RESEARCH PAPER

Immersive technologies & digital games for school disaster preparedness

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#1
Intro

1.1 Background

I hear, and I forget
I see, and I remember
I do, and I understand.

- Ancient Chinese proverb
(Confucius 551 BC)

The age of immersive digital learning is here. An affordable smartphone and a five dollar cardboard headset can immerse anyone into an alternative virtual reality, or augment the one around them. Extended reality (XR) immersive technologies and serious digital games are quickly becoming accessible to a huge number of people across the world, including the developing world, via the rise of smartphones and evolution of the technology to become more affordable and accessible. This technological landscape is changing and improving literally as these words are being read.

The world is still grappling with the best ways to harness the power of these technologies. Some applications can be tokenistic and capitalise merely on the "wow factor" of being immersed in VR or AR for the first time. However, one area where particularly VR and serious games have been consistently used over the past decade with huge benefits is in training. Security, aviation and medical organisations and institutions saw very early on the benefits of training soldiers, pilots or doctors in virtual space where they could make mistakes and not risk losing their, or someone else's, life. The field of education has also embraced XR for learning, though research on the effects of immersion on children is still in infancy stages.

Given the potential for XR on training, dangerous events and education, these technologies are also being applied to the field of emergency management and disaster preparedness, providing a realistic and safe space to prepare for crises and practice how to respond and harness the benefits of XR to improve learning outcomes and retain life saving information. Applications of serious digital games and immersive technologies range widely in the field of disaster preparedness, from first aid training to disaster drills to gamification techniques providing educational key messages. The Red Cross Red Crescent (RCRC) Movement is increasingly using immersive technologies for a range of aims, including building empathy, fundraising, awareness raising and behaviour change. However to date there is little use of these technologies at scale for

school based disaster risk reduction and preparedness, although some examples do exist.[1] XR in the RCRC Movement is still in an experimental stage and has yet to be applied in a systematic way that looks at the gaps in traditional approaches and uses the unique affordances of these new media technologies to add pedagogical and behavioural value to the auxiliary role of the Red Cross Red Crescent Movement.

Red Cross and Red Crescent National Societies (NS) across the world contribute to disaster risk reduction and preparedness in public schools and this is an important component of Red Cross Red Crescent programming globally. There is huge potential for XR technologies and serious games to address many of the shortcomings of traditional school based DRR (SBDRR) and contribute to SBDRR's aims including helping children and teachers learn about hazards and practice responding, for example escape techniques through immersion in virtual hazards and emergency situations. XR can be particularly helpful to analyse how students and teachers behave in an emergency, in order to improve preparedness, and how they respond and cope with hazards.

This research paper presents the current SBDRR and XR technological landscape, analyses the shortcomings of traditional forms of SBDRR and how XR has the potential to address these. It also synthesises and presents a range of learning on the inception, design, production, distribution, partnership models and scalability of a full range of XR technologies from gaming apps used on mobile phones to augmented reality applications that have the potential to turn schools into disaster zones in seconds. The research stresses the enormous potential of XR for SBDRR alongside cautioning that any use of XR must not recreate DRR education as it already is, but utilise the unique affordances of the technology to bring added value to what is already in practice with other learning modalities. The technological landscape is examined in light of the realities of the RCRC Movement with an emphasis on the potential for scalability across multiple National Societies. A series of possible models, learning points and recommendations are presented that aim to benefit the Global Disaster Preparedness Centre (GDPC) and the broader disaster preparedness and risk reduction community and contribute to determining the next strategic XR steps of the Red Cross Movement in school disaster preparedness and risk reduction.

1 For example the GDPC has built various digital app games targeted at children that are used in schools, and the Asia Pacific Disaster Resilience Centre has built a fire and ship evacuation VR simulations that are used in schools in the Philippines, Nepal, Republic of Korea, Mongolia, Singapore, Thailand, Vietnam and Indonesia.

1.2 Methodology

This research paper (meta-analysis and literature review) was commissioned in March 2019 by the Global Disaster Preparedness Centre in response to the following disaster preparedness learning question: *How does GDPC and American Red Cross International Services best leverage the potential of serious games and virtual reality*[2] *to be an effective way of supporting disaster preparedness programming in schools?*

The goal of the research is to provide information and options to all organisations globally interested in pursuing immersive technologies and serious gaming as a disaster preparedness educational tool for schools. It does this through two methods; this literature review and meta analysis that highlight key learning points to be applied for future deployment of this type of technology for school preparedness; and ten case studies[3] that document the intersection of effective emerging technologies and disaster risk reduction and preparedness education, capturing the breadth of innovative technologies related to school safety and identifying good practices, effective approaches, and technological features that support disaster preparedness programming in schools. Case studies were selected based on their relevance to SBDRR and the work of the GDPC, the desire to have a range of technologies and innovations represented and examples from both within and external to the Red Cross Red Crescent Movement. The meta-analysis looks at the shortcomings of traditional SBDRR and provides solutions and new models with XR technologies and innovative practices.

Information contributing to this research and supporting case studies was gathered using a range of methods including semi-structured interviews with over 20 organisations[4] including XR experts from academic institutions, digital agencies and research consultancies and focal points who have developed XR experiences with/for humanitarian agencies. An extensive review of XR research literature and experiences was conducted, covering serious gaming and extended reality: augmented and virtual. The authors' own expertise in the XR field was also applied.

2 *The research question was expanded to consider other immersive technologies including augmented reality*
3 *See Annex A, case studies*
4 *See full list in Annex F, Interviews*

1.3 Definitions

SBDRR definitions

IFRC defines disaster preparedness as: *"measures taken to prepare for and reduce the effects of disasters. That is, to predict and, where possible, prevent disasters, mitigate their impact on vulnerable populations, and respond to and effectively cope with their consequences."*[5]

5 https://media.ifrc.org/ifrc/what-we-do/disaster-and-crisis-management/disaster-preparedness/

Disaster Risk Reduction (DRR) *"aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through an ethic of prevention."*[6]

School based disaster preparedness or risk reduction is the application of the above in the school community and targets everyone involved in the teaching and learning activities (students, teachers, education personnel, support staff, headteachers).

Technology Definitions

XR (extended reality): Extended reality, also known as cross-reality and hyper-reality, is an umbrella term that encompasses human-machine interactions generated by computer technology with devices or wearables to create real and virtual environments which include VR, AR and in this research paper also enompasses mixed reality as part of XR.

Mixed reality (MR): Mixed reality is a hybrid definition combining both AR and VR.

Virtual Reality (VR): Virtual Reality is a technology that creates an immersive experience and content in most cases using a VR headset, a head-mounted display (HMD) or a fully immersive space. The current reality viewed by the user is replaced with a new computer generated environment in which the user is isolated from the real world.

Augmented Reality (AR): Augmented reality is an immersive technology superimposing layers of digital content into the physical world to enhance the user's real world experience.

Serious Games (SGs): games whose primary purposes are training and education, rather than pure entertainment.

Haptic technologies: Haptic technology, also known as kinaesthetic communication or 3D touch, refers to any technology that can create an experience of touch by applying forces, vibrations, or motions to the user.[7]

Simulation: In science, a simulation is the creation of a model that can be manipulated logically to decide how the physical world works.[8] Simulation has become the defacto design technique for all control systems design of today. In computers, a simulation (or "sim") is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By changing variables in the simulation, predictions may be made about the behaviour of the system. It is a tool to virtually investigate the behaviour of the system under study.[9]

Avatar: refers to a representation or a manifestation of a particular person or character, usually used in video games, virtual experiences and internet applications. An avatar can be used to represent the self or other characters in the virtual space.

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6 https://www.unisdr.org/who-we-are/what-is-drr
7 https://en.wikipedia.org/wiki/Haptic_technology
8 Dr. Richard Gran, https://www.youtube.com/watch?v=OCMafswcNkY
9 Banks, J; J. Carson; B. Nelson; D. Nicol (2001). Discrete-Event System Simulation.

#2
Context: School disaster preparedness and technology landscape

2.1 School disaster preparedness in the Red Cross Red Crescent Movement

2.1.1 Overview

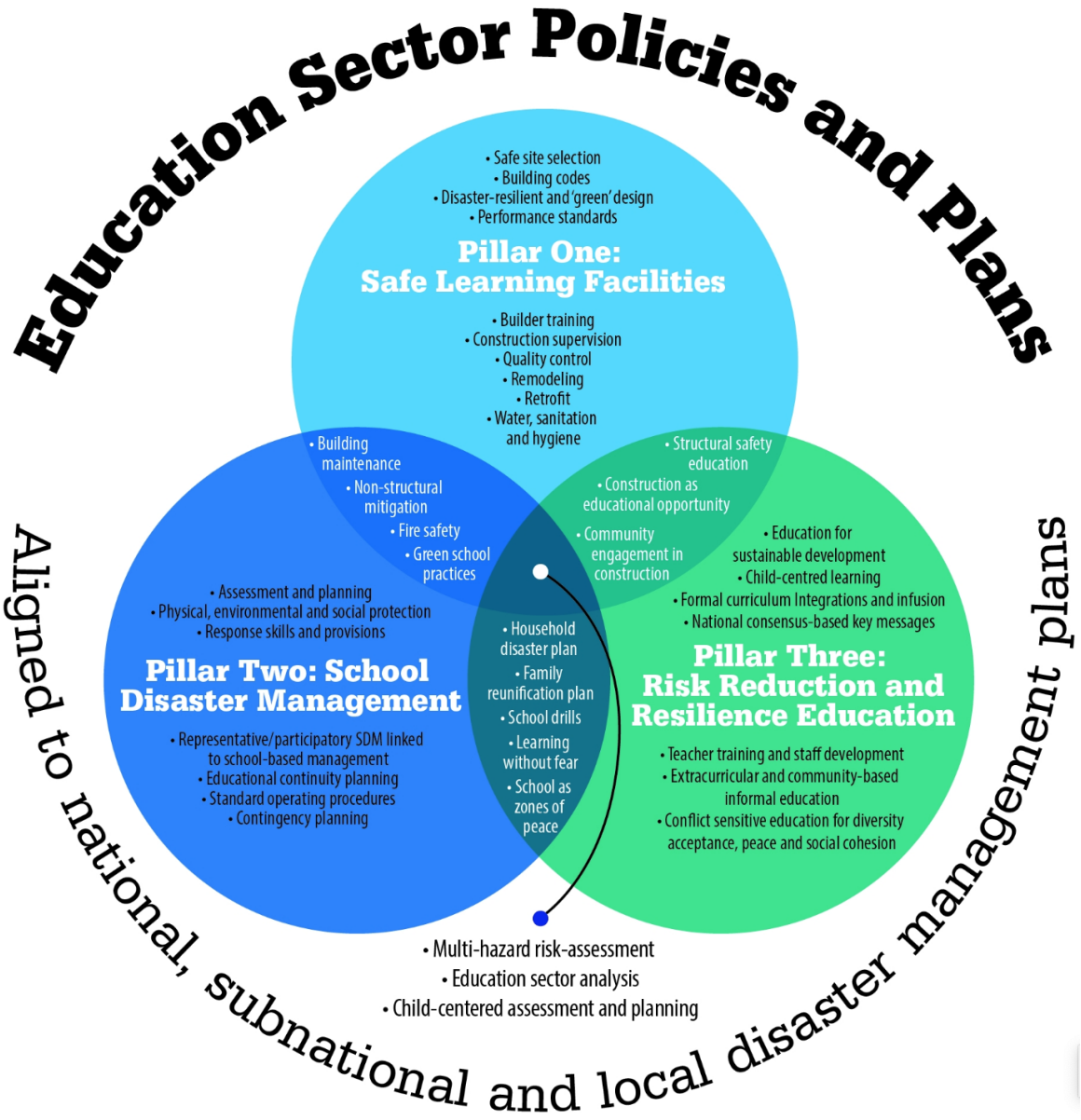
Red Cross Red Crescent National Societies across the world contribute to disaster risk reduction and preparedness in public schools and this is an important component of Red Cross Red Crescent programming globally. Typical school-based activities of Red Cross National Societies include disaster risk reduction, first aid, hygiene and health promotion, road safety and water and sanitation. The activities are typically run through Red Cross Red Crescent Disaster Management and Health programmes. National Societies have a unique position to influence school safely thanks to their existing relationships with national governments and support from a large number of volunteers.

For school disaster preparedness and risk reduction, Red Cross National Societies work across the three pillars of the **Comprehensive School Safety Framework (CSSF)**, as defined by UNISDR.[10] This Framework suggests a series of activities that include:

- Identifying the hazards in and around a school
- Conducting drills
- Preparing contingency and disaster management plans by involving parents, teachers and students
- Building on the capacities of an institution and individuals to cope with the challenges during an unforeseen event

Of the three main pillars of the CSSF, this research is most relevant for pillars 2 and 3. Pillar 1 focuses primarily on infrastructure rather activities linked to teachers and students.

10 https://www.unisdr.org/files/51335_cssbooklet2017updated.pdf



Pillar 2. School Disaster Management: This refers specifically to activities in schools. Key responsibilities under this pillar include:

- Drills on emergency procedures: to practice, critically evaluate, and improve on response preparedness.
- Adopting SOPs (standard operating procedures) for specific hazards, including building evacuation, safe assembly, evacuation to safe haven, shelter-in-place, lockdown, and safe family reunification.
- Adopting SOPs for specific schools.
- Learning safety rules for specific hazards.
- Engaging schools in increasing the effectiveness of early warning and early action systems meaningful and effective.

Some examples of RCRC activities under this pillar include making school safety plans, con-

Why school safety is important in Myanmar

In Myanmar, young people make up around 28% of the population*

8 million + are students

attending **42,000 +** schools

taught by **278,000 +** teachers

The country is vulnerable to frequent natural disasters

- Storms
- Landslides
- Earthquakes
- Floods
- Cyclones
- Drought

Including:

- **Jun 2010** Floods in northern Rakhine State
- **Mar 2011** 6.8 Magnitude earthquake in Shan State
- **May 2008** Cyclone Nargis
- **Oct 2010** Cyclone Giri
- **Oct 2011** Floods in Magway Region
- **Aug 2012** Floods across Myanmar
- **Nov 2012** 6.8 Magnitude earthquake in northern Myanmar
- **Jul-Aug 2016** Floods and landslides in six states & regions
- **Jul-Aug 2015** Floods and landslides in 13 states & regions

When disaster strikes, children and youth are among the most vulnerable. Why?

- Lack of understanding about how to respond
- Limited capacity to cope
- Poor structure of some school buildings

Disasters can result in:

Disrupted education | Psychosocial distress | Long term developmental impacts

For future resilience of families and communities, we need to make **schools safer, children and adults wiser,** and **communities readier** to respond to disaster

* According to the 2014 Myanmar Population and Housing Census. Young people include adolescents (aged 10-19) and youth (aged 15-24).

International Federation of Red Cross and Red Crescent Societies
www.ifrc.org Saving lives, changing minds.

香港紅十字會
HONG KONG RED CROSS

ducting simulation exercises, creation and capacity building of school disaster committees, first aid training, provision of basic response equipment for schools and training on search and rescue and evacuation.[11]

Pillar 3. Risk Reduction and Resilience Education: This pillar refers to education on risk and resilience issues that goes beyond the confines of schools - i.e. that affect their communities. Key responsibilities of relevance under this pillar include:

- Engaging students and staff in real-life school and community disaster management and first aid activities, including mapping hazards, developing school-based contingency plans, and implementing regular school drills for relevant hazards.
- Developing 'scope and sequence' to detail learning outcomes and competencies to integrate risk reduction and resilience into regular curriculums.
- Integrating risk reduction throughout the curriculum and providing guidelines for integrating risk reduction and resilience into carrier subjects
- Developing teaching and learning materials (for students and teachers)

Some examples of RCRC activities under this pillar include dissemination of awareness raising materials, organization of campaigns and competitions, and awareness sessions as part of the curriculum.

School disaster preparedness and risk reduction activities vary from country to country based on National Society and government capacity and the context of each country. There is no uniform approach, although there are initiatives that have been proposed to present a model for a school-based risk reduction initiative that reflects the pillars and elements of the CSSF[12].

Research has been conducted as to how RCRC NS typically add the most value to school preparedness and the following have been highlighted as key roles and opportunities - all with the potential to build on with immersive technologies:[13]

- Improve knowledge and information management with consideration of **new technologies and innovative approaches** to implement Comprehensive School Safety Framework.
- **Develop teaching materials** and disseminate to schools in line with Public Awareness Public Education (PAPE) Guidelines and its key messages.
- Lead and co-lead **training sessions for school teachers to implement school-based risk reduction.**

Under the umbrella of school safely, SOPs for emergencies and disasters for schools are an essential part of school disaster management policy.[14] These are a set of required safety proce-

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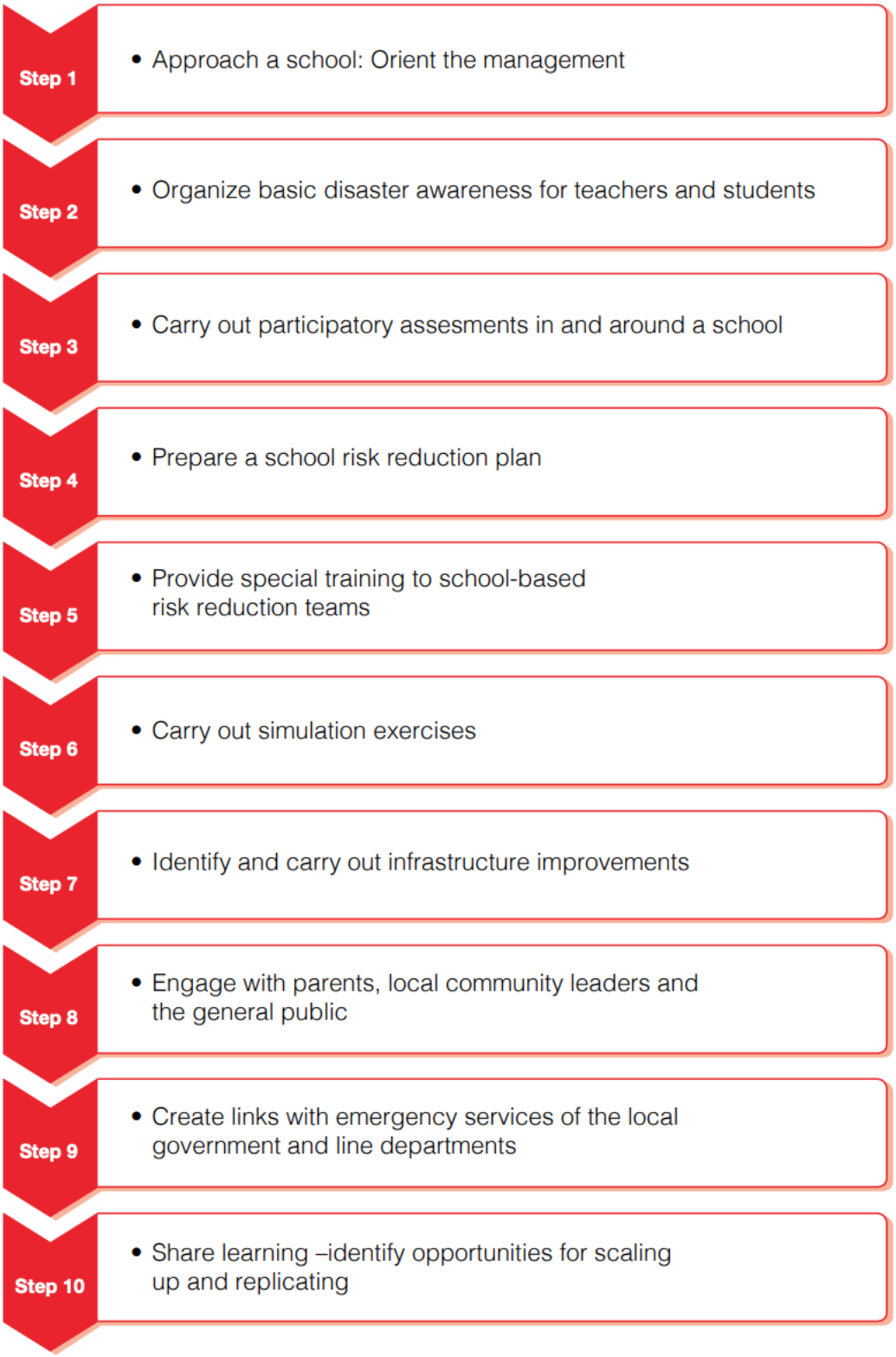
11 Myanmar and Philippines Red Cross Societies
12 Such as the handbook for school based risk reduction initiative/model which has been tested in various areas of Asia and provides differential strategies to impact children and youth : http://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2016/02/RCRC-Handbook-for-CSS.pdf
13 These were identified through a variety of consultations in South East Asia: http://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2016/02/RCRC-Handbook-for-CSS.pdf
14 These are outlined in RCRC guidance included in "Public Awareness and Public Education for DRR: https://resourcecentre.savethechildren.net/node/14186/pdf/pape_key_messages_tool_eng_2018.pdf

Figure 2.2: Ten steps of the school-based risk reduction approach for National Societies



dures to be known and followed by all school workers and students, in the event of disasters or emergencies and are built around six basic emergency procedures.

