265 (2013)
 41. Laugwitz, B., Held, T., Schrepp, M.: Construction and evaluation of a user experience questionnaire. In: Holzinger, A. (ed.) *USAB 2008*. LNCS, vol. 5298, pp. 63–76. Springer, Heidelberg (2008)
 42. Davis, F.D.: Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* **13**(3), 319–340 (1989)
 43. Ryan, R.M., Deci, E.L.: Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemp. Educ. Psychol.* **25**(1), 54–67 (2000)
 44. Ryan, M.-L., Thon, J.-N. (eds.): *Storyworlds Across Media: Toward a Media-Conscious Narratology*. University of Nebraska Press (2014)
 45. Sanders, E.B.-N., Stappers, P.J.: Co-creation and the new landscapes of design. *CoDesign* **4**(1), 5–18 (2008)
 46. Afrian, R., Hariadi, J., Akob, B., Islami, Z.: Local culture inventory for disaster mitigation learning. *IOP Conf. Ser. Earth Environ. Sci.* **412**, 012017 (2020). <https://doi.org/10.1088/1755-1315/412/1/012017>
 47. Aghaei, N., Seyedin, H., Sanaeinasab, H.: Strategies for disaster risk reduction education: a systematic review. *J. Educ. Health Promot.* **7**, 98 (2018). https://doi.org/10.4103/jehp.jehp_31_18
 48. Alshowair, A., Bail, J., Alsuwailem, F., Mostafa, A., Abdel-Azeem, A.: Use of virtual reality exercises in disaster preparedness training: a scoping review. *SAGE Open Med.* **12**, 20503121241241936 (2024). <https://doi.org/10.1177/20503121241241936>
 49. Amri, A., Lassa, J., Tebe, Y., Hanifa, N., Kumar, J., Sagala, S.: Pathways to disaster risk reduction education integration in schools: insights from SPAB evaluation in Indonesia. *Int. J. Disaster Risk Reduct.* (2022). <https://doi.org/10.1016/j.ijdrr.2022.102860>
 50. Anastasiadis, T., Lampropoulos, G., Siakas, K.: *Digital Game-based Learning and Serious Games in Education*, vol. 4, pp. 139–144 (2018). <https://doi.org/10.31695/IJASRE.2018.33016>
 51. Apostolakis, J.: Detector simulation. *Particle Phys. Ref. Libr.* (2020). https://doi.org/10.1007/978-3-030-35318-6_11

