XR TECHNOLOGY REVIEW

Technology type and description	Providers and devices	Pros based on scalability, impact, effectiveness, functionality, technical expertise needed	Cons based on scalability, impact, effectiveness, functionality, technical expertise needed	Age range	SBDRR areas of potential application and traditional shortcomings addressed	Theories of Learning and Learning outcomes contributed to	Relevant case studies/ resources	Evaluation and key considerations
Augmented Reality (Mobile Device AR)	All Smartphones and tablets with camera	• Not expensive (vs. full VR) as it can be run with a smartphone or tablet, requiring cameras - therefore scalable • Accessible to all ages and easy to use, depending on the content • Proven to be successful with students and in the education community. • Little technical expertise needed • Uses technology that schools are more likely to already have (ie tablets, smartphones) • Still new enough to provide motivation and the "wow" factor in students • Positive effect on learning performance and the learning experience (fun, interest, and enjoyment). • Promotes increased content understanding, learning spatial structure and function, long term memory retention, and improved physical task performance, • Positive social impacts and social interactions, especially collaboration and motivation, leading to more opportunities for students to communicate and collaborate in the real world. • Technical features of AR also have positive effects on learning - e.g. the interactive 3D models in AR can enhance students' learning experience and collaborative skills • Rich instructional materials (e.g. text, video, audio) can attract and immerse students into the learning • Allows more personalisation and customisation of the experience. Can show students things that cannot be seen in the real world (like molecules) • Including interactive features and gamified elements provides a strong result in acquiring new knowledge and increasing user engagement	Very few learning negatives have been found with AR, and those that are there can be easily avoided. Some include:[1] 1. Attention tunneling 2. Usability difficulties 3. Ineffective classroom integration 4. Learner differences • Less immersive than AR experiences with headset and VR	4+ Dependent on content type	Activities 1) Disaster awareness raising activities 2) Disaster drills and evacuations (procedures and steps, rather than immersive practice) 3) Training SBDRR shortcomings addressed • Feedback and improvement: can be integrated into gaming (e.g. Zika 360, when players select a right or wrong healthy practice, they are given feedback; tests encourage repetition and therefore improvement) • Improve decision making skills • Increased learning outcomes • Application of knowledge to real life contexts • Understanding of real hazard effects due to visual representation of hazards: for example of water levels rising • Situation awareness learning	Theories of learning • Game based learning (if gaming elements are present) • Situated learning theory - suggests that learning is constructed through an individual's interaction with people, objects, locations, and processes within a given physical environment. Learning outcomes • Learning • Behaviour Change • Awareness raising • Empathy	Case studies • Zika 360 • Free Rivers • Enter the Room • Beca XR • Floodwalk • The Future is Now Academic studies • Li, J, Erik D. van der Spek, Loe Feijs, Feng Wang, and Jun Hu, Augmented Reality Games for Learning: A Literature Review, 2017 • Radu, I, Augmented reality in education: a meta-review and cross-media analysis, 2014 • Martín-Gutiérrez, J. et al., 2015. Augmented reality to promote collaborative and autonomous learning in higher education. Computers in Human Behavior, p. 752–761. • Wu, H., Lee, S. & Chang, H. &. L. J., 2013. Current status, opportunities and challenges of augmented reality in education. Computers & Education, pp. 41-49. • Fourtané, S,	Evaluation and key considerations • Positive impacts documented can be categorised into 1) learning 2) social and 3) technological • Highly scalable due to low cost, low tech expertise needed, ability to function on already existing equipment, and examples already in the RC Movement • There has been fairly extensive research on the impact of AR on learning, vs non AR methods. The positives far outweigh the negatives, that can be easily avoided. • Examples of mixing AR with gaming have shown positive impacts on learning and behaviour change for health education (Zika 360) • Even in studies where there were no significant differences in knowledge gains between groups who use AR and groups who do not, the AR experience was more enjoyable and just as effective as other more established approaches to learning. • AR as a tabletop experience continues to have value even as the technology behind AR in the real world becomes more accessible (i.e. overlaying simulation on the users'