1. Building evacuation
2. Evacuation to a safe haven
3. Assemble and shelter outside
4. Shelter-in-place
5. Lockdown
6. Safe family reunification

These form the basis of the ten steps of SBDRR approach for National Societies (see image).

2.1.2 Audience

School-based preparedness and risk reduction activities target the following:

- Students: a primary audience
- Teachers: an essential vehicle to deliver SBDRR to children, who should also be recipients of training/knowledge
- Parents: Students act as a vehicle to deliver knowledge to their parents. This is often the only source of disaster education in the family.
- Local authorities and community leaders: critical for making community-level decisions on disaster preparedness activities
- RCRC branches and volunteers: School disaster preparedness in National Societies is often led by local branches and volunteers who take part in training-of-trainers courses before passing knowledge to schools

For a breakdown of age related DRR education delivery, see Section 2.2.2.

2.1.3 Key SBDRR activities

The core components and activities of SBDRR that are relevant to the potential for immersive technologies are:

- **Disaster awareness raising activities**
- **Disaster drills/simulations**
- **Training: a)** First aid training and **b)** Disaster management training

These three components of SBDRR are reviewed below. The GDPC has expressed a particular interest in the use of immersive technology for drills and simulations given that the majority of school-based disaster preparedness initiatives such as digital games that have been produced to date have focussed on awareness raising rather than drills or training.

1. Disaster awareness raising activities

Step 2 of the school based risk reduction approach is to *"Organise basic disaster awareness for students and teachers."* Awareness is a key factor in effective risk reduction. Heightened awareness

helps to enhance common knowledge of risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards. Related activities include public awareness and public education and the mainstreaming DRR in school curricula - for example holding education sessions in schools, the use of games, theatre, posters and other media and communications channels and techniques.

This is the area of SBDRR where more creative and interactive participatory measures have traditionally been used to engage students and to improve learning outcomes. For example, a range of digital and non-digital DRR games exist in the Red Cross Movement and beyond to engage students and their families. Some non-digital Red Cross Movement examples include *"Let's Get Prepared"*[15] a DRR Snakes and Ladders Game; *"Escuela Protegida,"*[16] a colouring and activity book for kids on school preparedness; and "Masters of Disaster® Family Kit"[17] containing disaster preparedness games and activities for families. Digital examples include the GDPC's "Monster Guard"; UNISDR's "Stop Disasters"[18] and the US Department of Homeland Security's "Disaster Hero".[19]

15 https://www.dropbox.com/s/0og4g1exre693ut/snake_Eng.jpg
16 https://media.ifrc.org/ifrc/wp-content/uploads/sites/5/2018/12/Libro-de-colorear-escuela-protegida.pdf
17 https://www.redcross.org/take-a-class/preparedness-programs#master
18 http://www.stopdisastersgame.org/stop_disasters/
19 http://www.disasterhero.com

2 Disaster drills/simulations

Drills allow students and staff to prepare for, practice and improve standard emergency response procedures and risk reduction. In some contexts these drills can be the only form of education about disaster response strategies. Drills are a cornerstone of school DRR and preparedness and are proven to be effective, but only if feedback is given to help participants learn and improve. School fire drills have been credited with a significant reduction in fire-related injuries and deaths and large-scale annual drills for earthquakes and other hazards have improved staff knowledge for disaster prevention, preparedness to respond and enhanced disaster policies, plans and procedures. They have also increased staff engagement in disaster planning in their own homes, encouraged them to seek training and reduced their exposure to physical risks.[20] The impact on students is less well documented, and where more of the shortcomings lie (see chapter 3).

School hazard drills and simulations tend to focus on sudden and unpredictable events, such as earthquakes, tsunamis, flash floods, fires, chemical emergencies and more recently in some parts of the world, school shootings. School fire drills have been commonplace since the mid-19th century, mostly centering on evacuation and safe assembly techniques. The standard operating procedures for all of these hazards and events vary substantially and therefore so does the content of the drills. SOPs for other hazards where there is more advance warning do not tend to require the same sudden-onset drill practice, but instead are usually tackled through other awareness raising activities and through teachers or school risk reduction committees ensuring that they have been followed. Drills are used to practice other standard operating procedures as listed above (building evacuation; assemble and shelter outside; shelter-in-place; lockdown; safe family reunification).

20 https://resourcecentre.savethechildren.net/node/14254/pdf/school_drills_r2a_brief_eng_2018.pdf

Simulation drills that are reviewed and assessed allow schools to test and improve their emergency response plans. More recently, mass-participation in community wide earthquake drills has become a popular way to promote disaster preparedness for both organisations and households and this is an area often supported by RCRC National Societies. There is a growing body of research on the extent to which drills contribute to improved individual and organisational safety. For a full literature review of school DRR drills see the Child-Centred Risk Reduction Research-into Action Brief: School Emergency Drills.[21]

It is widely agreed that effective drills should be seen as an experiential learning process and opportunity,[22] and feedback should inform improved techniques and response. Drills begin with advance preparation by staff, providing an opportunity to train students in classroom groups, remember procedures, and check on provisions. The most critical part of the drill process comes after the drill itself, where students can debrief with teachers. This should lead to an evaluation and updated action plan. Research has shown that often this feedback loop is missing after drills, blocking the learning process and putting lives at risk. Other important components of drills including using sample scenarios and injects[23] to add details to a scenario and make simulation drills more realistic; tailoring hazard drills to the most predicted threats and hazards; conducting at least three fire drills per year[24] and at least one full simulation drill to practice for the most common and/or most serious hazards that are predicted to affect the school's area.

3 Training

Training activities in schools for disaster preparedness and risk reduction generally centre around two topics: first aid and disaster management training for staff, volunteers, or school risk reduction teams. First aid training is in most countries one of the core services provided by National Societies and often one of the only entry points to health care or disaster management programming in remote communities. In addition to drills and evacuation training, other disaster management training includes training for staff, volunteers or school risk reduction teams in how to lead an evacuation and disaster SOPs and how to follow them.

The shortcomings of the delivery of these core activities through traditional methods are reviewed in Chapter 3.

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21 *https://resourcecentre.savethechildren.net/node/14254/pdf/school_drills_r2a_brief_eng_2018.pdf*
22 *https://resourcecentre.savethechildren.net/node/14186/pdf/pape_key_messages_tool_eng_2018.pdf*
23 *Injects refer to new information and challenges that are introduced during the drill, which require thinking and problem-solving, just as would happen in real life.*
24 *The standard advice for schools: https://resourcecentre.savethechildren.net/node/14186/pdf/pape_key_messages_tool_eng_2018.pdf*

2.2 Technology landscape

2.2.1 Immersive technologies available and use

Background

The concept of immersive technologies can be traced back to fiction literature and film, in particular in the genre of science fiction. With the aim of emulating real life experiences that stimulate the human senses and perception, immersive experiences allow users to communicate and interact with digitally designed environments. In the 1960s, cinematographer Morton Heilig developed "Sensorama", one of the earliest known examples of immersive, multi-sensory technology that featured a device integrating a stereoscopic color display, fans, odour emitters, stereo sound system and a motional chair.[25] During the late 1970s, the main body of immersive technology research was carried out by the military, in particular the US government through NASA. Their main areas of research included computer graphics, networked environments and simulations.[26]

In the 1990s, the gaming industry contributed to the development of immersive technologies and began trialing the first commercial virtual reality headsets including SEGA's VR headset and Nintendo's Virtual Boy. However, the technology was discontinued as it was not able to offer what designers were aiming for. It was only during the 2010s when the first commercial brands were able to build hardware that was powerful and compact enough for personal use. In 2014, social media giant Facebook acquired the virtual reality start-up Oculus[27] and this was the beginning of a new era of immersive technologies made accessible to wider audiences. In the present day, technological advances continue at a rapid rate, providing the affordability of super fast computers and smartphones, which together with fast internet connection mean that the scalability of immersive experiences is finally possible.

Recent research claims this new media will be one of the key mediums of the coming years with an estimated over 200M headsets sold around the world by 2020[28]. However, it is still a very experimental space that is constantly evolving, driven by new technological advances and

25 https://en.wikipedia.org/wiki/Sensorama
26 https://medium.com/e-tech/a-brief-history-of-immersive-technologies-7f98cdcd8aa2
27 https://www.theguardian.com/technology/2014/jul/22/facebook-oculus-rift-acquisition-virtual-reality
28 https://fortune.com/2016/01/21/200-million-vr-headsets-2020/

content experimentation. The entertainment industry is pushing hardware manufacturing and distribution, while software development is also rapidly evolving in the hands of designers and XR developers. This brings an incredible potential for use in the humanitarian sector and, more specifically, in disaster preparedness with the next generation.

Types of XR

For the purpose of this research three main groups of immersive technologies have been identified and presented here.

1. Virtual Reality
Virtual Reality (VR) encompasses immersive experiences and content in most cases using a VR headset, a head-mounted display (HMD) or a fully immersive space. The current reality viewed by the user is replaced with a new computer generated environment in which the user is isolated from the real world. Isolation from the physical location is one of the key attributes of VR as it occludes the user's surroundings. This limits, as well as expands, the possibilities of the technology. When VR works well, it should be seamless and should feel like the physical world. Researchers call this effect "psychological presence", a fundamental attribute of VR, which is the feeling that one is actually in the virtual world.

For presence to be created, VR has to work well. VR author Jeremy Bailenson[29] highlights the technical pillars that need to be executed flawlessly in VR:

1. Tracking and measurement of body movements in the virtual environment.
2. Rendering of the 3D models, objects, sounds and interactions simultaneously while movement is happening.
3. The manner in which the digital world is delivered to the user: the devices, including the headset, haptic devices and speakers.

Another pillar to add to this list is the importance of the experience design, and the effectiveness of the interfaces integrated in the content delivered to the user. Specific recommendations for designing in XR are summarised in Chapters 3 and 4. If any of these aspects are not well aligned, users can experience motion sickness and physical discomfort. But when VR is made with care and with quality, it can be so real that it changes perceptions and behaviours.

VR researchers are experimenting with wearables and haptic technologies which involve touch in order to integrate additional sensory inputs on top of visual and sound content in the experience. For example, haptic controllers in the form of gloves can allow the user to feel the touch of objects, or wearable clothing for sports to control the body for training performance such as full body haptic suits. Others are also experimenting with the sense of smell by adding scents to the experience integrated in a mask which releases scent to immerse users even more in the simulated environment. Recent innovations allow several players to be integrated simultaneously in the same virtual world and this opens a whole new world of opportunities for social and educational uses (see Chapter 4).

29 Bailenson, J, Experience on Demand, 2018

Tesla haptic VR suit for multi-players

Traditionally, virtual reality hardware was costly and clunky. VR researchers required substantial investment to create their own devices by purchasing equipment that could not be transported elsewhere. However, the technology continued to advance thanks to military, business, educational, medical uses such as flight simulators, staff training simulations and medical training. The video games industry has also contributed heavily to the development of both hardware and software. In the last five years, the market has made a swift upwards turn. With the advancements in 3D software, the power of computing, and the development of new portable headsets, virtual reality is finally easier to design as a portable, affordable, quality experience.

In training and learning, VR has been, and continues to be, a game changer.[30] There is research and evidence showing that those trained in VR perform better than control groups who use traditional media in pattern recognition and decision making.[31] In sports, football players are able to reproduce practice in the field. In education, students are able to interact with objects within a 3D environment, or join a virtual reality lecture. Medical students can be trained while watching live-streamed, 3D surgeries from anywhere in the world. Visitors can walk virtually through heritage sites or, visit a virtual museum collection. Humanitarian responders can be immersed in seemingly real-life disaster scenarios.[32] Virtual simulations are increasingly being used across multiple sectors for training and learning in the private sector. For example, VR company Strivr recently worked with Walmart on operations process and procedures to train store managers as well as to evaluate employee performance.[33] The opportunities for training and learning are enormous, and we are only on the cusp of what is yet to be discovered and made possible.

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30 Jeremy Bailenson "Practice Made Perfect" chapter, Experience on Demand, 2018
31 Jeremy Bailenson, https://www.youtube.com/watch?v=HZKGde91Xfs
32 https://medium.com/e-tech/a-brief-history-of-immersive-technologies-7f98cdcd8aa2
33 https://www.washingtonpost.com/technology/2019/07/12/walmarts-latest-tool-assessing-whether-employees-deserve-promotion-virtual-reality/?noredirect=on

Types of VR

The current virtual reality spectrum can be classified in several groups. Please refer to the technology review table in Section 3.3 for further details.

- **360 VR (with Smartphone Headset)**: In 360 VR, the content is usually filmed with 360 cameras or created digitally for 360 video. When playing this content through a VR headset, the user is immersed in it and they can look around as if they were inside the space. Interaction features are limited, and include:
  - Looking around the scene
  - Selecting objects by looking at them
  - Shaking the head to trigger interactions
  - Using a separate hand controller to interact with the scene and objects

This technology is usually linked to the use of a smartphone and uses its computing power and graphics capabilities to present the experience. The headsets merely act as viewers. The main challenges of 360 VR today are that content, movement and interaction are limited. However the advantage is that this technology is highly accessible as so many people own smartphones, and it has been integrated into the main video players such as Youtube and Vimeo. In the future, as mobile phones continue advancing, these limitations will likely be overcome.

- **Standalone Full VR:** Standalone headsets contain their own computer, graphics and audio capabilities. They have been developed by companies such as Oculus, HTC, Google, Samsung and others. Main features include all of the 360 VR features plus:
  - Full immersion and transportation in the VR space
  - Use of hand controllers to trigger menus and interactions
  - No computer or smartphone is required
  - Portable and cable free

Image: Oculus Quest

Standalone headsets can have a negative reputation as they come with limited computing capabilities, when compared to VR with computers. However the field of all-in-one headsets is a rapidly growing area and recently a new milestone[34] was reached with the launch of the Oculus Quest in May 2019. This is the first wireless standalone headset with integrated tracking sensors and high quality performance at an affordable price.[35] This opens up the potential for scalability in many areas, especially as feedback received to date has been positive. It is expected that in 2019-2020 one or two more quality standalone headsets will be released and will open up the space of standalone, portable VR. One of the main benefits of these type of headsets is that they require little expertise to set up, and given their cost affordability they could be a good solution for projects that require flexibility and scalability across a range of contexts.

- **Full VR with computer:** Computer powered VR headsets are able to provide a high-quality experience for VR users. If the computer offers gaming features such as high computing power and graphics quality, the VR experience can reach very high standards. The headsets manufactured in this set up are connected by cables to the computer and offer high resolution features. The combination of both devices can offer an almost real experience and limited side effects such as motion sickness. These headsets are manufactured by the main tech players including Oculus Rift S, HTC Vive, Samsung Odyssey, Valve Index and others. The resolution on the headset is usually superior than standalone headsets, and some also offer professional features such as quality of displays and increased field of view. As their computing power comes from the PC, the experience can run at high frame rates from 90Hz and above. Main features include:

    - Life-like simulations
    - High quality graphics
    - Ability to explore and walk around spaces
    - Full interactivity
    - Multiplayer experiences
    - Immersive audio

Although these are the highest quality headsets on the market, there are challenges with accessibility of these kits by non-technical users. They are expensive, with the combination of headset and computer usually exceeding 3,000 USD[36] and set-up, use and maintenance of a professional kit usually requires a high degree of technical expertise. These are challenges to consider when planning or scaling a project that would work with any National Societies or other organisations who may not have this expertise.

- **Full VR with wearables:** This type of virtual reality aims to enhance the connection of the full body with the virtual world. It uses not only headsets but also other types of haptic wearable devices such as vests, gloves, and full body suits. It is an area under development driven by sports and medical research. Examples include the Tesla haptic suit or Google's upcoming VR footwear.

34 *https://mashable.com/feature/oculus-quest-vr-review/?europe=true*
35 *400 USD at the time of writing.*
36 *Estimated cost of a VR ready gaming laptop and a professional VR headset.*

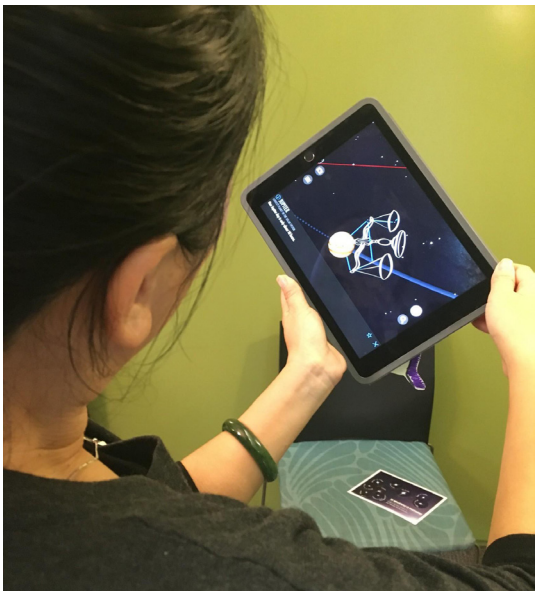
2. Augmented Reality

Augmented reality is an immersive technology superimposing layers of digital content onto the physical world to enhance the user's real world experience. Using a device camera and sensors, the technology can analyse the world around the user to reveal layers of computer-generated perceptual information. AR can be experienced by using only a mobile device such as a smartphone or a tablet. For a more immersive experience, AR can also be viewed with headsets or custom glasses (smart glasses).

One of the key challenges of AR has been to determine how to find points of reference in the physical world that can be used to activate the virtual layers. Mobile devices are not usually equipped with 3D sensors and this has been a major limitation to AR over the past years. The use of markers was required to trigger the experiences. However the new developments in mobile technologies and specific software for AR are advancing rapidly and there are already some devices that include this capability. For example the project Disaster Scope[37] uses a specific AR phone which can 3D scan and analyse the surroundings to create a 3D model of the space as well as locate the phone within it. With the development of mobile devices, cameras, tracking sensors and 3D software these challenges are set to be overcome in the next few years.

Types of AR

- **Marker Based AR:** Uses a marker such as a QR code or an image to trigger the AR scene.
- **Markerless / Location based AR:** Uses the location settings on the user's device to active the AR experience.
- **Superimposition AR:** Uses object recognition to replace an object or several objects in the scene.
- **Projection AR:** Projects digital content onto physical surfaces using a projector.