52. Cabatay, M., Gonzales, H.B.: Disaster prevention and risk reduction education implementation in special education schools in Indonesia: teachers' challenges, strategies, and recommendations. *Jurnal Pendidikan Sains Indonesia* (2024). <https://doi.org/10.24815/jpsi.v12i1.35191>
53. Cabello, V., Véliz, K., Moncada-Arce, A., García-Huidobro, M.I., Juillerat, F.: Disaster risk reduction education: tensions and connections with sustainable development goals. *Sustainability* (2021). <https://doi.org/10.3390/su131910933>
54. Checa, D., Bustillo, A.: A review of immersive virtual reality serious games to enhance learning and training. *Multimedia Tools Appl.* **79**, 5501–5527 (2019). <https://doi.org/10.1007/s11042-019-08348-9>
55. Cong, Z., Kan, C., Hagedorn, A., Thomas, S., Yeager, R.: Development of a virtual reality platform to promote disaster preparedness among older adults. *Innov. Aging* **5**, 350 (2021). <https://doi.org/10.1093/geroni/igab046.1360>
56. Cui, K., Han, Z., Wang, D.: Resilience of an earthquake-stricken rural community in southwest china: correlation with disaster risk reduction efforts. *Int. J. Environ. Res. Publ. Health* **15**, 407 (2018). <https://doi.org/10.3390/ijerph15030407>
57. Gil, M., Sylla, C.: A close look into the storytelling process: the procedural nature of interactive digital narratives as learning opportunity. *Entertain. Comput.* **41**, 100466 (2021). <https://doi.org/10.1016/j.entcom.2021.100466>
58. Hancox, D.: From subject to collaborator: transmedia storytelling and social research. *Convergence* **23**(1), 49–60 (2017). <https://doi.org/10.1177/1354856516675252>
59. Hwang, A., Kim, J., Lobo, S.N., Shu, Y., Won, A.: Being there to learn: narrative style and cross-platform comparison for 360-degree educational videos. *Proc. ACM Hum.-Comput. Interact.* **6**, 1–28 (2022). <https://doi.org/10.1145/3555169>
60. Immordino-Yang, M.H.: The power of the adolescent mind. *Phi Delta Kappan* **106**, 48–54 (2025). <https://doi.org/10.1177/00317217251342371>
61. Jerolleman, A.: Storytelling and Narrative Research in Crisis and Disaster Studies. *Oxford Research Encyclopedia of Politics* (2021). <https://doi.org/10.1093/acrefore/9780190228637.013.1615>
62. Jung, Y.-R.: Virtual reality simulation for disaster preparedness training in hospitals: integrated review. *J. Med. Internet Res.* **24**, e30600 (2021). <https://doi.org/10.2196/30600>
63. Kitagawa, K.: Disaster risk reduction activities as learning. *Nat. Hazards* **105**, 3099–3118 (2020). <https://doi.org/10.1007/s11069-020-04443-5>
64. Lovreglio, R., et al.: Prototyping virtual reality serious games for building earthquake preparedness: the Auckland city hospital case study. *Adv. Eng. Inform.* **38**, 670–682 (2018). <https://doi.org/10.1016/J.AEI.2018.08.018>
65. Luciana, M., et al.: Adolescent neurocognitive development and impacts of substance use: overview of the adolescent brain cognitive development (ABCD) baseline neurocognition battery. *Dev. Cogn. Neurosci.* **32**, 67–79 (2018). <https://doi.org/10.1016/j.dcn.2018.02.006>
66. Mergen, M., Graf, N., Meyerheim, M.: Reviewing the current state of virtual reality integration in medical education - a scoping review. *BMC Med. Educ.* **24**, 788 (2024). <https://doi.org/10.1186/s12909-024-05777-5>
67. Nakano, G., Yamori, K.: Disaster risk reduction education that enhances the proactive attitudes of learners: a bridge between knowledge and behavior. *Int. J. Disaster Risk Reduct.* (2021). <https://doi.org/10.1016/j.ijdr.2021.102620>
68. Neto, D.D.R., Barcelos, M.: Stories in the agenda: a Narrative Policy Framework study. *Revista de Administração Pública* (2020). <https://doi.org/10.1590/0034-761220190395x>
69. Nurdin, N.: Disaster risk reduction in education and the secondary high school science curriculum in Indonesia (2019). <https://consensus.app/papers/disaster-risk-reduction-in-education-and-the-secondary-nurdin/f36ab98a6cb95ede8ad4f66a762bc711/>

70. Perry, M.: Multimodal engagement through a transmedia storytelling project for undergraduate students. *GEMA Online J. Lang. Stud.* **20**, 19–40 (2020). <https://doi.org/10.17576/gema-2020-2003-02>
71. Pfefferbaum, B., Pfefferbaum, R., Van Horn, R.: Involving children in disaster risk reduction: the importance of participation. *Eur. J. Psychotraumatol.* **9**, 1425577 (2018). <https://doi.org/10.1080/20008198.2018.1425577>
72. Pratiwi, P., Dwiningrum, S., Sumunar, D.R.S.: Integrated disaster risk management in the education process in schools. *IDRiM J.* (2023). <https://doi.org/10.5595/001c.91284>
73. Rizvic, S., Boskovic, D., Okanovic, V., Sljivo, S., Zukic, M.: Interactive digital storytelling: bringing cultural heritage in a classroom. *J. Comput. Educ.* **6**(1), 143–166 (2018). <https://doi.org/10.1007/s40692-018-0128-7>
74. Scolari, C., Establés, M.-J.: Transmedia Literacy in the New Media Ecology An International Map of Teens’ Transmedia Skills (2019). <https://consensus.app/papers/transmedia-literacy-in-the-new-media-ecology-an-scolari-establ%C3%A9s/8b985e39a24e5bd1a527fe9641bc40b4/>
75. Sheehy, K., Vacková, P., Van Manen, S., Turnip, S., Rofiah, K., Twiner, A.: Inclusive disaster risk reduction education for Indonesian children. *Int. J. Incl. Educ.* **28**, 2529–2545 (2022). <https://doi.org/10.1080/13603116.2022.2115156>
76. Tombleson, B.: Building a model for transmedia learning. ASCILITE Publications (2023). <https://doi.org/10.14742/apubs.2023.686>
77. Xin, G., Kongmant, R., Turnbull, N., Thongkum, W.: Evaluating the application of virtual reality technology in disaster prevention education: a case study of Sichuan Province, China. *Stud. Health Technol. Inform.* **323**, 322–326 (2025). <https://doi.org/10.3233/SHTI250104>

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