Augmented reality (Glasses/ Headset)	Epson Moverio, Magic Leap, Microsoft Hololens	• The future of SBDRR • Supports situated learning theory, in which learning takes place in both a physical environment and a psychosocial context • Given that augmented reality technology overlays virtual content on the location where is played, it can make the experience highly scalable, and can fit any specific location, by simply using a smartphone and an affordable paper headset. • 100% customised to the location • More effective than fully immersive VR at showing what a disaster (e.g. flood) would look like in students' own schools (for example in Disaster Scope)	• Still expensive: e.g. Magic Leap costs $3,000 • Hyper-realistic disaster scenarios should be used with caution on younger age groups • Cannot be used standalone if simply visually representing the disaster without more information or instructions • Some hazards not yet able to replicate - e.g. earthquake (see Disaster Scope) • Does not provide feedback	+7 Dependent on content type	Activities 1) Disaster awareness raising activities 2) Disaster drills and evacuations 3) Training SBDRR shortcomings addressed • Increased learning outcomes • Application of knowledge to real life contexts • Understanding of real hazard effects due to visual representation of hazards: for example of water levels rising • Situation awareness learning	Theories of learning • Situated learning Learning outcomes • Learning • Behaviour Change • Awareness raising	Case studies / examples: • Disaster Scope Academic studies • As above for general AR benefits • AR with headset or glasses is still very new and not many academic papers or case studies available to date	Evaluation and key considerations • Potentially the most significant XR medium for disaster preparedness, once the technology becomes more affordable (estimated in 2 years) • The solution to a customised experience to each school and will highly scalable with smartphones and cardboard headsets once most phones have the technology • Currently not able to provide feedback • Needs to be supported by training package • Mixed reality AR/VR
Game app (web or smartphone)	Smartphones, tablets and computers	• Easy to access • Tech set up is basic and scalable • Wide reach and distribution, allowing to reach a large number of users. • Easy maintenance as long as it complies with browser standards • Can provide a balanced space between gameplay and learning which can be beneficial for teaching disaster preparedness - particularly for awareness raising and knowledge. • Allow for more immersion as interactivity is advanced • Consoles offer advanced and professional gaming • More effective for learning procedural knowledge than paper based equivalents. • Enhance the capabilities of traditional approaches to deliver disaster preparedness and response knowledge • Appropriate for delivering DP/DRR messages to younger audiences	• Limited features • Console games can be expensive to build and maintain • Have to be maintained to meet app stores requirements • Can be expensive to produce high quality games[2] • Lack of downloads of apps if not promoted well • Not immersive	+4 Dependent on content type	Activities 1) Disaster awareness raising activities 2) Training SBDRR shortcomings addressed: • Engaging and increase participation • Increase motivation • Engaging • Help information retention	Theories of learning • Game based learning Learning outcomes • Awareness raising • Behaviour change	Case studies/ examples: • 1979 Revolution Black Friday • Monster Guard • Tanah Academic studies/ articles • Darvasi, P, York University, EMPATHY, PERSPECTIVE AND COMPLICITY: How Digital Games can Support Peace Education and Conflict Resolution, 2016 • Çiftci, S., Trends of Serious Games Research from 2007 to 2017: A Bibliometric Analysis, Journal of Education and Training Studies Vol. 6, No. 2; February 2018	Evaluation and key considerations • Driving the game through storytelling provides high levels of engagement and empathy - particularly when the user becomes a character in the game that creates a strong emotional connection • Using game mechanics such as conversation trees can be very useful to instill knowledge whilst maintaining high engagement • The use of choose-your-own-adventure techniques along with branched narratives offer users an engaging and unique experience and a way to learn from their decisions. • Distribution and publicity plans for apps are important, so that they get downloaded. • Engagement of local RC branches/chapters is key to promote any technology produced (Monster Guard) • Apps should be named with something that it easy to find by searching in the app store. E.g. a name that includes the type of hazard, rather than something like "Monster Guard".