SkyView app, image Christchurch City Libraries

37 See case study number 9

The strength of AR lies in the fact that components from the virtual world such as graphics, audio, and data blend into the user's reality, altering the view of the physical reality. This means that AR provides an efficient tool for visualisation of content,[38] allowing the development of educational, medical and other applications. AR has seen very interesting uses in the gaming sector such as Pokemon Go, a popular location based game that has been credited for making users discover new locations and help local businesses through footfall.[39] AR has also been applied to innovative medical uses providing benefits for surgical procedures,[40] overlaying interactive content to teach knowledge,[41] or even help children with autism read facial expressions to develop better social skills.[42]

AR has great potential to be used in education and training, engaging students in the learning process as well as helping them improve visualisation skills. One example is the app SkyView which allows users to learn astrology by pointing their phone at the sky or the ground and see where stars, satellites, planets, and constellations are located at that exact moment and receive information about these. The WWF Free Rivers[43] app allows anyone to learn about free flowing rivers in AR and also allows teachers and trainers to explain abstract concepts and help students understand what they are being taught.[44] Although limitations exist with this technology, they are mostly related to technical issues. With the current level of technological growth, this limitation can be overcome in a matter of years.

38 *Singhal, S., Bagga, S., Goyal, P., & Saxena, V. Augmented Chemistry: Interactive Education System. International Journal of Computer Applications, 2012.*
39 *https://en.wikipedia.org/wiki/Pok%C3%A9mon_Go*
40 *Chang, Y. J., Chen, C. H., Huang, W. T., & Huang, W. S. Investigating students' perceived satisfaction, behavioral intention, and effectiveness of English learning using augmented reality, 2011*
41 *Yeom, S. Augmented Reality for Learning Anatomy, 2011*
42 *https://med.stanford.edu/news/all-news/2018/08/google-glass-helps-kids-with-autism-read-facial-expressions.html*
43 *Case study number 2*
44 *Nor Farhah Saidin, Noor Dayana Abd Halim & Noraffandy Yahaya. A Review of Research on Augmented Reality in Education: Advantages and Applications, 2015*

A recent case worth highlighting is the release of Magic Leap in 2018, a spatial computing platform offering a lightweight standalone AR glasses device which is able to seamlessly overlay realistic virtual content over the physical world. The technology used is still being developed and has attracted funding from companies like Google and Alibaba.[45]

Some designers state that AR is set to be the future of design as it integrates seamlessly with mobile phones, already an integral part of our lives. As technology becomes further integrated into our lives in less obtrusive ways (à la Google Glass) it is certain that augmented reality will provide opportunities to enhance user experiences beyond measure.

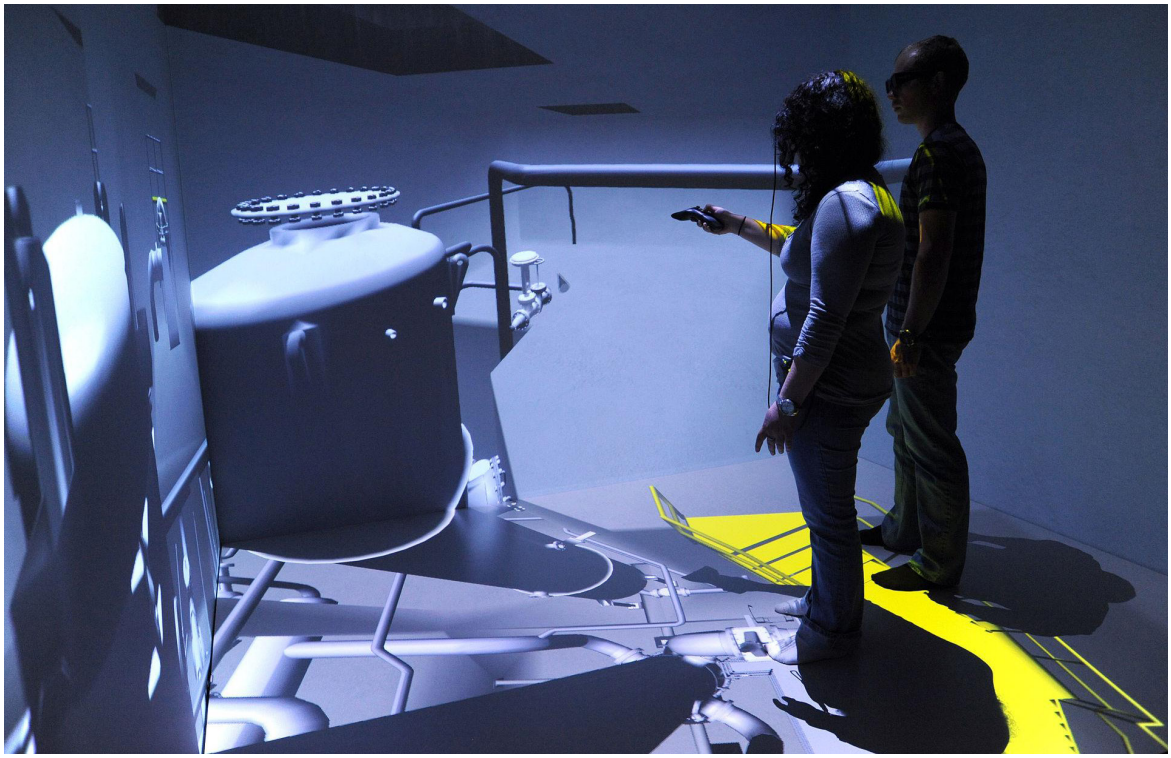
3. Extended Reality

Extended reality (XR), also known as cross-reality and hyper-reality, is an umbrella term that encompasses human-machine interactions generated by computer technology with devices or wearables to create real and virtual environments which include VR, AR and in this research paper also encompasses mixed reality as part of XR. Mixed reality (MR) is a hybrid definition combining both AR and VR. Recently released MR devices such as Microsoft's Hololens and the Magic Leap demonstrate what mixed reality can do by allowing users to interact with holographic augmentations in a seamless manner.

The ultimate aim of XR is to seamlessly integrate the virtual and physical worlds to create new and enhanced experiences. This requires the integration of several technologies, including mixed reality, which refers to the combination of both VR and AR.

- **Immersive spaces:** VR in space with headset, computer and projections.

Immersive experiences take over a dedicated space, such as a purpose built room or a media



45 https://www.techradar.com/news/magic-leap-one

room. These spaces allow for the use of VR, AR or mixed reality headsets, along with other media to blend the virtual world, for example: projections, displays and external audio.

One 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.[46] This system allows multiple users to be in the same space.

Innovations in the use of immersive spaces continue to appear in the arts and entertainment sector, with artists pushing the boundaries of perception and space. For example, the work of Japanese technology studio teamLab[47] transforms large gallery spaces into full-body immersive art experiences in which users can explore dreamlike worlds evoking nature and technology. Their exhibitions present interconnected spaces which react with visitors and between each other.

Borderless by Teamlab at Mori Museum, Tokyo

UK based art studio Marshmallow Laser Feast recently created an experience at London's Saatchi Gallery called "We Live in An Ocean of Air" to explore our connection with the natural world. In this experience, participants were able to walk around and explore the VR environment, and also interact with it using their breath, pulse and even using their hands instead of controllers.

46 NYU https://wp.nyu.edu/aimlab/resources_main/cave/
47 https://www.teamlab.art/

We Live in An Ocean of Air by Marshmallow Laser Feast at the Saatchi Gallery, London

Another innovative use of immersive mixed reality and AR is The Weather Channel Segments. These short segments used when there is a threat of flooding show the viewer what it would be like to be in the middle of the flood if water levels were to rise as predicted. They are built in an immersive mixed reality environment, a step up from AR in which, instead of projecting small objects in front of presenters on-air, the entire space around the presenter can be transformed into a virtual environment powered by games engine Unreal. The maps and data are presented in real time and the weather conditions driven by forecasts.

While immersive spaces can provide state-of-the-art immersive experiences, they require a great amount of resources to install, run and maintain as the technologies used and the level of expertise required is very high. One benefit they offer is that they can be set up as permanent or semi-permanent spaces where research can be centralised and multiple experiences can be presented to different audiences at the same level of quality.

2.2.2 Usage and age restriction guidelines

Players and Avatars

One of the powers of new XR technologies is to place the user at the centre of the experience and to enable them to make their own decisions. Experiences can be designed integrating different perspectives and points of view including:

- First person view actor: the experience is viewed as if the user was looking through their own eyes, and they make decisions about how to interact with the experience. They are the main characters and they are responsible for their actions. This view is typical of games and full VR experiences that allow interaction.
- First person view observer: the experience is viewed in first person. The user is not able to make decisions about the main narrative, but can explore it. This is typical of 360 video.
- Third person view: the user can view and control the main character, usually represented by an avatar.

With the development of new experiences that allow multiple players, it is expected that new points of view will be developed. Preceded by virtual platforms like Second Life, in "social VR" participants can get together in the virtual space and interact with each other, as avatars. This is considered to be one of XR's next milestones.[48]

Another consideration is the integration of the "narrator" or "guide". This is a common technique used in games and educational experiences to allow the user to navigate the experience. In the context of XR, it can be very effective to integrate a guide to direct the narrative of the experience, delivering key messages as well as connecting the user with the experience through empathy. The recently launched Star Wars - Vader Immortal game for Oculus Quest features a droid copilot that acts as a guide, reminding the user of actions that need to be completed.

Vader Immortal: A Star Wars VR Series – Episode I

48 See Chapter 4.

In games, such as 1979 Revolution: Black Friday,[49] the main character receives guidance and support from other characters involved in the game, such as friends and family. In Lifesaver VR,[50] the narrator is a voice over guiding the experience and is timed with interactions on screen. Non-character driven experiences can also provide guidance through in-experience menus, warnings and alerts. For example in WWF Free Rivers[51] bubble menus appear to guide users through the experience.

Health and safety

The effect of XR technologies in the long term is not yet fully understood as the technologies are so new. Moderation is recommended for all users and particularly for children. Instead of hours of use, which can apply to other screens, it is recommended to think in terms of minutes. If the experience is AR on screen, use time can be increased, but most VR experiences are not recommended to exceed five to ten minutes for children.[52]For adults, it is recommended to take breaks approximately every 20 minutes.

VR and other immersive experiences, in particular those using headsets, also come with the extra challenge of sickness and discomfort. To minimise the risk of motion sickness, time should be limited and XR experiences should not be scheduled during the last lesson of the day to ensure student safety after leaving school.[53] The Oculus store grades experience comfort levels however there is no defined standard in other stores. Features such as vignetting, which reduces the field of view during movement, or teleportation allow the user to move around without discomfort. By definition, VR blocks out the real world so it is key to define a safe space to play, free of sharp edges, pets, walls or other obstacles and dangers.

More recommendations on health and safety can be found in the devices' health and safety warning instructions, such as the Oculus VR warning notes, the Microsoft Mixed Reality notes or ClassVR who offer an updated VR health and safety guide on their website. Any safety warnings developed should include notes about how to use headsets, how to set up a safe space, what are the common risks associated with XR and what to do in case of discomfort. It is recommended to print a summary of health and safety warnings and ensure all users read it before they start the experience.

It is also recommended to create an onboarding time for each user once they are immersed in the XR experience, especially for those that have never experienced XR technologies before. This is particularly important to consider in the case of fully immersive VR experiences. Onboarding should include usage notes, menu instructions as well as instructions for how to end the experience in case of physical discomfort.

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49 Case study 8
50 Case study 5
51 Case study 2
52 Jeremy Bailenson in Aubrey, J. S., Robb, M. B., Bailey, J., & Bailenson, J. Virtual Reality 101: What You Need to Know About Kids and VR. San Francisco, CA, 2018
53 Handbook for a School-based Risk Reduction Initiative by IFRC
http://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2016/02/RCRC-Handbook-for-CSS.pdf

Privacy & Security

XR technologies raise many issues around user privacy and security and many of these questions are still unanswered. Security and privacy risks have been raised concerning the access and use of user data by third party agents and particularly on user data gathered from wearables and mobile devices. For data protection, there is a lengthy list of properties that need to be addressed such as integrity, availability, confidentiality, unlinkability, anonymity and pseudonymity and plausible deniability.[54] Since most of the VR hardware and software providers have privacy policies available on their websites it is strongly recommended to carefully review these policies and act on them.

Recommended points to consider include:

- Review data gathered and inputted into the XR platform, as it might include sensitive information that needs to be protected.
- Any data collected, processed and stored in any XR application has to be reviewed. Making data public without the end user's consent, for example sharing it within a platform provided by the hardware or software manufacturer might break privacy rules. This is especially important when organising XR events as the organisers control the hardware and software however users do not have the time to choose their privacy preferences. A best practice for event organisers is to disable all possible sharing options from the device settings.
- Sharing data with third parties may include sensitive information and it would have to be reviewed. However where possible this option should be disabled.
- Tracking data for user testing while developing an application should be another point of concern for XR developers. The best practice is to maintain anonymous tracking and to avoid collecting any personal identifiable information from the user.

Age Recommendations

Any new technology should be considered with care and moderation, especially with anyone under age. New technologies bring fundamental changes to the lives of 21st century children who are the most frequent users of emerging digital and online services[55] such as YouTube or Instagram. However not every child benefits equally from online opportunities.

Children and young people are also avid users of video games and are increasingly aware of VR and XR experiences, however there is not yet an official standard body such as PEGI ratings[56] generating guidelines for different technologies and age groups.

The age of seven is a critical point, as it is typically the age by which children understand the plausibility of media events.[57] Thirteen is the age recommendation of full VR headsets stated by

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54 *Security and Privacy Approaches in Mixed Reality: A Literature Survey* https://arxiv.org/pdf/1802.05797.pdf

55 *OECD, New technologies and 21st century children: Recent trends and outcomes OECD Education Working Paper No. 179, 2016*

56 https://pegi.info/

57 *Claxton, Laura J.; Ponto, Katelyn C. Understanding the Properties of Interactive Televised Characters, 2013 and Woolley, J and Maliki E. Revisiting the fantasy-reality distinction: children as naïve skeptics, 2013*

their manufacturers (HTC Vive, Oculus Rift S, Oculus Quest and others). Oculus' CEO explains the age limit chosen:

"It's early days and we really are trying to be conscious of health and safety".[58]

VR author Jeremy Bailenson also supports a similar message:

"Until research yields more clues on the effects of VR on children, common sense should prevail."

Recent research on children and virtual reality focuses on children aged eight - 12[59] and investigates if there are any potential harmful effects of experiencing VR under 13. Some of the conclusions outlined in the report include:

- All children asked to play for longer.
- They used VR in very social ways, for example simultaneously talking to their friend outside the experience.
- Children seemed to prefer low poly or cartoon graphics, such as Job Simulator (pictured below). This allowed them to bring their own narratives into the experience.
- Recommended frames per second were 60 fps, and any below 30 fps was disorientating.
- Children's engagement was multisensory and they played with their whole bodies.
- They enjoyed breaking the rules and doing things they couldn't do in the real world, such as setting things on fire.

Job Simulator Screenshot

58 chttps://www.vrfocus.com/2015/06/oculus-rift-age-limit/
59 *Children and Virtual Reality, Emerging Possibilities and Challenges, 2017*

In the case of AR, the impact has to be assessed differently to VR as the content can be viewed on screen based devices, rather than headsets. This allows technology recommendations to be more aligned with content recommendations.

Aside from the technology, one important aspect to consider is the nature of the content and how it might influence or even traumatise children. A good content rule is, if you would not want children to live with the memory of the event in the real world, then do not have them do it in XR. Read more about Content Design and recommendations in Section 4.2.
Below is a summary of recommendations per age group.

Age	Tech	Content	Notes
0-3	No tech or screen based activities recommended at this age[1]	No tech or screen based activities recommended at this age	No tech or screen based activities recommended at this age
3-6	Screen based experiences (mobile, tablet, computer or gaming console)	Gaming, fantasy	Short time periods, under 5 mins
7-9	Under adult supervision - screen based experiences, AR and 360 VR experiences	Gaming, fantasy, low shocking realistic simulationsvv	Concrete operational cognitive development - age from 7 years old - short periods (5-7 mins)
9-12	Under adult supervision - screen based experiences, AR and 360 VR experiences	Gaming, fantasy, middle shock realistic simulations	Concrete operational cognitive development short periods (5-10 mins)
13-17	Under adult supervision. Full interactive VR, immersive spaces	Gaming, fantasy, middle shock realistic simulations	Formal operational cognitive development. Breaks every 10-15 mins
+18	Full interactive VR, immersive spaces	Gaming, fantasy, shocking realistic simulations	Adult - All content is allowed too. Breaks every 20-30 mins

2.3 History of XR in disaster preparedness and risk reduction

Since the 1970s, new technologies have been used to create simulations that bring disasters to life through computer visualisations and game environments. Different lines of work have advanced this niche, including scientists who create computer simulations to analyse natural phenomena and military defence bodies who worked to develop training systems for emergency responders. In 1992, the Advanced Disaster Management Simulator (ADMS) was introduced in response to a plane crash at the Manchester Airport (UK) to train incident commanders in a real-time interactive virtual reality environment, which was built as a game simulation and was explored using computer monitors and joysticks. This tool still exists and is being used by several national bodies around the world including the New York City Office of Emergency Management.[60]

60 https://en.wikipedia.org/wiki/Advanced_disaster_management_simulator

ADMS on WPIX Channel (date unknown)

Before XR technologies became more widely accessible, DP/DRR training and simulations were offered through screen based devices such as computers, monitors or gaming consoles. In the last decade serious games (SGs) have become popular training and behavioural analysis tools and examples are present across industries, for example:

- The oil industry[61]
- Terrorist attacks[62]
- Fire evacuation[63]
- Earthquake evacuation[64]
- General disaster evacuation[65]

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61 For example in Mayer, I., Wolff, A., & Wenzler, I. (2013, September). Learning efficacy of the 'hazard recognition' serious game. Serious Games Development and Applications, 118-129; and Metello, M.G., Casanova, M.A., & Carvalho, M.T.M. (2008, December). Using Serious Game Techniques to Simulate Emergency Situations. GeoInfo, 121-182.

62 For example: Chittaro, L., & Sioni, R. (2015). Serious games for emergency preparedness: Evaluation of an interactive vs. a non-interactive simulation of a terror attack. Computers in Human Behavior, 50, 508-519.

63 For example: Smith, S., & Ericson, E. (2009). Using immersive game-based virtual reality to teach fire-safety skills to children. Virtual Reality, 13(2), 87-99.

64 For example: Tanes, Z., & Cho, H. (2013). Goal setting outcomes: Examining the role of goal interaction in influencing the experience and learning outcomes of video game play for earthquake preparedness. Computers in Human Behavior, 29(3), 858-869.

65 Cohen, D., Sevdalis, N., Taylor, D., Kerr, K., Heys, M., Willett, K., Batrick, N., & Darzi, A. (2012). Emergency preparedness in the 21st century: Training and preparation modules in virtual environments. Resuscitation, 84(1), 78-84.

Many of these screen-based simulations are available online as websites or mobile applications on the Google and Apple Stores. Examples include: *Stop Disasters Game* by UNDRR, available online, provides game simulations for up to five hazards; *Humanitarian Hero* by American Red Cross, a game that embarks users in several missions with the aim to become a humanitarian hero and *Tanah: The Tsunami and Earthquake Fighter* by the GDPC, a disaster preparedness educational mobile app designed for kids and families. Alongside these specific applications and websites, there is a world of video content which has been used for DRR education, some of it available on online platforms such as YouTube.

The DRR community is actively engaged in researching and testing innovative XR ideas. The main change seen from the use of XR technologies is the possibility to fully immerse the user inside the simulation, which opens new avenues for DRR training, especially in the field of simulations and drills. 360 video (both in VR format or for web) has been widely used to build empathy and generate engagement. The successful use of virtual reality simulations in disaster management training initiatives is a popular area for research, particularly building evacuations for fire and earthquake, and has proven to influence behaviour and learning outcomes. On the horizon is the research focused on augmented reality as a new medium for training disaster preparedness with location specific features which allows targeting the experience to any given location, with clear benefits for scalability.

