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Utilizing Extended Reality in Disaster Risk Reduction Education: A Scoping Review

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Abstract : Background: In response to the rise in natural disasters linked to climate change, numerous studies on Disaster Risk Reduction Education (DRRE) have emerged since the '90s, mainly using a didactic transmission-based approach. Effective DRRE should align with an interactive, experiential, and participatory educational model, which can be costly and risky. A potential solution is using simulations facilitated by eXtended Reality (XR). Research Question: This study aims to conduct a scoping review to explore educational methodologies that use XR to enhance knowledge among teachers, students, and citizens about environmental risks, natural disasters (including climate-related ones), and their management. Method: A search string of 66 keywords was formulated, spanning three domains: 1) education and target audience, 2) environment and natural hazards, and 3) technologies. On June 21st, 2023, the search string was used across five databases: EBSCOhost, IEEE Xplore, PubMed, Scopus, and Web of Science. After deduplication and removing papers without abstracts, 2,152 abstracts (published between 2013 and 2023) were analyzed and 2,062 papers were excluded, followed by the exclusion of 56 papers after full-text scrutiny. Excluded studies focused on unrelated technologies, non-environmental risks, and lacked educational outcomes or accessible texts. Main Results: The 34 reviewed papers were analyzed for context, risk type, research methodology, learning objectives, XR technology use, outcomes, and educational affordances of XR. Notably, since 2016, there has been a rise in scientific publications, focusing mainly on seismic events (12 studies) and floods (9), with a significant contribution from Asia (18 publications), particularly Japan (7 studies). Methodologically, the studies were categorized into empirical (26) and non-empirical (8). Empirical studies involved user or expert validation of XR tools, while non-empirical studies included systematic reviews and theoretical proposals without experimental validation. Empirical studies were further classified into quantitative, qualitative, or mixed-method approaches. Six qualitative studies involved small groups of users or experts, while 20 quantitative or mixed-method studies used seven different research designs, with most (17) employing a quasi-experimental, one-group post-test design, focusing on XR technology usability over educational effectiveness. Non-experimental studies had methodological limitations, making their results hypothetical and in need of further empirical validation. Educationally, the learning objectives centered on knowledge and skills for surviving natural disaster emergencies. All studies recommended XR technologies for simulations or serious games but did not develop comprehensive educational frameworks around these tools. XR-based tools showed potential superiority over traditional methods in teaching risk and emergency management skills. However, conclusions were more valid in studies with experimental designs; otherwise, they remained hypothetical without empirical evidence. The educational affordances of XR, mainly user engagement, were confirmed by the studies. Authors' Conclusions: The analyzed literature lacks specific educational frameworks for XR in DRRE, focusing mainly on survival knowledge and skills. There is a need to expand educational approaches to include uncertainty education, developing competencies that encompass knowledge, skills, and attitudes like risk perception.

Keywords : disaster risk reduction education, educational technologies, scoping review, XR technologies
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