VR with Smartphone	All Smartphones and tablets with camera	• Easy to use with own smartphones • Affordable and mobile • An extremely powerful motivational tool - especially as so new. Game-based VR systems increase children's motivation over more traditional teacher–learner forms of VR-based instruction • Potential to act as an "empathy machine" • Makes training in dangerous (virtual) situations like disasters possible Towards learning outcomes: • Beneficial for training • Proven to facilitate learning and enhance knowledge acquisition and transfer • Concretises abstract ideas and concepts and make more realistic • Enables active interactions with the content and to "feel data" • Allows for situated, authentic, contextualised learning that is often feasible in a traditional learning environment, either because constructing a realistic setting would be too expensive, or because using a real world location could be dangerous. • Allows for embodied learning: utilising the body during learning can have a positive effect on outcomes. Behaviour change: • Increased collaboration • Modify attitudes and behaviours in the real world • Effective tool for behavioural analysis • Proven to be effective in generating empathy and influencing behaviour change in young people (VR Action Lab) DRR: • Safer and reduces risks • Opens up situated learning in dangerous or difficult circumstances. • Offer simulations that cannot be done in the real world • Helps to teach vital but not exciting safety skills (e.g. first aid, disaster	• Low quality graphics vs VR with computer • Battery linked to mobile phone • Low cost headsets don't have lens customisation • Does not always improve technical skills (e.g. of chest compression rate in CPR training) • Can be overwhelming and cause cognitive overload • VR induced side effects such as motion sickness are common • Safety concerns of injury in the real world (distraction and danger) • Can present barriers to learning. These barriers can be technological, pedagogical and learning-based.[3] • Can cause trauma if simulating distressing real life events like disasters. Caution when using with sensitive or vulnerable groups. Alternative design methods can be used to overcome this challenge • Unsafe for young children who can't tell the difference between reality and VR	+13	Activities 1. Disaster drills and evacuations 2. Training: Proven to be effective for first aid training (CPR specifically) to improve bystander response and improve learning outcomes SBDRR shortcomings addressed • Learning by doing • Good for training - this has been the most consistently proven best use of VR • Increases realism and concretises abstract ideas like disasters • Allows feedback and behavioural analysis • Increases motivation and situational awareness • Decision making skills can be practiced including with unpredictable events • Overcomes logistical challenges like using the whole school area, or numerous staff members • Cost effective if rolled out at scale	Theories of learning • Situated learning • Embodied learning Learning outcomes • Training • Awareness raising • Empathy • Behaviour change	Case studies/ examples: • Lifesaver VR • Stay Safe VR • Immersed 2.0 • VR Action Lab • Disaster Preparedness Simulator Academic studies/ articles • Feng, Z. Vicente A. González, Robert Amor, Ruggiero Lovreglio, Guillermo Cabrera-Guerrero, Immersive Virtual Reality Serious Games for Evacuation Training and Research: A Systematic Literature Review • Southgate, E. (2018). Immersive virtual reality, children and school education: A literature review for teachers. DICE Report Series Number 6. Newcastle • Comparing bystander response to a sudden cardiac arrest using a virtual reality CPR training mobile app versus a standard CPR training mobile app - Marion Leary, Shaun K. McGovern, Zainab	Evaluation and key considerations • Any use of VR must include a clear theory of learning or pedagogy in the design. • VR should not be the only method or solution, but used to promote the learning outcomes that it is most suited for and complement other methods, like face to face training. This is because VR can encourage taking action like calling 911 or overcoming the bystander effect (as proven in first aid training simulations from BRC and Resus) but skills learnt in VR might not be 100% accurate (like chest compression depth) and you can only ever be in a VR simulation for 15/20 mins at a time. • Studies taken from medical education and training do not indicate that VR should take the place of other forms of education, particularly the early stages where new knowledge is received but rather that it should be utilised at the assimilation stage, where learners take that new information and apply it, as in the case of residents applying new surgical knowledge[4]. • VR experiences should be short • Good for real life experiences (think of VR is as an actual experience, not a media experience) • When using VR you need to tell stories in a different way - the traditional

1 Radu, I, Augmented reality in education: a meta-review and cross-media analysis, 2012
2 For example, 1979 Revolution Black Friday (see case study)
3 BRC education review
4 BRC education paper

Global Disaster Preparedness Center

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360 VR (with Smartphone Headset)	Google Cardboard, Samsung Gear VR	As above. The following points are specific to 360 VR: • An affordable form of VR, being used by many charities/non-profits • Proven to be effective in increasing empathy leading to behaviour change - for example to overcome the bystander effect • Creates a sense of 'presence' without overwhelming the viewer (as full immersive VR can) which is to make the viewer feel there are inside the action • Allows students to be transported to a place or places that would otherwise be impossible to access • Students can make better connections with their learning provide concrete, specific learning examples • Integrates with scalable platforms (like YouTube and Vimeo) • Can be embedded into websites • Adds a level of immersion into a real place that increases the quality of the learning experience[1]	• Not as immersive as full VR • Needs to be filmed individually per context therefore not as scalable to multiple locations	+7 Dependent on content type	Activities 1) Disaster awareness raising activities 2) Disaster drills and evacuations 3) Training SBDRR shortcomings addressed • Good for training - this has been the most consistently proven best use of VR • Increases realism of actual locations • Increases motivation and situational awareness • Overcomes logistical challenges like using the whole school area, or numerous staff members • Cost effective if rolled out at scale	Theories of learning • Situated learning • Embodied learning Learning outcomes Empathy Training Awareness raising	Case studies / examples: • Zika 360 (awareness raising) • British Red Cross First Aid 360 VR (training) • Plan International UK - Mami's story (empathy) • MSF (various, empathy and training) • Climate Centre (awareness raising) • ICRC The Right Choice (empathy) Academic papers As above for smartphone VR	Evaluation and key considerations As above for smartphone VR.