Another important addition to XR today is the integration of digital serious games as part of XR experiences, offering a unique combination which can produce behavioural and pedagogical outcomes. This is still an emerging field in which researchers and creators are testing experimental new ways to engage users more and find new innovative ways to transmit knowledge using a variety of practices.

All of these developments and opportunities for SBDRR are considered in Chapters 3 and 4.

#3
Analysis

Introduction

This chapter presents a gap analysis of the limitations of traditional SBDRR activities and the potential solutions that XR provides to address these limitations. Learnings and recommendations on the design, production and delivery of XR experiences specific to the Red Cross Movement are presented at the end of this chapter, to build on the technological affordances for specific SBDRR activities. It is important to note that XR should not replace traditional teaching methods, in particular methods that are proven to work. Any use of technology must not recreate education as it already is, but utilise the unique advantages of the technology to bring added value to what is already in practice with other learning modalities, targeting shortcomings and providing solutions where the technology is accessible, scalable and affordable.

3.1 Gap analysis of SBDRR limitations & XR opportunities

Many traditional SBDRR methods of delivery are effective in conveying disaster knowledge and raising awareness of disaster management for children and adults. There are however a range of identified shortcomings in traditional methods of delivery and learning. The challenge of the main SBDRR activities - training, drills/simulations and awareness raising - often lies in conveying knowledge in an engaging and effective manner that can change behaviour while allowing for contextualisation and dissemination at a wide scale.

XR technologies have the potential to change teaching methodologies and overall reach, supplementing the already established practices and procedures applied in schools. Research has found that XR, for example VR and serious games for building evacuations, employ novel and effective techniques to overcome the limitations of traditional approaches. For example, VR technologies have proven valuable in investigating behaviours in fire evacuation, such as system perception, pre-movement behaviour, wayfinding, exit choice and navigation interactions.[66] This emerging technology allows users to be exposed to more realistic evacuation scenarios by representing several threats concurrently.

This section presents a gap analysis of the limitations of traditional SBDRR activities and the potential solutions that XR provides to address these gaps. The shortcomings are classified by the main SBDRR activities outlined in Chapter 2: 1) Disaster awareness raising activities; 2)

66 These are documented in literature reviews and case studies including the Auckland City Hospital case study and literature review.

Disaster drills and evacuations; and 3) Training (first aid and disaster management). In reality there is overlap between these activities - for example drills are a form of disaster management training and are also an awareness raising activity. However because they are often conducted as separate activities, and to allow for the analysis, they are presented here in three categories.

3.1.1 Disaster awareness raising activities

In activities that focus on disaster awareness raising, the main goal is that students develop knowledge, understanding and skills on disaster management. This is the SBDRR activity where there has been the most creativity shown to date in harnessing technologies to increase learning outcomes, including mobile phone apps and digital games. However the bulk of SBDRR awareness raising activities are still conducted in a unidirectional, non-participatory manner. Students are often the passive recipients of information, leading to low levels of motivation, knowledge retention and understanding of real hazard effects. XR technologies have the ability to motivate students and improve learning outcomes and knowledge retention due to the "wow factor" they still hold and their ability to visually represent what is often delivered by verbal or written methods.

Some of the shortcomings of this activity are presented below, alongside the opportunities that XR technologies offer to address and fill these gaps.

Participation and Motivation

Often students are **passive recipients of information** *rather than being actively engaged in the awareness raising activity. They* **lack participation** *and* **motivation** *due to methods of delivery with low engagement, that can also be outdated or monotonous.*

XR Opportunities

XR experiences increase student engagement and motivation. This benefit is applicable to all new XR technologies. AR and VR still have the "wow" factor and the ability to motivate participation. For example, research has found that tablet-enabled AR used in school learning is 1) able to prove a positive increase in student engagement and 2) increase student motivation towards learning.[67] User's increased enthusiasm is noted in the case study of ZIKA360[68] where students were highly engaged during the duration of the activity and actively participated.

Learning by doing - whether with immersive or gaming technologies - is naturally more participatory than passive information receiving. Moreover, studies have shown that **users' behavior can change** when using VR, making them feel more personally accountable or responsible for the action in each scene. This transforms into higher degree of participation and engagement

67 Hibberd, R, A Johnson, D To and S Vora-Patel, Engaging the 21st century learner: Using augmented reality to increase student engagement and student achievement in an inquiry-based learning environment, 2012
68 ZIKA360 Case Study Number 1

in the activity. For example, immersive VR is proven to enhance the enthusiasm of children for fire-safety skills training by improving their engagement with the learning environment.[69]

VR is an extremely powerful motivational tool. Game-based VR systems increase children's motivation over more traditional teacher–learner forms of VR-based instruction. **Digital game-based learning**, when used appropriately, can provide students and educators with better attitudes towards learning, increase student motivation, foster higher-order thinking, influence personal real-life perceptions, impacts decision-making processes, and aide students learning achievements.[70]

Participation and motivation can also be integrated in the process of designing and building an experience. In the case of VR Action Lab[71], the design process increased participation by involving members of the target audience group in making the experience. The user-centered approach with people and not for people involved in the particular issue (bullying) allowed the creators to engage more young people in the process and to achieve better results. In the case of Disaster Preparedness Simulator,[72] the user-centered design process involving not only teachers and students but also local authorities in the Philippines increased awareness of the project and participation and motivation of all the actors involved, with benefits for the uptake of the tool.

Knowledge Acquisition, Retention and Application

It is **difficult to apply knowledge gained through traditional educational methods** *to real life contexts*. According to research presented by Dunleavy & Dede,[73] *"Even students who excel in educational settings often are unable to apply what they have learned to similar real-world contexts."* This is even more the case in disaster education, where concepts can be very abstract if not experienced previously in real life.

XR Opportunities:

Immersive technologies, with their emphasis on "learning by doing" can address this shortcoming through providing knowledge through a medium that makes the user feel they have experienced the event in real life, making it easier to retain and apply knowledge learned. This advantage is explained in research on educational communications and technology:

"The potential advantage of immersive interfaces for situated learning is that their simulation of real-world problems and contexts means that students must attain only near-transfer to achieve preparation for future learning.

69 *Smith, S., & Ericson, E. (2009). Using immersive game-based virtual reality to teach fire-safety skills to children. Virtual Reality, 13(2), 87-99.*
70 Von Gillern, S., Alaswa, Z. Games and Game-based Learning in Instructional Design, 2017
71 VR Action Lab by Harmony Labs, Case Study Number 3
72 Disaster Preparedness Simulator by Ania Design Labs. Case study Number 9
73 2014, p. 737

Flight and surgical simulators demonstrate near-transfer of psychomotor skills from digital simulations to real-world settings; research on the extent to which AR can foster transfer is an important frontier for the field."[74]

For example, in the case of sports training, VR expert Jeremy Bailenson explains how he worked with a student to create a VR simulation to train football players, using 360 footage so that,

"real footage would help create the sense of presence, the sensation of "being there" in the virtual space, that was crucial to the learning experience we were creating."[75]

Recorded footage of the training sessions allowed players to repeat scenes as many times as required to study the game in detail. The VR training was implemented in 2014 and as a result the team's total offense improved from 24 points per game to 38 points per game during this same period.

AR combined with gamification can lead to increased knowledge acquisition and retention. When combined with gaming techniques, AR experiences have shown positive impacts on learning, reinforcing existing learning and gaining new knowledge, and on behaviour change for disaster or health education. Using gamification has also shown motivation to obtain a high score, thereby increasing engagement. Students playing the Zika360[76] AR app were interested in the app and in taking the quiz, which tested student knowledge acquired during the experience and provided a score. Most of the students obtained very high scores and those who did not, subsequently asked to repeat the quiz. This shows that the tool was effectively designed to validate and reinforce the key messages that the project aimed to deliver.

Using game mechanics such as conversation trees can be useful **to instill knowledge whilst maintaining high engagement.** This is shown in the 1979 Revolution[77] game, which includes a branching storyline in which the user is the main decision maker and driver of the narrative.

Visualisation & Visual Representation

The combination of visualisation and representation of concepts and situations contributes to improved cognition. However in traditional forms of DRR education, there is a **lack of understanding of real hazard effects due to a lack of visual representation of hazards** - for example of what water levels rising in a flood would actually look like. This naturally leads to a difficulty understanding and visualising the impacts of a disaster.

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74 Spector, M, David Merrill, Jan Elen, M. J. Bishop, Handbook of Research on Educational Communications and Technology, 2013
75 Bailenson, J, Experience on Demand, 2018
76 Case study number 1
77 1979 Revolution Black Friday, Case Study number 8

XR Opportunities

XR contributes to improving visualisation of "hard to visualise" concepts that can not be normally seen in the real world, including hazards. XR can overcome this barrier because it has the potential to visually represent the hazards and their impacts, whether in immersive VR, or headset/mobile AR. AR can effectively make visible concepts that may be hard to explain and research has demonstrated the beneficial use of AR technology as a means of visualising concepts. For example, the *Disaster Scope* AR app[78] can effectively visualise fire smoke in an indoor space and allow participants to understand the escape route, also contributing to the learning of spatial skills. *The Weather Channel* uses immersive mixed reality to show the viewer what it would be like to be in the middle of the flood if water levels were to rise as predicted, to motivate people to evacuate their homes in times of high flood risk.

Visualisation of hazards leads to increased understanding of what experiencing the hazard would be like, activating the memory of a visual representation of the hazard, which in turn motivates behaviour change and increases knowledge retention. In WWF's *Free Rivers*,[79] the AR visualisation allows users to understanding a complicated topic of rivers, dams and flooding, with high quality graphics, accurately designed people, plants, ecosystems and animals, and clear, vivid visuals which have a positive effect on teaching about a subject that is otherwise hard to visualise, or that can be perceived as not engaging.

3.1.2 Disaster drills and evacuations

> *"From a pedagogical point of view, it is difficult to ensure that [traditional] evacuation drills provide effective training. In fact, evacuation drill participants often receive no feedback whatsoever to help them assess their evacuation choices retrospectively."*[80]

Drills and evacuation simulations aim to empower people to act and survive in case of disaster, for example by practicing how to physically evacuate a school in an emergency. Approaches such as videos, posters, seminars, courses, or evacuation drills are used in evacuation training. However there is little post-disaster research on the effectiveness of school drills and their role in the prevention of injuries and deaths. One exception is research by Save the Children into school drills and how to make them more effective.[81] *This study concludes that "while drills may provide important and necessary learning opportunities, it is not clear whether they improve children's situational awareness and decision-making skills. Researchers recommend improved situational awareness, mastery of response skills, realistic simulation scenarios, practice in decision-making, increased school*

78 Case study number 9
79 Case study number 2
80 Lovreglio, R, Gonzalez, V., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M., Sacks, R., Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study, 2018
81 Johnson, Victoria A., Towers, Briony, Petal, Marla, Child-Centred Risk Reduction Research-intoAction Brief: School Emergency Drills, for the Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector, 2018

accountability self-assessments, and 'after-action reviews' to stimulate improvements in school disaster management."

There is great potential for XR to address some of these recommendations and particularly the main limitation of evacuation drills: the difference between the real-world emergency and the simulated emergency, a major barrier to participant learning. It is essential that drills provide opportunities for children and teachers to apply their knowledge to a range of scenarios, be put to the test with problem solving and unexpected scenarios and then give and receive feedback on how they responded. XR is of particular relevance to improving disaster drills and evacuations given the number, types and nature of shortcomings of traditional methods that make it difficult to gain real mastery of response skills. These are listed below, with the potential of XR to address them.

Realistic Disaster Simulations

Traditional SBDRR cannot provide realistic simulation scenarios. The main limitation of evacuation drills is the difference between the real-world emergency and the simulated emergency, which can seriously prevent participants' learning.

XR Opportunities

"A VR experience is often better understood not as a media experience, but as an actual experience, with the attendant results for our behavior."

Jeremy Bailenson, Experience on Demand

XR can **simulate a disaster** either in a virtual, augmented or mixed reality environment in realistic ways that make the user feel like they have actually experienced it. The hazards that are most experimented on with XR to date are fire and earthquake, as they have the least warning and are the most likely to require rapid building evacuation. One of the key challenges is to develop disaster scenarios that are realistic but not overly frightening for students. Research has found that well-planned drills and associated learning activities do not increase anxiety or worry in children; rather, they increase their knowledge of what to do and their confidence in their coping abilities.[82] The method used will depend on the age group targeted and recommended age restrictions. Acquisition of response skills and drill practice should be modified for different age levels and abilities and should leverage children's unique strengths and capabilities.[83] For learnings on designing simulations with the appropriate realism/fear balance to promote action but not overwhelm, see Section 3.2.1.

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82 Johnson, V., R.Ronan, K., Johnston, D., Peace, R., Evaluations of disaster education programs for children: A methodological review, 2014

83 For a full list of pointers per age group, see p. 5 onwards in the following paper: Johnson, Victoria A., Towers, Briony, Petal, Marla, Child-Centred Risk Reduction Research-intoAction Brief: School Emergency Drills, for the Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector, 2018

A huge advantage of XR technologies is that they can be used to train for potentially dangerous situations that are hard to recreate in the real world, through this recreation of realistic disaster simulations. VR is being used by companies in the private sector to train employees to learn how to cope with potentially dangerous situations that are difficult to train for in in real life, for example Verizon is using VR to train staff on how to act in case of robbery. AR can also be used to train on dangerous topics, for example by bringing to life floods or fire as shown in *Disaster Scope*.[84]

XR can test a wide range of varied and realistic scenarios including:

1. Scenarios from real footage, such as from 360 video in VR. In this case the scenario is exactly like reality and provides real references of the physical world. This can be effective to portray characters. For example in *VR Action Lab,* the creators wanted to show real young people in the experiences so that users, who were also young people, could empathise with them. In the case of *LifeSaver VR*, the characters are also real from 360 footage, with the aim to create an emotional connection with the target audience. The British Red Cross' 360 First Aid Bystander Effect VR experience, 360 video allows the viewer to feel like they are in the train where the first aid emergency takes place.

2. Scenarios created in 3D with computer graphics and 3D software. The type of graphics can vary from cartoon-like to hyper-realistic 3D. These graphics are computer generated and allow for more control of the assets and customisation without having to redo full scenes. For example, the ICRC VR team create experiences simulating conflict zones and areas of their work such as a prison-based simulation for detention delegates. By examining a realistic scenario, delegates learn to assess detention conditions as well as to speak to prisoners. These simulations are created using advanced 3D graphics and built using video game engines to offer maximum control. ICRC opted for 3D graphics rather than 360 video to make the simulations generic in appearance and therefore more applicable to multiple contexts or countries where they work. FEMA's Immersed, Ania Design Lab's Disaster Preparedness Simulator and APDRC's VR for resilience fire and cruise ship simulations all use 3D graphics to deliver the experiences.[85]

One of the main benefits of working with 3D graphics is the possibility to create libraries of assets, which can be reused in different experiences, making the system more scalable and more cost effective in the long term, particularly if shared across the RCRC Movement or humanitarian sector.

Situational Awareness

Traditional drills do not incorporate **situational awareness learning:** Traditional drills do not allow children to learn situational awareness, the perception of environmental elements and the comprehension of their meaning.

84 *Case study number 9*
85 *See case studies numbers 10, 6 and 7*

XR Opportunities

XR can create a realistic environment to show the scope of a disaster in the actual location where the training is happening, such as in a school. For example, the Disaster Scope[86] AR app reveals how floods would affect students by allowing students to be immersed in a flood situation in their school. By showing the water height students can understand which areas of their school and the surroundings could potentially be safe or unsafe during floods.

There are three key aspects of situational awareness in which XR technologies can be effective:

1. Prepare: How to prepare for a disaster.
2. Respond: Acquire decision making skills and learn how to act during a disaster.
3. Recover. Learn how to act after a disaster.

In FEMA's Immersed 2.0, the experience challenges homeowners to make decisions for themselves in a flood and see the impacts their decisions and consequences of inaction have across the whole neighbourhood. For example, how to ensure you can still commute in a flood or pick the kids up from school. The Zika360 AR app shows a representation of the community and the common areas where preparedness must be implemented, including in school, at home and in a medical centre.

Feedback & Evaluation

In many traditional drills, there is little integration of feedback or monitoring and evaluation mechanisms. Drills as they are usually conducted in SBDRR often do not provide feedback to participants help evaluate and assess choices made and to improve performance. Those in charge of drills often focus on improving the speed of the drill, rather than looking at how to improve technique, for which feedback on performance is critical. Feedback should improve both the process and the participation for students and teachers, but this is rarely the case. This shortcoming is highlighted in a comprehensive literature review of evacuation drills that states that, *"From a pedagogical point of view, it is difficult to ensure that evacuation drills provide effective training. In fact, evacuation drill participants often receive no feedback whatsoever to help them assess their evacuation choices retrospectively."*[87] This is one of the greatest shortcomings of traditional drills and one of the most significant opportunities for XR.

XR Opportunities

XR can provide feedback to users both in the experience, for example on choices made within a VR simulation, and out of experience, for example in a classroom setting afterwards and/or as part of a broader training package. The technology can also provide feedback to the developer, owner or instructor (for example the teacher), including on analytics and analysis of behaviour patterns. Some examples[88] of in-experience feedback can include:

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86 Case study number 9
87 Lovreglio, R, Gonzalez, V., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M., Sacks, R., Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study, 2018
88 ibid

- A life bar showing the health of the virtual user/player in the experience to highlight the severity of the consequence of any unsafe actions taken.
- A cause of "death" message (i.e. an in-game text message indicates why the users lost their life) and a behavioural recommendation. Note: Levels of realism should be weighed with ethical considerations in countries where a portion of the population has been affected by major disasters or with young children, which may preclude their use in favour of lower fidelity options.
- Use of 'knowledge points' for correct decisions, and the loss of points or time penalties for incorrect decisions.[89]
- Immediate and formative user feedback about performance at each decision level[90]
- Taking users back to the point where they made a wrong decision and allowing them to restart from that point.[91]
- Including a quiz in the experience that can act as a tool for testing and receiving feedback from users and provide an effective way to understand if the user has achieved the desired learning goals.[92]

Some examples of out of experience feedback include:

- Integrating the experience into a training package so that is is not standalone and where users are provided feedback after the experience.[93]
- Screening the experience being used live so that other students/teachers can join in the feedback discussion and make one person's experience more participatory.
- Providing feedback at the end of the experience tailored to each user, for example through a list of correct and incorrect actions based on national guidelines or school SOPs and how users can improve for next time.[94]

XR has the potential to give more detailed and tailored feedback without a huge increase in human resources to observe the drills in real time. Feedback can be used to improve both the process and participation and go beyond focusing on the speed and efficiency of the drills. This feedback can come from other students who are, for example, watching the XR simulation on a screen, or via a multiplayer experience.

XR can also enable investigation of user behaviour, particularly linked to decision making. For example, simulating earthquake damage in a virtual environment can allow the assessment of users' reactions to different evacuation conditions, acting as a "virtual laboratory" with greater experimental control than traditional drills.[95]

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89 This is a technique used in the app LifeSaver VR, which provides instant feedback on the user's handling of CPR tests by showing a score.
90 For example in Lifesaver VR when the user is told if they are applying chest compression rates at the appropriate speed.
91 This is the approach used in Lifesaver VR when CPR compressions are not done correctly. This technique is used in 1979 Revolution allowing users to go back to specific points when the story branch doesn't meet a desired ending due to wrong decisions.
92 For example as in Zika 360, case study number 1
93 For example see case studies Disaster Preparedness Simulator and Stay Safe VR, numbers 9 and 5
94 As done in the Auckland City Hospital earthquake simulator: Lovreglio, R, Gonzalez, V., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M., Sacks, R., Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study, 2018
95 ibid

Decision Making

Traditional drills do not improve decision making skills: For example by making participants make decisions in unexpected scenarios, or foster critical thinking skills to be able to respond effectively. This is relevant to all participants: teachers, staff and school children. Traditional drills are often focused only on evacuation via the same route and do not take into account changing scenarios and unexpected events that require rapid decision making.

