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Does extended reality work for skills training?

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In this position paper, we outline some key arguments on why extended reality (XR), an umbrella term for virtual, augmented and mixed reality, might work well for skills training, specifically in the context of emergency preparedness. Previous work demonstrates that XR offers benefits in skills-training and experience-based learning (Çöltekin et al., 2020a, 2020b). Not only can we fully control and simulate all imaginable scenarios in XR, but we can do this safely, enabling responders to learn from past experiences and preparing for future events. While XR may not entirely replace traditional emergency preparedness training, it can greatly enhance it, especially for high-severity, low-frequency events.

XR has been proposed and used in the emergency-related fields since the 2010s, where training dominates much of the discourse (Zhu et al., 2021, Khanal et al., 2022). This is no surprise, as skills training is experience based, i.e., arguably, does not require much conscious thought, i.e., it aims to ingrain correct responses and lessen the need for slow, knowledge-based behavior (e.g., del Amo et al., 2018, Rasmussen 1983). As XR offers unlimited repetitions and variations for even the rarest scenarios and enables experience-based learning, it supports an effective conversion of knowledge to skills (e.g., del Amo et al., 2018). Furthermore, by recording scenarios from the participant's point of view, XR allows for much better post-training briefings than would be possible from the participant's recollection alone (Forondo et al., 2016).

Of the different types of XR, VR excels in fully controlled experiments and the simulation of rare events, where full immersion leads to memorable experiences (e.g., Lokka & Çöltekin 2026, Lokka et al., 2018), which is key to learning, In contrast, AR and MR excel at augmenting existing training methods with relevant information embedded "in-situ", offering most value in-field exercises and during actual response interventions. From an interaction point of view, AR and MR enable seamless information push as needed or on-demand, potentially leading to lower task- and cognitive load among responders (Elmasllari, 2018). Also importantly, XR can enable team-based simulation and training for collaboration, and coordination during emergency response (Reed et al., 2017). Current XR technology enables shared exercises to be organized by single units or even a few responders wanting to learn together. Another key advantage is that small teams can participate (virtually) in shared large-scale XR exercises, for which travel time in the real world would have been a limiting factor (Khanal et al., 2022).

Based on the evidence presented above, we conclude that XR responds to the key needs, i.e., safety, cost-effectiveness, logistics, and collaboration, in emergency training. It is well-suited for most emergency-related scenarios and training, but excels at simulating low-frequency, high-impact events. We expect the future role of XR in emergency preparedness to be even larger, as recent advances in generative artificial intelligence, such as realistic AI-generated sound, video, behaviors, and dialogues, can foster and support new opportunities for experiential learning.

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