Full VR (standalone)	Oculus Quest, Magic Leap, Lenovo Mirage Solo, Oculus Go	• Affordable vs computer version • No need to use a laptop or computer or phone • No cables • Easy install, it has cameras for positional tracking • Huge potential for scalability across NS for SBDRR	• Limited graphics capabilities compared to full VR with computer • Systems might be closed (Oculus)	+13	Activities 1) Disaster drills and evacuations 2) Training SBDRR shortcomings addressed • Learning by doing • Good for training - this has been the most consistently proven best use of VR • Increases realism and concretises abstract ideas like disasters • Allows feedback and behavioural analysis • Increases motivation and situational awareness • Decision making skills can be practiced including with unpredictable events • Overcomes logistical challenges like using the whole school area, or numerous staff members	Theories of learning • Situated learning • Embodied learning Learning outcomes • Training • Awareness raising • Empathy • Behaviour change	First version released in 2019 (Oculus Quest) - no case studies or academic papers specifically on this yet.	Evaluation and key considerations • Huge potential for SBDRR given that no gaming laptops or smartphones required. • Easy to distribute to and train NS as only one piece of kit required • Costs can be completely absorbed by GDPC or distributing PNS
Full VR (with computer)	HTC Vive, Oculus Rift , Samsung Odyssey, Valve Index	• High-end experiences, quality viewing, interaction through controllers • High graphics definition including realistic effects such as smoke and water • High level of interaction and customisation • Network Synchronization for multiple players • High frame rates and less motion sickness	• Limited freedom to move (cables), requires space • Requires expensive gaming laptops • High costs with laptop, headsets and controllers	+13	Activities 1) Disaster drills and evacuations 2) Training SBDRR shortcomings addressed • Learning by doing • Good for training • Increases realism and concretises abstract ideas like disasters • Allows feedback and behavioural analysis • Increases motivation and situational awareness • Decision making skills can be practiced including with unpredictable events • Overcomes logistical challenges	Theories of learning • Situated learning • Embodied learning Learning outcomes • Training • Awareness raising • Empathy • Behaviour change	Case studies/examples • Immersed • Virtual Reality Based Disaster Resilience Training (APDRC) • ICRC VR simulations • BRC First Aid Academic papers As above for smartphone VR	Evaluation and key considerations • Currently used by various parts of the Movement, both ICRC and also APDRC across a range of Asian NS • This is the highest quality of graphics with VR, and therefore simulations like the ICRC's are very realistic and useful for training delegates that will have to experience similar real life situations • Not the recommended option for scaling across NS, given the high cost and technical equipment required • Sacrifice of quality of graphics is beneficial to gain cost effectiveness and scalability. As technology of Full Standalone VR improves this will be even more the case.
Immersive Experience (VR in space) E.g. CAVE Projection room	N/A	• Provide state-of-the-art immersive experiences • Create a more authentic learning experience because total immersion leads to presence and aids the transfer of knowledge • Allows multiple users to be in the same space. • Can be set up as permanent or semi-permanent space where research can be centralised and multiple experiences can be presented to different audiences at the same level of quality.	• Not as scalable • No large scale longitudinal studies on effects of complete immersion on children or adults yet • Early research highlights a range of ethical, safety and child protection issues related to using this technology in classrooms • Constant supervision of students required • Students can become so immersed that they ignore the safety area warning system • Limited space to track the movement of users • Require a great amount of resources to install, run and maintain	+13 Dependent on content type	Activities 1) Disaster drills and evacuations 2) Training SBDRR shortcomings addressed • Learning by doing • Increases realism and concretises abstract ideas like disasters • Allows feedback and behavioural analysis • Increases motivation and situational awareness • Decision making skills can be practiced including with unpredictable events	Theories of learning • Situated learning • Embodied learning Learning outcomes • Training • Awareness raising • Empathy • Behaviour change	Case studies/examples Weather Channel Academic papers Herrera, F., Bailenson, J.N., Weisz, E., Ogle, E. & Zaki J. (2018) Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking	Evaluation and key considerations • Age restrictions and ethical dilemmas of so much immersion, particularly for younger children • Not scalable across multiple countries. • One common example is the CAVE system (cave automatic virtual environment), a room with projection screens as walls, where high resolution and stereoscopic projectors display realistic 3-D computer graphics, creating an immersive user experience