XR Opportunities

XR can incorporate decision making skills for a huge range of scenarios into simulations that are impossible to recreate in the real world. Decision making is closely linked to feedback. For example, in Ania Design Lab's virtual reality *Disaster Preparedness Simulator*, detailed storyboards and decision pathways were designed for the simulations, that show how each precautionary measure taken in the simulation leads to a specific consequence and level of risk. For instance, if the user in the typhoon simulation chooses to leave their home and go to a relative's house, they get caught by the storm surge and the game ends. Decision making both provides users with feedback on their performance and increases engagement and learning.

XR can also analyse behaviour linked to decision making. For example, in a VR simulation evacuees' viewing directions can be monitored and which elements and objects users are looking at before making their decisions.[96] This type of data is difficult to collect with classic evacuation drills and can be key to identifying what factors influence evacuation behaviour.

XR, in particular VR, supports **problem based learning**, where users are given a task and have the freedom to explore their own lines of enquiry, using their own prior knowledge and/or new information as it becomes available. One of the most frequently lauded educational benefits of VR is its ability to present to a group of users with multiple, incomplete, yet complementary perspectives on a problem, situation within a physical space. This is particularly useful for disaster response scenarios.

In the BRC *Bystander 360 Experience* users are presented with a common situation where someone needs help and the people around are not able to provide it. The experience puts the user in the position of each character in the scene, and makes them listen to their thoughts and doubts about providing support to the affected person. This narrative provides an efficient form of behaviour change and increases decision making skills.

Predictability and Repetition

Traditional drills are too predictable and too repetitive: Several studies have found that despite constraints on time and resources, most school staff identify a need for more realistic drills.[97] Drills often take place in **predictable settings** that do not reflect the reality of being in a major emergency. Often the same drill (for example drop, cover, hold) is repeated over and over, with a focus on improving the time it takes, rather than the quality.

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96 Lovreglio, R, Gonzalez, V., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M., Sacks, R., Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study, 2018, p.671

97 For example: Perkins, Jane C.Johnson & Wales University, Preparing Teachers for School Tragedy: Reading, Writing, and Lockdown, ProQuest Dissertations Publishing, 2015

XR Opportunities

Traditional drills can build in injects, be unannounced and find other ways to replicate the unpredictability of a disaster and build critical thinking. However XR can do this in a way that offers many more potential disaster scenarios and **branching storylines**, that more faithfully represent the multitude of often unexpected choices that a student/teacher will have to make in a disaster evacuation/response.[98]

Given the potential to present different scenarios and branching narratives such as **decision trees** in one simulation, as us done for three different disaster scenarios in Ania Design Lab's *Disaster Preparedness Simulator*,[99] XR can overcome this shortcoming easily.

Experiences that integrate digital games techniques and interactivity are particularly effective at overcoming this shortcoming. In *1979 Revolution*[100] each user receives a personalised experience as they make decisions that affect the narrative and how it evolves. The narrative is based on conversation trees, which allow the creators to design different layers and paths to view the experience. No one experience is the same and it is anything but predictable.

Resources and logistics

Traditional drills and evacuation simulations are **costly in time and resources.** Drills can fail from a pedagogical point of view as they require **significant logistical challenges**, including staff, venue and materials.[101] Drills **disrupt the activity** *and running of full schools*, making it hard to organise and repeat, as a lot of coordination is required. They also can only be performed once so if the drill does not go as expected there is not enough flexibility to repeat it.

XR Opportunities

Virtual, augmented or digital gaming environments require significantly less logistical requirements once the technology is made available and as long as schools are able to use it without technological difficulties. Drills with the same level of scenarios, branching storylines and options would require huge numbers of staff, materials and space. XR drills can be confined to one room while other activities in the school continue.

The resources required to produce XR experiences, in particular full VR, will require a substantial upfront investment, but the cost is absorbed by the creators, rather than the school or end user. Where research has been conducted on the cost of XR simulation experiences per person, for example in *Disaster Scope*[102] the cost per student is low (0.33 cents per student per experience).

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98 See Disaster Preparedness Simulator case study 9 for an example of how branching storylines and decision trees are used for evacuation drills in a virtual environment.
99 Case study number 6
100 Case study number 8
101 Rahouti, A, Guillaume Salze, Ruggiero Lovreglio, Sélim Datoussaïd, An Immersive Serious Game for Firefighting and Evacuation Training in Healthcare Facilities, 2017
102 Case study number 9

Emotional Engagement, Empathy and Behaviour Change

Traditional SBDRR simulation methods *do not emotionally engage participants in the learning process* - a key to changing behaviour.

XR Opportunities

XR can combine emotional and analytical learning, with greater impact on learning outcomes and behaviour change,[103] allowing participants to retain knowledge longer than traditional approaches.

Behaviour change is almost always a desired learning outcome of the main SBDRR activities. There are many examples of **XR leading to increased behaviour change**, modifying attitudes and behaviours and increasing collaboration in the physical world. For example, behaving prosocially after embodying a superhero in immersive VR[104] or being more environmentally conscious after cutting down a virtual tree versus only reading about deforestation.[105] 360 VR has been proven to be effective in increasing empathy leading to behaviour change - for example to overcome the bystander effect or to stop bullying among young people.[106] Examples of mixing AR with gaming have shown positive impacts on learning and behaviour change for health education, for example in the Zika 360 experience.[107] Key to increasing behaviour change is designing the XR experience with a combination of emotional connection with analytical tasks like decision making in virtual reality experiences.[108] For example, in Lifesaver VR an emotional connection is generated through strong storyboarding and scripting and user immersion into the characters, and in *Immersed 2.0* this is achieved through a family home that shows flood damage with everyday items that create a sense of connection.

3.1.3 Training: First Aid and Disaster Management

Training is a key activity of SBDRR across the Red Cross Movement. This includes first aid and disaster management training. At the same time, training has been the most consistently proven best use of immersive technology like virtual reality, for example in the medical and security fields, since the first forms of the technology were created. There is significant potential for using XR for disaster management and first aid training.

3.1.3a First Aid

First aid is one of the Red Cross Movement's core activities and often the only training conducted in some communities. First aid is often a core activity of SBDRR, but has a tendency to be one way, time consuming and not engaging.

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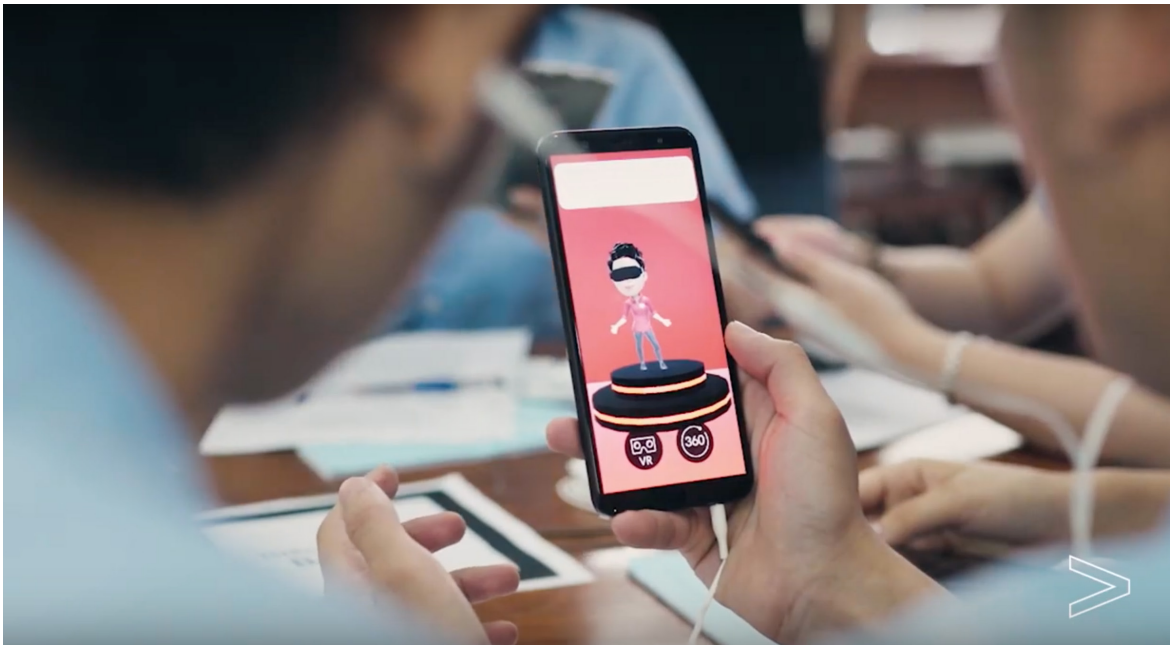
103 See case study of FEMA's Immersed for an example of this, case study 10.
104 Rosenberg, R. S., S. L. Baughman, and J. N. Bailenson. 2013. Virtual superheroes: Using superpowers in virtual reality to encourage prosocial behavior.
105 Ahn, S. J., J. N. Bailenson, and D. Park. 2014. Short- and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior. Computers in Human Behavior 39:235–245.
106 British Red Cross Bystander effect VR and VR Action Labs (case study number 3)
107 Case study number 1
108 For examples of analytical decision making, see the case study of Ania Design Lab's Philippines Disaster Preparedness Simulator (case study number 6), and the example of Auckland City hospital earthquake preparedness simulator (Lovreglio et al 2018)

Engagement
First Aid training is not engaging and it is not seen as interesting by trainees. This impacts on knowledge retention and learning outcomes.

XR Opportunities

XR has the potential to turn topics seen as uninteresting into engaging and motivating experiences. For example, the *WWF Free Rivers app*[109] was successful in turning the topic of river health into an engaging topic for school children.

XR, in particular VR, has been proven to increase engagement and learning outcomes in different types of first aid training. Examples of this include improving CPR skills in the *Lifesaver VR* app[110] by Resus UK and the British Red Cross's 360 video VR experience integrated into their first aid training curriculum has been proven to increase the likelihood of overcoming the bystander effect with strangers. BecaXR is another example of motivational experiences. Created by Save The Children and Accenture it uses AR and VR to help disadvantaged vocational school students and out of school youth visualise potential career paths by providing practical life skills to enter the labour market including public speaking and interviewing.



BecaXR promo video screenshot from YouTube

Learning Efficiency and Scalability
First aid courses can be time consuming (from three or four hours up to two days) and expensive, and there is competition in schools over other topics. There is a need to make it easier for schools to teach first aid to children.[111] In addition, *first aid courses would benefit from quicker and*

109 Case study number 2
110 Case study number 4
111 Sukra, E, Pros and cons of first aid training? 2010

repeated methods of teaching, "because the bottom line is that we just want to know that people will get down on their knees and do chest compressions when they see someone in cardiac arrest. Current CPR training is excellent but if that is limiting the number of people taking it, it should be made briefer and easier."[112] First aid skills are so simple that some researchers wonder if formal training is even necessary. A 2007 study found very little difference in the quality of skills learned by people taking a four-hour instructor-led CPR course and those teaching themselves with a 30-minute DVD and a mannequin.[113] Quicker, more repeated methods of teaching would more likely empower someone to act.

XR Opportunities

XR has the potential to take the critical parts of first aid - such as CPR - and turn them into short, impactful experiences where the user learns by doing, for example in *Lifesaver VR*.[114] Once the experience has been designed and proven to be effective, the training resources needed in terms of time and staffing are reduced, in turn decreasing considerably the cost and resources invested. XR experiences can then be repeated often at little cost, once schools have the equipment/technology, rather than having to run full-day training courses.

LifeSaver VR is successful at providing more skills than the mobile application version as participants are able to interact and perform real tasks with instant feedback on their performance.

If built as apps, XR experiences such as *Lifesaver VR* can be delivered via public websites and app stores to reach wide audiences.

Behaviour change

Through traditional methods of first aid delivery it is hard to address one of the largest barriers to action: the bystander effect [115] because it is difficult to simulate a real life crisis in traditional training.

XR Opportunity

The bystander effect can be overcome by just being aware of it and generating empathy through having the virtual experience. British Red Cross's 360 video VR experience *"Being a Bystander"*[116] is integrated into first aid training courses and has been proven to increase the likelihood of overcoming the bystander effect with strangers. The experience places the viewer in a train where someone has collapsed, and from the perspective of all the carriage occupants the user experiences the typical responses of people who are not sure whether to take action. After the simulation, training participants discuss the various perspectives and what they would have done and do differently next time. Experiencing the situation in such an immersed, realistic way, makes people more likely to act the next time they are in that situation.

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112 ibid
113 ibid
114 See Lifesaver VR case study number 4
115 BRC First Aid 360 VR Bystander Effect
116 https://www.youtube.com/watch?v=KrrJMu-IjUA&feature=youtu.be

Accessibility
Traditional forms of first aid are hard to teach more vulnerable groups, for example those with high illiteracy rates.[117]There is also a lack of inclusivity of disabilities and special needs when designing trainings, SOPs and simulations.

XR Opportunity

XR can be designed to require less written content and therefore be more accessible to illiterate groups, as long as they have access to the technology. For example, *Lifesaver VR*[118] contains very little written text, and the text there is could be spoken. *Being a Bystander* contains no written text. VR for the visually impaired is still far from having acceptable solutions. Accessibility settings for devices should be enabled to allow for larger text and spoken alternatives.[119]

3.1.3b School Disaster Management Training
Disaster management training for staff or school risk reduction teams includes training in how to lead an evacuation, training on the content of disaster SOPs and how to follow these SOPs. A key learning point on disaster management training is the importance of focussing on the skills and training of teachers.[120] This is often overlooked with more focus given to students. However as many disasters have shown, including the Japan earthquake that sparked the development of the AR app *Disaster Scope*,[121] the lack of teacher training in SOPs can lead to the injury and death of students in a major emergency. Learning can be taken from the private sector where companies like Walmart are beginning to use VR to train staff in store operations procedures.

Knowledge Retention
Low retention of information, particularly on disaster SOPs, school disaster risk management plans and how to follow them is reported in traditional DM training methods.

XR Opportunity

The learning by doing approach of XR - in particular VR - has been proven to facilitate learning and enhance knowledge acquisition and transfer.

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 doctors applying new surgical knowledge.[122]
In the example of disaster management training, knowledge could be delivered by traditional methods and then put to the test via XR, for example to practice specific hazard SOPs or as part of drills.

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117 ICRC and BRC work on First Aid in vulnerable conflict zones
118 Case study number 4
119 See Chapter 5 for ideas for future research, including on inclusion in XR.
120 Suggested as an area for future research in Chapter 5
121 Case study number 9
122 Gordon, E, Virtual and Augmented Reality in Education, A Review of the Literature, British Red Cross, August 2017

An example of putting knowledge into practice is VR learning company Strivr that has worked with Walmart on operations process procedures to train store managers as well as to evaluate employee performance. Inside the simulated environment, candidates might find themselves standing in a busy aisle facing multiple problems, such as spills, misplaced items and trash, and being given 30 seconds to figure out which to resolve first.[123] According to Walmart, the virtual assessment helps eliminate bias from the internal hiring process.

Engagement
Lack of engagement with the topic. This is particularly because hazard SOPs are not always designed in a participatory way, or that the content is not considered engaging or interesting.

XR Opportunity

XR has the potential to make a topic like *Disaster SOPs*, often considered uninteresting, more engaging and participatory. See section on "Engagement" under First Aid training.

Feedback and M&E
Feedback to participants and monitoring and evaluation is rare and therefore there is little evidence of how effective trainings are or how to improve skills based on trainings.

XR Opportunity

As with disaster drills and evacuations, XR has the potential to integrate feedback in a cost effective and safe way, both in the experience (both directly to the user, or to the developer/ owner/ instructor via analytics) and out of the experience. See drills section on "Feedback" for more details.

For disaster management training, XR provides the opportunity to focus on feedback to teachers or members of school DM committees to improve their training in safety procedures or SOPs. Some examples of this include security training used by IFRC in their *Stay Safe VR* app that trains delegates how to choose safe residences, using 360 video for immersion. Auckland City Hospital's *Earthquake Simulator* trains hospital staff in building evacuation. And Harmony Lab's *VR Action Lab* can be used to train teachers in prevention of bullying, when combined with a curriculum. This last example shows how the same XR experience can be used to train both students and teachers when accompanied by a broader curriculum with specific key messages per target audience.

123 https://www.washingtonpost.com/technology/2019/07/12/walmarts-latest-tool-assessing-whether-employees-deserve-promotion-virtual-reality/?noredirect=on

3.2 XR design, production, delivery, distribution and monitoring: learnings and analysis

The vast and diverse membership of the Red Cross Red Crescent Movement with 190 National Societies, IFRC and ICRC make it difficult to provide XR solutions in a one size fits all approach. When choosing the type of media and designing and rolling out an XR approach or experience, it is important to consider the breadth of the Movement and the needs for an adaptable and scalable approach.

The GDPC supports innovation and learning in disaster preparedness across the Red Cross Red Crescent Movement and therefore any XR design would ideally be scalable across a range of National Societies. The technical capabilities, HR and funding resources of National Societies vary greatly, from those developing VR simulations like the Republic of Korea Red Cross, to those that have very limited budgets even to allocate staff to run and maintain the technology required. Even the most scalable option is not always scalable in low income or under resourced contexts. For example, in the Philippines, the most cost effective VR option chosen by Ania Design Labs when producing their *Disaster Preparedness Simulator* was still considered too expensive by some local officials, due to the cost of the smartphone.[1] National Societies with the most limitations are likely to also be the target audience, with more need for innovative disaster preparedness. Therefore XR tools and their delivery should be made as cost effective and user friendly as possible to ensure take up and maintenance by National Societies with low resources or technical expertise. A sustainability plan is critical to ensure that the experience is well used after creation and distribution.

This section summarises key considerations and opportunities on XR production, design, delivery, distribution and monitoring taken from learnings from the ten case studies[2] and a host of academic and educational literature reviewed as part of this study. The section builds on learnings already presented in section 3.1. The above realities of the RCRC Movement have been taken into consideration when presenting these key considerations.

3.2.1 Design and production

Design process

When designing any educational experience there is a **need for an educational framework** to present why it makes sense to use a particular type of technology. The specific characteristics of the RCRC Movement should be considered when selecting the approach or technology and designing the experience. **Any solution needs to be scalable**. For example, it may be pertinent to sacrifice quality of graphics to achieve a technological setup that is easier to use (e.g. affordable headsets with smartphones vs. expensive gaming laptops with attached headsets).

The most successful examples of XR for disaster preparedness, or indeed XR more broadly, are when **the intended learning outcomes are identified and defined first**, in order for the

1 *See Disaster Preparedness Simulator case study (number 6). The technology selection was a smartphone and Google cardboard for immersive VR.*
2 *See annex A, Case studies*

ogy and approach to meet the learning needs rather than being led by the technology. Prioritising learning outcomes will help inform **how to choose the XR media that fits the needs**. For an overview of the pros and cons of different XR methods see the Technology Review table in section 3.3. **Any educational immersive technology programme should have a clear pedagogy or theory of learning in the design and not be subservient to any particular pedagogy or the properties of the technology.** As XR is still new and constantly evolving, the hype surrounding it has meant that this has not always been the case, or that the technology has dominated the learning outcomes during the production process. **Regularly checking in with the intended learning outcomes** is a key design principle to not being distracted by the "cool factor" of new technologies. **User testing** can help with this process and sufficient time should be incorporated into the design process for this. **Considering the XR type of choice as a concept** rather than a certain type of technology will help the technology to keep focussed on and meet learning outcomes.

Considerations for XR media selection in addition to learning outcomes should include age range and what balance is required between personalisation and controlling the narrative (for example, augmented reality allows more personalisation or customisation of an experience and virtual reality allows for more control of the narrative). There needs to be a clear advantage in selecting a particular technology, or combination of technologies - there is no one size that fits all. XR may not be the solution for all training, awareness raising, or simulation needs. In some cases, XR for education or training needs will only be applicable at certain stages in an overall process. See Section 3.1.3b for more on applicability of XR at different stages.

For children, young people and adults, a **triadic design** that balances the following three criteria during the design process is often successful: **reality** (how the game is connected to the physical world), **meaning** (what value needs to be achieved), and **play** (how to create playful activities).[124] The correct balance of these three ingredients will depend on the audience. Younger audiences benefit from more play and less reality, but older students and young people can benefit from greater reality, where there is less risk that the key messages and desired outcomes will get lost in the gamification of serious messages. FEMA explain the rationale of less gamification in their VR experience Immersed 2.0[125] despite user requests for more: "The danger with gamification is that it becomes more about doing damage than about what to do about the risk and the damage. It can increase engagement and numbers of participants and users, but does not lead to the same result." FEMA does however recognise that with younger audiences gamification of serious topics may be more appropriate to deliver key messages. It is key to **balance the requests of users with behavioural science** to ensure learning outcomes can be achieved, particularly in participatory design processes.

For achieving learning outcomes of Red Cross Red Crescent SBDRR programming and ensuring the XR experience not only complements but also addresses the range of traditional shortcomings, **participatory design that incorporates students, teachers, local officials and government and RCRC volunteers is critical**. This will ensure: 1) the accuracy of the content, particularly important with disaster preparedness key messages that often need to be approved by Government, or that are set by Government and the National Society follows; 2) the relevance of the

124 Rüppel and Schatz, 2011, in 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, 2018
125 See case study of FEMA's VR experiences Immersed and Immersed 2.0 (case study number 10)

content; and 3) the ability to include the experience into the national disaster management curriculum and integrated into broader SBDRR training packages. A user focussed participatory design process can be time consuming, but ensures that the experience is used post-development. For example, Ania Design Lab spent approximately six of the eight months of the *Disaster Preparedness Simulator*[126] production in a "co-design process" developing the scenarios, storyboards and decision pathways together with representatives from local government, schools (teachers and students) and community partners. Data was also gathered from the National Disaster Risk Reduction and Management Council. The process was challenging and time consuming, but allowed the developers to fully understand what kind of VR scenario they should be developing and ensure the technology delivered the learning outcomes and was in line with national requirements. Harmony Labs's *VR Action Lab*[127] also included a highly user-centred design approach and this allowed them to both engage more young people and to achieve better results. IFRC's Zika 360 worked with National Societies, communities and schools in a participatory experience that gathered user feedback and worked in partnership to deliver the experience. Examples where this user-centred participatory approach was not taken have compromised the accuracy and alignment with RCRC or government disaster messaging, ownership of the content and relevance of the experiences.[128] When co-designing experiences, it is important. Creative autonomy in the design process should add to, and not compromise, the framework and process.[129]

Remaining relevant in a rapidly changing technological landscape can be challenging. Creating a solid and well developed experience can allow for building on the original work with new storylines or new technologies without having to start from the beginning. Two examples of this are the digital game *1979 Revolution Black Friday,*[130] where the developers built a new branch of the storyline in VR after the original app-based game, and FEMA's *Immersed*,[131] which was originally built with gaming laptops and HTC Vive headsets and is now being converted to an app for Samsung Gear VR to allow for greater scalability. FEMA are also using the 3D assets of Immersed to build a new version, Immersed 2.0, targeted at a different audience. **Forward planning based on forecasted advancements in technology is important** when working with technologies that are evolving rapidly over a short period of time, to provide options to remain relevant.[132] Equally, **implementing continuous improvement and growth** to update the content and functionality of the applications in order to keep users engaged and content relevant is key. This learning is documented by the team at Save the Children and Accenture's XR team during the pilot phase of their collaboration for BecaXR, as well as by Harmony Labs during their production process of VR Action Lab.[133]

Inclusivity and diversity should be a core design principle. This is a responsibility for the designer of any experience because XR has the potential to have an impact on inclusion in the real world, as the case study of VR Action Labs shows with regards to bullying.[134] There is

126 *See case study number 6*
127 *See case study number 3*
128 *For example the APDRC's VR based disaster resilience training, case study number 7*
129 *See case study number 3*
130 *See case study number 8*
131 *See case study number 10*
132 *See chapter 5 for the future technology landscape*
133 *See case study number 3*
134 *See case study number 3*

also the potential to increase discrimination if not designed inclusively. For example, in video games female characters are commonly shown as hypersexualised and subordinate to male characters, none more shocking than the VR video game "Rape Day" that caused international outrage.[135] Conversely, there are examples of VR being used to increase empathy of minority communities or vulnerable groups, including Stanford University's Virtual Human Interaction Lab's projects on empathy at scale, for example that allow the user to become homeless or experience life as a person of colour.[136]

The **design process**, whether managed internally or with an external agency should have a dedicated focal point with time in their job description for managing the production process and agency liaison. Iterative design processes are the most effective, with ample time to perfect the content, including time built in for user testing with the target audiences and making changes based on this feedback.

Content and functionality

All countries have a different range of disasters and national requirements for SOPs. Therefore any **XR solution should be customisable to the national and local context to be scalable** across the RCRC Movement. Customization for different hazards would also be beneficial, although beyond gaming this requires building different VR or AR scenarios. Auckland City University's VR/AR Lab is currently exploring building a multi-hazard VR gaming platform that is customisable that could be licensed to customers like the Red Cross. This could be an interesting model for the RCRC to consider in the future once the technology becomes more accessible and once they have built a range of hazard prototypes.[137]

The **translation of experiences into other languages is at times not sufficient to engage other countries or cultures** in integrating a curriculum and approach into their schools, as was the experience of the *VR Action Lab.*[138] The curriculum was translated, but full localisation of the experience, including tailored video and scripts would have been needed to effectively roll out the project to other locations. In the case of *Zika 360,*[139] the 360 VR video provided an engaging experience to raise awareness and empathy, however scalability was limited due to the localised context of the film footage. **Localisation, for example through 360 video, improves user experience at the place of roll out, but limits scalability to other contexts.**

A main question posed regarding the use of XR for disaster preparedness with school children is **how to communicate risk and provide safety recommendations through the virtual disaster experience without scaring or traumatising children**. As seen in section 3.1, one of the benefits of XR is being able to realistically portray emergency situations. However it is important that various criteria be in place to prevent trauma. AR with headset is particularly realistic but this high level of realism can be frightening, particularly for younger audiences or vulner-

135 *Marika G. 'Rape day'-A virtual Reality Video Game Causes Outrage. Psychol Psychother Res Stud. 2(3), 2019*
136 *https://vhil.stanford.edu/projects/2015/empathy-at-scale/*
137 *Earthquake is the only one available to date.*
138 *See case study number 3*
139 *See case study number 1*

able people.[140] Advocates of the positive effects of the arousal of fear in the experience user[141] state that a moderate level of fear will lead to behaviour change if:

1. The threatening stimuli used to scare are accompanied by recommendations that are perceived by the recipient as effective towards averting the threat
2. The recipient feels capable of carrying out these recommendations in the real world.

Scaring people about a risk without meeting these two conditions is counterproductive and research conducted on "fear appeal models" predict that in this case the individual will try to reduce the negative emotion, for example through risk denial and defensive reactions, instead of learning how to cope with the risk. A realistic VR reconstruction of an emergency situation or major hazard is inevitably scary to some extent - especially to younger audiences. Therefore the use of realistic virtual simulations of disasters should ensure that the above two criteria are met in order not to overwhelm or traumatise younger audiences.

Age restrictions are equally critical for getting the right balance of fear to motivate action but not traumatise.[142] Alternative design methods to achieve this can include sacrificing on the realistic quality of graphics in VR. This does not automatically mean a less realistic or immersive experience but can help to separate the immersive experience from reality.[143] An alternative to realistic simulations could be designing cartoons or low poly graphics - these are documented in the Children and Virtual Reality report[144] as a favourite technique amongst 8-12 year old. It is possible to create a sense of emergency in an experience that maintains a tension that engages the user without being traumatising. For example, the LifeSaver VR app[145] does this through a simple and effective interface, providing quick feedback about performance in real time and generating a sense of urgency. Despite being faced with a friend who has collapsed in the experience, the user is able to repeat the CPR technique until they perfect it and the experience always ends with the user eventually saving their friend, providing a sense of empowerment.

Lack of user feedback in school disaster drills and simulations is one of the primary shortcomings of traditional SBDRR that XR has the most potential to improve on. The possibilities for user feedback and **decision making** are covered in section 3.1.2 under drills and simulations.

Behaviour change is almost always a learning outcome desired of the main SBDRR activities. There are many examples of **XR leading to increased behaviour change**, modifying attitudes and behaviours and increasing collaboration in the real world. This is expanded on in section 3.1.3.

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140 See case studies 9 and 3 on Disaster Scope and Action Labs VR.
141 For example as documented in: Chittaro, L., Buttussi, F., & Zangrando, N. (2014, November). Desktop virtual reality for emergency preparedness. Proceedings of the 20th ACM Symposium on virtual reality software and technology, 141-150.
142 See section 2.2.2 on age restrictions
143 See FEMA's Immersed case study number 10
144 Children and Virtual Reality, Emerging Possibilities and Challenges, 2017
145 See case study number 4

XR technologies, in particular for evacuation simulations, **can go beyond the learning outcome of behaviour change, to investigating and analysing human behaviour**. XR experiences have the potential to allow the understanding of behavioral patterns and behavior changes beyond educational and training aspects. This means that it is possible to use this data to improve disaster preparedness targeting and constantly evolve the quality and relevance of the content. By collecting and analysing behavioral data within a simulation, it is possible to reveal behavioral motivation, validate behavioral models, explore decision making, recognize behavioral patterns, and assess user responses under various controlled conditions.[146] There are conditions that will improve the potential to analyse behaviours accurately in XR, for example Feng et al[147] give the example of a VR evacuation simulation that uses a model of a building that the user is familiar with. However this poses a scalability challenge as it is unlikely to be possible to design a model of every single school building. The use of a hypothetical building can not test familiarity with a building layout, which would be a key behavioural factor to assess in an evacuation simulation, however alternative solutions can be used to make users familiar with hypothetical virtual environments, such as letting users navigate around it before the simulation or drill is run or building in AR that uses the actual location and avoids the need for virtual customisation.

Different hazards require significant design differences. For example, earthquake simulations can have much longer and more intricate storylines than fire simulations.[148] In addition, certain XR mediums will be more appropriate for specific hazards. For example, it is difficult for AR with headset to simulate an earthquake at the time of writing, but it is very effective for flood or fire smoke. This is predicted to change in the near future.[149]

Other content and functionality ideas reviewed that add to the quality of an XR experience include:

- Using a **combination of appealing visuals plus gamified content** increases use of XR applications and positively impacts on awareness raising.
- The **use of a real life props** that add to the immersive experience of VR, for example the use of a pillow to practice chest compressions in Lifesaver VR.[150]
- **Keeping the content simple and focussing on specific key message(s)**. Simplifying the experience's features to the minimum can be very effective in achieving targeted goals. For example in AR experience Disaster Scope fire evacuation training, the main message to children is that they should evacuate the premises by crawling.
- **Language customisation** is necessary for full scalability.

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146 Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. Computers & Education, 59(2), 661–686.
147 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,
148 Auckland EQ protopype research, p. 680
149 See chapter 5 on Technology: Looking to the future.
150 See case study number 4

Partnerships

Leveraging partnerships for XR development and roll out in the humanitarian sector will lead to greater impact. There are various examples of models from case studies reviewed that can provide inspiration for future GDPC partnerships, both internal and external to the RCRC Movement. Specific opportunities for potential future partnerships are included in Chapter 5. The following are a summary of learnings from the case studies reviewed in Annex X and literature reviewed that apply as general principles for XR partnerships.

- A commercial partnership with a technology provider, as with Disaster Scope, can be beneficial to scale the project as well as to maintain the technological standards and maintenance.
- When working with commercial companies it is important to own the copyright. There are limitations to scalability that come from working with a commercial company that issues licencing fees and retains the copyright. For example, The Republic of Korea Red Cross has not been able to scale up their virtual reality based disaster resilience training simulations to the scale they would have preferred due to restrictive licensing arrangements.[151]
- Having an established and ongoing relationship with a digital agency is beneficial. It can help to keep costs down and allow the continuous and cyclical updating and refinement of the experience as user feedback is gathered.
- There are clear content relevance and cost advantages of working with local design companies and through local partners.
- Collaborating with academic institutions and experts to generate evidence and research papers can bring a more rigorous and scientific approach to a project, highlighting the potential of the project as well as to open new pathways for investigation.
- Working with academic research groups could be beneficial to pilot test experiences that could further developed and be scaled following extensive user testing.

3.2.2 Delivery, distribution and M&E

When planning an immersive experience to ensure behaviour change is achieved, the delivery, distribution and monitoring and evaluation is as important as the design process to ensure a sustainable impact. Even the best designed experiences working in partnership with top agencies and incorporating participatory design features can not surpass the pilot phase if delivery and sustainability is not well planned.[152] Or, the experience can be effectively delivered and knowledge about mitigation actions transferred[153] but users still need to be empowered to act upon these mitigation tips.

Integration into broader SBDRR training

The number one rule of XR delivery is that an XR experience should not be delivered in isolation, but should be integrated into a broader learning experience that includes measurable learning outcomes. The type of XR and the desired outcome will dictate the level of integration that is needed into broader training courses or curricula. XR is often used for creating empathy to raise awareness of issues that can contribute to fundraising. This is being used extensively

151 See case study number 7
152 For example, Harmony Labs VR Action Lab that has not moved beyond a pilot (case study number 3)
153 Such as FEMA's Immersed, see case study number 10

across the humanitarian sector through 360 VR, for example through the Climate Centre to help visualise the effects of climate change[154] and the ICRC to raise awareness of the impacts of war on civilians in their applications *The Right Choice*[155] (360 VR) and *Enter the Room*[156] (AR). These tend to be used as standalone experiences at events and conferences.

XR experiences for SBDRR and for student learning **work best when integrated as part of the learning curriculum or as an adjunct to face to face training and not standalone**. This is important because XR experiences are short and should remain focussed on a small range of key messages to not overload the user. In addition, messages around disasters should be in line with national curriculum requirements. AR for DRR in particular can come with limitations to knowledge acquisition and the immersive experience will not achieve all the desired learning goals by itself. For example, *Disaster Scope*,[157] a cutting edge AR app that allows students and teachers in Japan to experience floods and fires, is extremely effective at making the user experience what these disasters would be like, but does not specifically instruct the user in detail as to what to do in the disaster to stay safe, or on more detailed SOPs.[158] There are a range of example of XR being used as part of training packages that improve learning outcomes when combined with a classroom element. For example *Lifesaver VR*[159] combined with face-to-face training leads to improved learning outcomes for several key elements of successful CPR. Integrating the WWF AR *Free RIvers*[160] experience in a classroom training kit with the teacher as the presenter of the app was effective with schools. The Amercan Red Cross' *Monster Guard* disaster gaming app for kids comes with lesson plans and accompanying activity guides on the website.

It is also important that XR be used to promote the learning outcomes that it is most suited for and complement other methods like face to face training because although XR can encourage taking action like calling 911 or overcoming the bystander effect, skills learnt in XR might not be 100 percent accurate (such as chest compression depth).[161] This added to the fact that VR simulations should last for a maximum of 15 minutes makes the integration into broader curricula key.

Google and Harmony Lab's *VR Action Lab* effectively executed this concept of developing a curriculum for schools with the VR experience by designing a six-lesson curriculum including a design toolkit for VR media makers and organisations, a curriculum guide for teachers and an issue briefing book. The curriculum can be carried out as a complete set or cherry picked according to needs. The curriculum booklet is aimed at teachers and also includes information about how to use VR in the classroom, best practices, exercises and recommendations. VR Action Lab's experience reinforces the need to integrate media experiences within the wider classroom context. Providing the experiences integrated in the curriculum gave students the means to achieve the goals of the project. There has not, however, been the extensive desired

154 https://www.climatecentre.org/news/798/at-d-c-days-virtual-reality-puts-players-in-driving-seat-on-disaster
155 https://visualise.com/case-study/the-right-choice-icrc-red-cross
156 https://info.icrc.org/enter-the-room
157 *See case study 10*
158 *With the exception of teaching users to crawl on the floor to avoid smoke and evacuate the room.*
159 *See case study 4*
160 *See case study 2*
161 *As proven in VR first aid training simulations from the British Red Cross and Resus UK.*

roll out across middle schools in the United States, partially due to the fact that the school administration was not involved in the development - a key learning point when working with schools to develop XR for DRR.

Another example of training curriculum integration is Ania Design Lab's *Disaster Preparedness Simulator*. They deliver their XR experience in schools as part of a one hour training package designed to supplement the Disaster Readiness and Risk Management modules of the Philippine basic education curriculum. This allows for a briefing, the simulations and a debriefing with feedback where further information on hazards and disaster preparedness is disseminated to the students, including IEC materials. The debriefing also provides the opportunity to discuss and provide feedback to users on their performance in the simulation and any issues that arose. Instructors are encouraged to allow users to interact and discuss with each other, sharing insights and experiences from the simulation with their peers. This also allows the instructor to gather data via observation of the discussion.

Distribution options

Various models of distribution of disaster XR experiences exist, depending on the technology. Scalable options like smartphone/tablet VR or AR downloadable on app stores increase uptake and are easily distributed. Less scalable but higher quality options like HTC Vive headsets that require gaming laptops to work usually can only be used with the owner of the experience. This is the case with *Immersed* and the ICRC's simulations, including the BRC first aid and APDRC/KRCS earthquake simulation being built in 2019. In order to allow scalability of the APDRC's fire and cruise ship simulations across Korea and other NS they support[162] they purchased a series of laptops and headsets for each NS and brought focal points to Seoul to take part in a training of trainers to roll them out across their NS. There has been no evaluation of how these are being used across the NS, but it is a good example of scaling a VR experience in multiple NS. A similar model with stand alone headsets or headsets with smartphones would be a more cost effective way to replicate this model in the future.[163]

A potentially interesting model for distribution could be in partnership with a third party - for example a telecoms company or a software developer - offering a rental service option. This is the model used by *Disaster Scope*[164] in Japan and could be beneficial for other schools and local authorities as this method removes the difficulties of updating and maintaining the technology, while saving costs per trained user.[165] This could work well in NS with limited capacity to update and maintain the technology.

There is currently a gap in XR experience and knowledge sharing across the Red Cross Movement. Some RCRC actors interviewed for this research were unaware of other XR initiatives within the Movement that could have provided useful insights and learning and informed their decisions on XR media, technology, design and distribution. There is an opportunity for the GDPC to act as an information and knowledge sharing hub for XR, or this could be taken a step

162 Philippines, Nepal, Republic of Korea, Mongolia, Singapore, Thailand, Vietnam and Indonesia
163 The estimated cost of quality standalone headset vs gaming laptop and headset,for example as used by ICRC, is 1/10 - 4000 USD vs 400 USD
164 See case study number 10
165 The estimated cost of using Disaster Scope in public school is only 0.33 cents per user in Japan

further to create a centralised experience development team that could share expertise and technical support across the Movement. Creating a project with publicly available resources could be useful to other organisations interested in the work. A framework for collaborative best practices would also be beneficial, not only for technology but also XR strategy. This kind of material could be shared by GDPC in a common hub or resource for organisations and practitioners.

M&E
Very little thorough monitoring and evaluation exists for the XR initiatives reviewed in this research. Most experiences only gather anecdotal feedback or post-distribution surveys that give a sense of the users experience but are not robust in showing the impact on behavior change or the particular learning outcome. In a field that is so new and where evidence of impact is lacking, particularly in XR for school disaster preparedness, building in an evaluation system and ensuring outcomes are measurable from the inception of a project will help not only that particular project but contribute to the body of evidence of the benefits of XR for SBDRR. In the case of Lifesaver VR[166] that did research the impact of the VR experience, research papers showing evidence proved the importance of the tool in improving CPR skills. These can be used for advocacy as well as to further develop the experience. Working with academic institutions can add rigour to the evaluation process, for example the work of Auckland University on the Auckland City Hospital Earthquake simulator.[167]

3.3 Technology Review Table

This table reviews all the main forms of XR technology, and presents their pros, cons, and applications. Although it is recommended to start any experience design from learning outcomes and not the technology, this table is a reference that can help determine the best choice of tech to fit the SBDRR or wider DRR need. The table can be found here:
https://www.preparecenter.org/resources/xr-technology-review-appendix

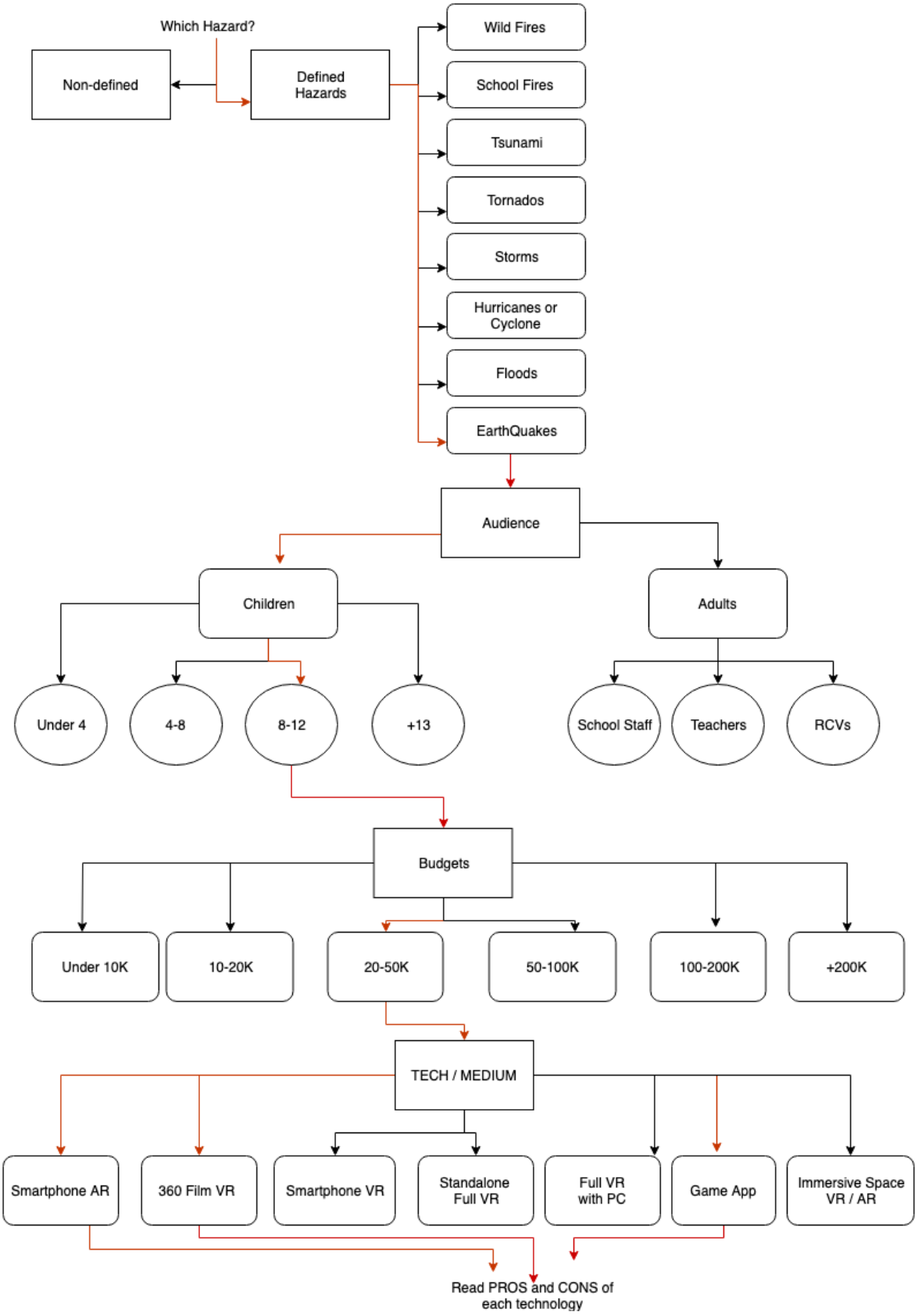
3.4 Decision flow

Decision flow charts can be used to define the best approach to building an XR experience for specific SBDRR activities. A decision flow has been created for drills/simulations as an example. It is advised that the GDPC produce a similar flow chart for whatever activities are prioritised for XR. Decision flows can also be built from other entry points, for example specific hazards, learning outcomes or budget availability.

The example below shows a flow chart to plan an earthquake XR experience, for a target audience of 8-12 years old, with a projected budget of 20-50K. As shown in the chart, the options

166 *See case study number 4*
167 *See Partnerships section of Chapter 5.*

include: Smartphone AR, 360 VR and game app. Options would have to be considered based on learning and project outcomes.



#4
Solutions & Recommendations

"You should do impossible things in VR.
You shouldn't do things you would do otherwise."
Jeremy Balinson, Recode Decode interview

4.1 Immersive experience solutions for SBDRR

Chapter 3 highlights that immersive technology not only has the potential to address some of the shortcomings of many of the traditional approaches to SBDRR, but can go beyond addressing these shortcomings to adding value to DP/DRR learning outcomes, ultimately contributing to protecting and saving lives.

Based on the SBDRR and technology landscape presented in Chapter 2, and building on the learnings from Chapter 3 on both the affordances of different types of XR technologies and learnings on the design, production and distribution, Chapter 4 presents four models that are recommended to be applied to SBDRR in the present and very near future, integrated as part of training modules and curricula. These can be viewed as a menu of XR "recipes" with recommended ingredients for the GPDC and partners. The first two models are types of XR experiences (virtual simulations and location based experiences) and the second two are functionalities (digital game-based learning and social collaboration) that should be built into the XR experience of choice and that will increase engagement, motivation and collaboration in the real world.

These are followed by a summary of key recommendations when using XR for SBDRR, that can also be applied more broadly across the DRR sector.

4.1.1 Virtual simulations for training & learning

Virtual simulations are extensively used for educational purposes. As seen in Chapter 3, simulations can provide a range of benefits for SBDRR training, from increased awareness, visual representation, behaviour change and knowledge retention. Virtual simulations are best recommended when it is expensive, impractical or dangerous to allow users to experience something similar in the real world. In such situations, which can include any hazard or disaster, users

will spend time learning valuable lessons in a "safe" virtual environment. Often the convenience and advantage is to permit mistakes during training for a safety-critical system and to receive feedback on and learn from these mistakes.

In immersive virtual environments an artificial environment makes participants feel like they are living a "lifelike" experience, despite being simulated. This virtual environment may become so realistic that it is difficult for individuals to differentiate between the virtual and the real world.[168] This is a key consideration in the development of these kind of experiences for children and especially those who have suffered trauma. See chapter 3.2.1 for more information on content design.

Interactive features in the simulation are key to engage users, allow them to make their own decisions and provide user feedback. Interactivity usually involves allowing the user to perform actions such as grabbing objects, moving around and making choices to drive the experience. In the design, teaching methods must be defined to deliver knowledge, providing feedback about the user's progress and response. Feedback can be provided immediately or after completion of the simulation.[169]
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 doctors applying new surgical knowledge. This indicates that XR is ideal for drills, once some hazard and disaster response knowledge has been delivered via traditional methods, and then virtual drills/simulations can practice what would actually need to happen to carry out SOPs for specific hazards.

Expected learning outcomes
Knowledge acquisition
Knowledge retention
Hazard awareness
Behaviour change
Decision making skills
Acting under pressure

XR medium
Virtual reality is often the preferred tool for simulations to train **for potentially dangerous situations or situations that are impossible to recreate in real life, like hazards**. VR creates a "safe environment" to practice and repeat things that could be dangerous to replicate. VR allows creators to totally immerse users in a simulated and controlled environment. For example: natural hazards, saving hostages, aviation disasters, or working in war zones.

Mixed reality is a new upcoming technique which combines the power of virtual simulations embedded within the real world, offering the benefit of using the physical location as a base to deliver the experience. **AR** is an effective platform for drills and evacuation training however

168 LaValle, Steven (2017). Virtual Reality. Cambridge: Cambridge University Press.
169 See Chapter 3, section 3.1.2 for a full review of feedback options in simulations.

the level of immersion in AR can be limited due to technical restrictions and because the real world is still visible within the scene. For example, this could be a limitation in the simulation of earthquakes where the whole scene needs to shake.

Tech Notes

The preferred hardware solution for virtual simulations for training and learning are standalone virtual reality headsets with no computer or smartphone needed, as they can offer a quality experience while keeping costs and the technical resources needed to a minimum. For example, the recently launched Oculus Quest.

Also recommended is the use of high range VR headsets with VR suitable high spec smartphones, which offer quality experiences while meeting basic health and safety minimum requirements. These include Samsung smartphones with Samsung Gear VR. The benefit of this type of device is to be able to use the smartphone for other uses, outside the XR experience, as well as the lower cost, making this combination a scalable option. In the higher end hardware range, there are professional VR headsets used along with gaming computers that provide the best quality experience. However, these devices can be costly to scale and hard to manage due to the technical expertise needed. Immersive spaces are also recommended for these types of experiences, where users can safely interact inside a room or a dedicated space.

Software solutions include

Environment: Unity 3D, Unreal Engine
3D Modelling: Maya, 3DS Max, Blender, Cinema 4D
Distribution Platform: Oculus, Steam VR, Samsung Gear VR
Development platform: Android, Windows

Advanced features include:

The following are ideas that can be included in the simulations to add quality, realism, increase scalability and improve learning outcomes.

- Multiple scenes for multiple hazards: The same simulation application may contain multiple scenes which aim to train on multiple hazards. For example, the same application could contain scenarios for earthquake, tsunami and typhoon, such as the Disaster Preparedness Simulator.[170] This allows for a more complete training for students and the ability to select from a menu of options that is suitable to the particular hazards of a country.

- Use of props and physical objects: Physical objects can be added as a reference to a real world object. For example in LifeSaver VR[171] real life props such as a mannequin or pillow can be used to apply CPR, adding a new layer to the immersive experience. The new developments of the Disaster Scope[172] fire simulation include using a fire extinguisher.

- Data integration: Although this is still experimental, it is becoming increasingly possible to integrate data from third parties to include real data about the hazard or location where

170 Case study number 6
171 Case study number 4
172 Case study number 9

the experience is being deployed. For example connecting live flood data to the AR and VR system, or adding weather predictions to a typhoon simulation.

- Haptic Feedback: Haptic technologies allow to feel touch therefore the sense of realistic simulation increases. One approach can be to add motion and vibration to the VR hand controllers, or implement the use of haptic gloves and other wearable devices or peripherals.

Considerations:

- For a full list of pros and cons of specific XR technologies/approaches, see the Technology Review table in Section 3.3.
- The GDPC and/or Movement partners could consider building a series of VR simulations for different hazards that other users could customise for their country/region. If built in VR, it would be possible to provide customisable 3D assets.[173] These could be in one experience and selected from a start menu.
- It may be worth sacrificing quality of graphics and experience for scalability to make simulation solutions viable across a range of National Societies, for example by using standalone headsets like the Oculus Quest or a smartphone/cardboard headset combination.
- Limitations in the technology and the design should be addressed to avoid raising health and safety concerns such as motion sickness. Refer to chapter 2.2.2 for more information on health and safety.

4.1.2 Location Based Experiences

Location based XR has the potential to transform any given location into a disaster zone for training purposes. By overlaying 3D content and immersive sound, the physical scene can be transformed in seconds. The technology to achieve this exists but the design of the systems to employ the technology is not yet fully researched and the potential has yet to be fully understood. However it is already clear that from knowledge retention to behaviour change, location based XR is a perfect solution to create effective and realistic drills and evacuations and is likely the future of XR for disaster preparedness and risk reduction.[174]

In location based experiences, the physical location should be considered carefully. Location based systems such as GPS take the user's location into account when processing and presenting information. Currently, it is possible to track the location where the phone is positioned, such as an individual classroom. However these systems become cutting edge when they can expand their capabilities beyond the room, to full indoor buildings such as schools. At the time of writing this has not been widely applied to disaster management but is predicted to advance rapidly over the next two years with smartphones embedded with this technology.

Supporting indoor augmented reality for evacuation calls for advances in a number of research areas, including accurate and efficient indoor localisation, efficient rendering and user-friendly interfaces, and effective evacuation functionalities that should be built into the experience.[175]

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173 Consider options of using 3D assets already designed by other Movement partners including ICRC
174 For example as is done in the Disaster Scope AR app, case study number 9
175 Ahn, Junho & Han, Richard. (2012). An indoor augmented-reality evacuation system for the Smartphone using personalized Pedometry. Human-centric Computing and Information Sciences.

Indoor localisation, which involves understanding where the user is and creating a virtual map of the building, is a key design requirement for indoor XR systems, however there is no standard for an indoor positioning system. Existing methods include using visual markers positioned at specific locations and wireless technologies such as wifi or bluetooth.

The *Disaster Scope*[176] AR app is an example of how this could work in the future, however it only uses tracking of the room where the phone is located and cannot yet assess a whole school building.

Expected learning outcomes
Behaviour change
Knowledge acquisition
Knowledge retention
Hazard awareness
Decision making skills

XR medium
In location based experiences, **augmented reality** with smartphone and headset/glasses is the preferred technology to use, as it uses a mobile device location settings and camera to deliver the experience, overlaying digital layers of information on top of the physical world. In contrast to virtual reality which completely replaces the real world, augmented reality displays virtual objects and information along with the real world registered to real world locations.

The current advances in **mixed reality** technologies are opening up many more opportunities as the power of new platforms and devices provide a higher quality experience. For example Magic Leap is still a niche product but offers an advanced augmented experience.

In the case of **VR**, location based technologies allow the user to be inside the virtual experience and to match the physical location with the virtual. However they do not make the most of the physical space as they lack a picture of the real world. AR is therefore the recommended medium for location-based experiences.

Tech Notes
The preferred hardware solutions for AR are advanced smartphones with advanced camera and high resolution. The new generation smartphones such as Apple iPhone X and Google Pixel 3 also contain 3D sensors, which analyse the space around the phone. The use of tablet devices with quality cameras is also recommended as their screens are bigger than smartphones, however they cannot be used along with headsets. There are also mixed reality headsets to make the experience more immersive. However the power of **mixed reality** is expected to change with platforms such as Magic Leap and HoloLens. See chapter 5 on the future technology landscape.

Software:
Environment: ARKit, ARCore, custom indoors tracking systems

176 Case study number 9

3D Modelling: Maya, 3DS Max, Blender, Cinema 4D
Development platform: Android, Windows, Apple

Advanced features include

- **Expanded environments:** Mapping and creating a virtual map of the building where the drill or training is happening. In the case of SBDRR, this would mean mapping the school and the exits to be able to create a realistic experience of the real location. The experience expands to other rooms, buildings and outdoors. Using a navigation guide, the user can move around the selected area to discover and explore interactive scenes.

Considerations

- For a full list of pros and cons of AR, see the Technology Review table in Section 3.3.
- Using AR with headsets brings a new world of immersion to the experience.
- AR is effective and impactful but should be used with caution as the high level of realism can be frightening, particularly for younger audiences.
- The technical limitations of AR around space recognition and visualisation have to be researched as the technology is limited. However any current limitations are predicted to be overcome in the next couple of years.
- With the arrival of 5G technologies, the possibilities of this model will increase as the rendering power and location tracking will improve considerably.
- The visual quality and clarity of an augmented reality experience is imperative. If it is not high quality it will cause users to exit the experience and thus can nullify all value of the application.

4.1.3 Digital game-based learning

Digital game learning involves a set of techniques which can be plugged into an immersive experience to increase engagement and learning performance. Students can develop confidence through repeatedly practicing key skills during gameplay. Digital game-based learning, when used appropriately, can provide students and educators with a long list of benefits. Digital game-based learning often facilitates better attitudes towards learning, increases student motivation, fosters higher-order thinking, influence personal real-life perceptions, impacts decision-making processes, and aides students learning achievement.[177]

Digital games and serious games can provide a balanced space between gameplay and learning which is beneficial for teaching disaster preparedness, particularly for awareness raising and knowledge acquisition. The combination of VR and serious games encourages participants to retain knowledge longer than traditional approaches due to full engagement and high emotional and physiological arousal.[178]

177 Kapp, K. M. (2012), The gamification of learning and instruction: game-based methods and strategies for training and education, San Francisco, in Games and Game-based Learning in Instructional Design
178 Chittaro, L., Buttussi, F., & Zangrando, N. (2014, November). Desktop virtual reality for emergency preparedness.

The basic method is playing the game, which means that the user is in control of the actions and the course of the experience, receiving feedback on their actions during, and after. During gameplay the player works to achieve the game's goals, usually through challenges. Below are some of the **gamification techniques** which have been identified in this research as contributing positively to learning and training:

- Branching scenarios are typical of exploration games and challenge players to navigate a non-linear path with multiple outcomes. By exploring the different paths, users can learn how their actions might influence the outcome.
- Decision making features can reinforce concepts, judge decisions and evaluate outcomes.
- Memorisation features allow to retain information usually by challenging the user to prove their knowledge.
- Simulation games in which players take the identity of a selected character in the game. These characters can take different roles to provide a base for learning different skills.
- Test and scoring systems allow for the analysis of situations, making decisions and cross referencing solutions.
- Motivational elements include providing scores, time counts, feedback on results as well as repetition of mistaken choices or paths to allow the user to learn.

Mobile gaming apps such as Monster Guard and Tanah have been used by GDPC in the SBDRR field and there is some internal learning on these as an approach. It is recommended that these learnings also be applied to the integration of gaming techniques to XR experiences.

Expected learning outcomes

Engagement
Understanding content
Developing specific skills
Behaviour change
Knowledge acquisition
Knowledge retention
Hazard awareness
Decision making skills

Tech Notes

Digital games techniques can be applied across all types of immersive technologies. It is recommended that gaming features be added to XR developed by GDPC and partners, particularly when targeting younger students.

Advanced features

- **Multiplayer games:** With multiple players, each user can observe how the other players perform and obtain feedback on their own actions.

- **Difficulty levels:** Adding layers of difficulty opens the possibility for the game to serve different age groups as well as to increase motivation. A way to define levels can be to have multiple players who receive different sets of features with increased complexity, for example beginner, intermediate and advanced.

Considerations

- Where is the balance between easy and difficult? In designing games levels, research and testing should be integrated to assess the right level of difficulty for each age group.
- It is important to strike a balance between user requests for increased gamification and the lessons of behavioural science, that indicate that this can detract from key messages.[179]

4.1.4 Social XR solutions

Immersive social platforms allow people to be together and interact with each other in the virtual space. Positive social impacts and interactions are encouraged by XR learning games, especially collaboration and motivation, leading to more opportunities for students to communicate and collaborate in the real world. Exploring computer-supported collaborative learning, learners perform tasks in groups in order to achieve shared goals. This is a pedagogical approach which can be applied to educational XR. The ability to facilitate this interaction is claimed by some in the field as VR's greatest educational potential.

In an increasingly social digital world, young learners are eager for opportunities for digital interaction, such as interaction with immersive 3D environments and feedback on their actions. Additionally, opportunities for human-to-human interaction within the application and outside of it (such as through social media sharing) support youth interest and engagement, but should be approached cautiously given considerations of user privacy and safety.

Expected learning outcomes

Social engagement
Behaviour change
Knowledge acquisition
Knowledge retention
Critical analysis
Decision making skills

XR medium

Social integration is a common aim for all extended reality technologies, however the focus is on virtual reality as some devices allow for synchronisation of multiple headsets.

Technology Notes:

Selected VR devices are recommended for this kind of experience, which need to be equipped with synchronisation features for social interaction with other players. For example Facebook is leading the development of social applications with a range of developers and companies who are testing new platforms such as AltspaceVR, Vtime and VR chat.

Advanced features:

- Group training in evacuations and simulations, allowing players to interact with each other.

179 *See case study 10 for example of FEMA and the research they did in behavioural science, although this was for an adult audience.*

For example a teacher could realistically lead a building evacuation as they would in real life. This overcomes the issue of experiencing simulations where there are no other characters, one of the shortcomings of many current VR evacuation/drill simulations.
- Group gaming, for examples in multiplayer competitions in hazard knowledge or knowledge of SOPs.

Considerations

Necessitates multiple headsets and therefore would be more costly and less scalable.
As players are able to interact freely with each other there are some considerations around moderation of their interaction, especially in children.
This technology is still in its infancy and this field is not yet well researched.

4.2 Summary of Key Recommendations

The following is a summary of key recommendations for the GDPC and partners when considering using XR as part of SBDRR. These can also be applied more widely across the DRR sector. The recommendations condense the analysis of Chapter 3 and build on the proposed models in section 4.1.

Defining an approach and learning outcomes

- It is critical that intended learning outcomes are identified and defined first, during the project conception, in order for the technology and approach to meet the learning needs rather than being led by the technology. Any educational immersive technology programme should have a clear pedagogy or theory of learning in the design. Pedagogy must be given equal consideration during the design process.
- Consider the XR type of choice as a concept rather than a certain type of technology. This will help the technology to meet learning outcomes, rather than the focus being on the technology type itself.
- Any use of technology must not recreate education as it already is but utilise the unique affordances of the technology to bring added value to what is already in practice with other learning modalities.
- Design and integrate the XR experience as part of a training module, curriculum or approach, and not as a standalone experience. This aspect should have as much weight as the XR experience design.
- Consider the specific characteristics of the Red Cross Movement when selecting the approach or technology and designing the experience. Any solution needs to be scalable. For example, consider sacrificing quality or detail of graphics to achieve a technological setup that is easier to use.
- Explore computer-supported collaborative learning where learners performing tasks in groups in order to achieve shared goals. This is a pedagogical approach which can be applied to educational XR. The ability to facilitate this interaction is claimed by some in the field as VR's greatest educational potential.
- Adopt an organisational openness to taking risks on new ideas or technologies: this is key for innovation.

Experience design

- Design the experience in participation with target users and include students, teachers, community leaders, local/national government, and RCRC volunteers. This will ensure the accuracy and relevance of the content and the ability to include the experience into the national DM curriculum and as part of broader SBDRR training packages.
- Apply a triadic design that balances reality, meaning and play.
- When designing realistic disaster simulations, content should be empowering and follow the principle of self-efficacy[180]: this is the key to overcoming fear in realistically simulated events, coupled with targeting the correct age range.[181]
- Ensure that realistic simulations that can be scary or moving for younger audiences are age-appropriate and accompanied by recommendations that are perceived by the recipient as effective towards averting the threat and possible to carry out in the real world.
- Design introductory messages and warnings to prep users on what they should expect. Consider adding special messages for participants who might have had a previous trauma or disaster experience.
- Consider the design differences required for different hazards. For example, earthquake simulations can have much longer and more intricate storylines than fire simulations[182]
- Forward plan based on forecasted advancements in technology. This is important when working with technologies that are evolving rapidly over a short period of time, to provide options to remain relevant.
- Design with diversity and inclusion as core design principles. This is a responsibility as XR has the potential to have an impact in the real world.
- Implement user testing systems to ensure the design matches the user needs and expectations.
- Design the experiences following best practices to avoid motion sickness and user discomfort.

Experience content

- Capitalise on content and proven gaming concepts already available in the Red Cross Movement. For example, Climate Centre games and Minecraft for community mapping.
- Include a guide in the experience to make the user feel more immersersed and integrated. When this is not done, levels of immersion are lower because it is harder to connect with the topic.[183]
- Create a library of shared 3D assets that can be used to build upon and shared across the Red Cross Red Crescent Movement.

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180 The belief that an individual has on his/her ability to execute a behavior.
181 See section 2.2.2 on age restrictions of XR
182 Lovreglio, R, Gonzalez, V., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M., Sacks, R., Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study, 2018
183 E.g. with the ICRC experiences

Health & safety and age restrictions

- Carefully consider what technology is appropriate for the target audience. Age considerations are important, particularly with immersive technologies, and to date this has not been given much prominence to date in XR used with children.
- Any technology needs to come with clearly articulated psychosocial guidance. This should include the age range applicable for the technology and guidance for teachers in how to support students through the experience.
- Teachers or those promoting this technology must take a cautious approach, drawing on manufacturer health and safety guidelines and the substantial research on child development in order to make informed decisions about ethical and safe use of the technology.
- Consider privacy implications of using technology with young people and put safeguards in place.
- Any safety warnings developed should include notes about how to use headsets, how to set up a safe space, what are the common risks associated with XR and what to do in case of discomfort.

Production process

- Regularly check in with the intended learning outcomes during the production process. This is a key design principle to avoid being distracted by the "cool factor" of new technologies.
- User testing is critical and sufficient time should be incorporated into the design process for this. As this is an emerging field, any project must be committed to ongoing refinement of the product based on testing with end users.
- Designate a focal point to manage the process, with time built in to their job description.
- Consider the copyright and ownership of the materials and the experience itself, and how they will be safeguarded over time.
- Choose your technology carefully with the goal of creating a scalable project.

Distribution process

- Plan distribution and sustainability from project inception.
- Distribute as part of a broader curriculum or training package.
- Involve school administrations to ensure wider distribution and overall success.
- Assess how to adapt the experience to other regions, countries or cultures, bearing in mind that translation is not enough - cultural adaptations and customisations are needed.

Partnerships

- Explore how other XR content could be shared across the sector, with the GDPC as an XR information and resource hub. There are many examples of XR that are not currently being documented or shared and this is a missed opportunity where GDPC can play a role and fill this information and learning gap.
- Create a library of 3D assets for the Red Cross Movement
- Partner with academic institutions - this can be a cost effective use to overcome limited resources and allow for a more rigorous monitoring and evaluation systems.
- Collaborate with other parties that understand the risks, challenges and opportunities and are willing to go where no one else has gone.

#5
Future Considerations

5.1 Technology: Looking to the future

The technological landscape for immersive technologies is in constant development and flux and is predicted to reach wide audiences in the near future. With more creators entering this space, it is expected to see an evolution in the way applications are built and experienced. From the creation of natural interfaces to integrated data systems, the future of this immersive tech space is dynamic and exciting. Below are some of the key considerations which may influence the evolution of XR in the future.

Virtual reality has long been a dream for many technologists and designers. Today it is possible to buy an affordable standalone headset to receive a quality immersive experience without much technical expertise. The next years are predicted to advance this technology to the wider public. One of the key considerations for VR is its application in the professional and business sectors. Given that VR can effectively train and educate people, as shown in this paper, it is expected that many more institutions, corporations and organisations will start implementing VR as a standard training tool for staff and employees. This will also be the case for the education sector that will use VR and other XR technologies to provide a more engaging experience for students. VR combined with haptic devices will provide highly realistic experiences and the feeling of really being somewhere else.

Augmented reality has already been named as the future of design. Its potential for SBDRR is immense and is yet to be discovered. In approximately one to two years, the augmented reality technology used in Disaster Scope[184] such as advanced tracking and sensors are expected to become more powerful, affordable and available at a wider scale, therefore opening a new line of work for researchers and application developers. The impact of AR decreasing in price and mobile phones being more suited for it will be huge. AR in the real world will be effective but there will still be value in smartphone AR/tabletop experience to take people to other places, rather than augmenting their surroundings. This is particularly the case for awareness raising. For SBDRR it will be real world that is the most useful. AR and mixed reality headsets are expected to become more user friendly and soon we will have real world AR glasses or lenses. The combination of AR plus 5G and machine learning will allow us to recognise our surroundings and easily add digital layers and objects over them.

For location-based XR technologies the implementation of **5G mobile technology** opens a new

184 Disaster Scope, case study number 10

world of opportunities by allowing high amounts of data and information to be integrated in real time in the experience. This will increase the rendering quality - the visual quality power for virtual simulations.

During the next two to five years, it is expected to see a convergence of 5G, AI, internet of things and sensors and VR/AR. The combination of all this data will enable us to both map our physical world into virtual space and superimpose a digital layer onto our physical environments. This will offer immense new opportunities, for all sectors. In particular it is possible to envisage how this technology will bring great efficiencies to the fields of disaster risk reduction and preparedness. At the same time it will pose a range of ethical, political and economic challenges. This will take us into another dimension, a hybrid new world.

5.2 Partnerships: Looking to the future

The GDPCs future work in XR will doubtless need to involve partnerships both inside and outside the Red Cross Movement and into the private and academic sectors. This section reviews some of the partnership ideas that arose during the research for consideration as part of future planning, recognising that the GDPC already has established partnerships that they may wish to build on.

ICRC

The ICRC have the only dedicated virtual reality team of the Red Cross Movement based in Bangkok that is open to working with Movement partners to support building immersive VR experiences for internal RCRC clients. Currently, in addition to the work they do internally, the VR team is working with National Societies such as British Red Cross on a first aid simulation, and Republic of Korean Red Cross on an earthquake simulator.[185] The ICRC VR team acts as an agency to serve internal RCRC projects. Advantages to working with the ICRC team include the ability to keep production costs at a low as these are currently largely absorbed by ICRC, although this model may change in the future. Another advantage is to be able to use their library of 3D assets which avoids starting from scratch. The disadvantages are that the ICRC does not provide strategic advice, but executes the request of the client. This is a viable model if the RCRC client knows exactly what they want, but otherwise could lead to a product that is not user-centric or integrated into the broader work of the NS.

Climate Centre

The Red Cross Red Crescent Climate Centre have extensive experience with interactive methodologies to reach out to children and have a specific youth engagement team. The Climate Centre has developed a wide range of games, including within the recently updated Climate Training Kit released in June 2019.[186] To date they have not digitised these games or explored how they could be built in XR, but are interested to do so and to collaborate with the GDPC. They already have games designed for relevant SBDRR learning topics that explain complex systems in a way that is easy to understand. These could be used or adapted for XR content.

185 *See case study on VR training for fire and earthquake evacuation of the APDRC, case study number 7*
186 https://www.climatecentre.org/training

For example:

- Early warning systems: https://www.climatecentre.org/training/module-2/subitem-2a
- Exercises leading to the production of a contingency plan, in a gamified way:
  - https://www.climatecentre.org/resources-games/games/1/ready
  - https://www.climatecentre.org/resources-games/games/2/paying-for-predictions

Auckland University

Auckland City University's VR/AR Lab is currently exploring building a multi-hazard gaming platform that is customisable and that could be licensed to customers like the Red Cross. They would like to discuss opportunities for collaboration with the humanitarian sector. It might be possible for the RCRC to test their existing earthquake school simulation free of charge with communities, and the feedback would be useful for their research. In addition, this multi-hazard gaming platform could be an interesting model for the RCRC to consider in the future once the technology becomes more accessible and once they have built a range of hazard prototypes.[187]

Other academic partnerships with institutions already linked to the GDPC would be worth exploring, given the advantages of working with academic institutions to bring a more rigorous and scientific approach to a project, highlighting the potential of the project as well as to open new pathways for investigation.

Private Sector

A potentially interesting model of working could be in partnership with a third party - for example a telecoms company or a software developer - offering a rental service option. This is the model used by Disaster Scope[188] in Japan and could be beneficial for other schools and local authorities as this method removes the difficulties of updating and maintaining the technology, while saving costs per trained user.[189] This could work well in NS with limited capacity to update and maintain the technology.

5.3 Ideas for future research

1. **Next steps:** When GDPC have decided where they would like to focus their efforts in XR, it is recommended to conduct a more detailed piece of analysis on the specific XR medium and SBDRR activity areas of interest to inform product design, choice of software, hardware, costings etc. building on this analysis.
2. **DP training and education for teachers:** Despite the critical role that teachers play in keeping students safe and alive in disasters, as shown in the case study of Disaster Scope, very little of the existing tools or literature focuses on this critical audience.
3. **XR and curricula integration:** The topic would benefit from more research into the most effective way to develop curricula with XR integrated. Some examples of case studies ad-

187 Earthquake is the only one available to date.
188 See case study number 9
189 The estimated cost of using Disaster Scope in public school is only 0.33 cents per user in Japan

dressing this and learnings are reviewed in Chapter 3.

4. **Disability and inclusion in XR:** This is an under researched topic and there is limited guidance on design principles for inclusion. It would be beneficial for the GDPC to look more into this topic before designing an XR experience.
5. **Hazard and XR detailed analysis:** Different hazards require significant design differences and some XR media is more suitable to specific hazards. It is recommended that additional research be conducted on the specific hazards that the GDPC would like to focus on, or that an overall review of specific hazards and their preferred media and design preferences be assembled.
6. **Gamification techniques:** There are many techniques and mechanics in digital and serious games which could be researched and tested to identify the most relevant ones for SBDRR.
7. **Use of haptic technologies:** It is recommended to investigate how much haptic feedback contributes to the simulation experience for disaster awareness and training.

5.4 Conclusion

The age of immersive learning is here and is a rapidly evolving field, however it is still under-researched, particularly for school students, and further studies on the effects of immersion and on the pedagogical potential of XR are essential if the affordances of the technology are to be leveraged for creativity, collaboration and deep learning. Building this knowledge base will take time. There is however already sufficient research to prove the potential for XR to address some of the shortcomings of traditional SBDRR and provide creative, innovative solutions where relevant and possible. This paper presents some of these solutions, key considerations and recommendations both for XR approaches and design and delivery. These include XR technologies that are available now and some that are speculative and will very likely be available at scale in the near future, with monumental impacts on how XR can improve the quality and reach of SBDRR. When working in a space that is constantly advancing and shifting, projections into the future and building experiences that can be updated to reflect the advancements is key.

Ultimately, the decision on where to focus XR efforts in SBDRR should be dictated by priorities in pedagogy, respect of existing well-functioning practices and the realities of the Red Cross Movement, including options and opportunities for scalability. Considering the XR of choice as a concept rather than only a type of technology will help the technology to meet learning outcomes, keeping the needs and safety of students and teachers at the centre of the immersive learning road ahead.

Credits

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Production: Digital & Nomad
Commissioned by Global Disaster Preparedness Center and American Red Cross

About GDPC
The Global Disaster Preparedness Center (GDPC) is a joint venture between the International Federation of Red Cross and Red Crescent Societies (IFRC) and the American Red Cross with the aim to expand and enhance disaster preparedness (DP) capacities of the global Red Cross Red Crescent (RCRC) network through a service oriented, demand-driven approach.
Date: August 2019

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IMMERSIVE TECHNOLOGIES & DIGITAL GAMES FOR SCHOOL DISASTER PREPAREDNESS RESEARCH

ANNEX A

CASE STUDIES

Estela Oliva and Mandy George

Date: Aug 2019

IMMERSIVE TECHNOLOGIES & DIGITAL GAMES FOR SCHOOL DISASTER PREPAREDNESS RESEARCH

CASE STUDY 01

ZIKA360

Estela Oliva and Mandy George

Date: Aug 2019

Project name: ZIKA360
Project owner: IFRC
Release date: Pilot during 2018-2019
Locale: Honduras, El Salvador, Colombia
Languages: Spanish

URL: http://cruzroja-zika.org/

XR medium: 360 VR, AR
Hazards: Health (Zika)
Activity: Training, Awareness Raising, Advocacy
Age group: +8 years, adults

Table of Contents

#1
Project Background

ZIKA360 is an innovative learning tool aiming to bring a new approach to the fight against the Zika virus. By combining two experiences, a virtual reality film and an augmented reality app, the project tackles the topic of disease transmission prevention as well as community engagement from the angle of innovation.

The project was created by the International Federation of Red Cross and Red Crescent Societies (IFRC) Americas Regional Office and designed along with Global Vision, an external production agency, with funding from USAID. The IFRC wanted to embrace innovation to achieve greater impact on advocacy campaigns and awareness raising activities regarding neglected tropical diseases, including Zika, Dengue and Chikungunya. "We wanted to break new ground building an experience that fosters innovation, heightens awareness and creates empathy among users and their communities."[1]

ZIKA360 is part of the CAZ project (Community Action on Zika), a three year initiative by Save the Children and IFRC, with support from the United States Agency for International Development (USAID). CAZ's goal is to reduce Zika virus transmission and minimise the risks of microencephalitis and neurological diseases associated with vulnerable communities in Colombia, El Salvador, Honduras, Nicaragua and Dominican Republic. ZIKA360 was conceived as a collaboration between the National Societies (NS) of Colombia, Honduras and El Salvador, and their knowledge and expertise in the topic, combined with an external production agency, have been decisive in making the experience come to life.

1 *Americas Community Engagement and Accountability Newsletter, May 2019.*

#2
Aims & Rationale

ZIKA360 was created to serve the following main goals:

- Advocacy: to engage with local authorities and councils to raise awareness
- Awareness raising in the community to influence behaviour change and train people on basic procedures to understand, prevent and stop the spread of the Zika virus

The overall CAZ project objectives are:

1. Empowerment of the community through mobilisation related to vector control
2. Improve the capacities of vulnerable populations through social and behavioral change
3. Promote the participation and capacity of communities in community surveillance measures

#3
Audience

ZIKA360 aims to reach two audience groups:

- School students 8-16 years old (extending to parents)
- Adults in the context of advocacy and fundraising

During the initial pilot about 60 children were involved. Eight was chosen as a minimum age, as it was estimated that children under eight would not understand the app and how to use it. However some younger kids also tested it and provided good feedback. The VR experience was recommended in the user guide for +12, although 8-11 year olds also tested it and the feedback was positive. However no motion sickness was recorded in children under the recommended age of 12.

#4
Experience

The ZIKA360 experience combines the technologies of Virtual Reality (VR) and Augmented Reality (AR) to address in an innovative way the themes of prevention of vector-borne diseases and community mobilisation.

1) 360 VR video

A 360 film can be viewed using a VR headset or a screen-based device. The experience was filmed with real camera footage and is not only made for school students but also focuses on adult advocacy. With a duration of 8 minutes, the film is grouped into four sections including:

- impact
- perception
- action
- sustainability

The tone of the film is emotional, as it presents real stories from people who have been affected by the virus, including a mother whose baby is sick. Testimonials are presented from different angles: parents, staff working in schools, a gynecologist, social workers and school students. Some graphic messages are inserted in the film to highlight key messages. To start the film the user guide recommends sitting down, to avoid any motion sickness.

2) AR app (game with tablet)

An augmented reality application for tablet devices aims to directly benefit the learning experience of children and young people, as well as adults, by providing a dynamic and interactive experience. Users explore a 3D community where they learn to identify mosquito breeding areas, how to eliminate them and how to prevent mosquito breeding by understanding the mosquito cycle of life, habits and learning the symptoms of the Zika virus disease. The whole app experience takes approximately 30 minutes to complete.

Below is a description of the main areas of interaction:

Intro

When opening the app with the dedicated tablet device, an intro video explains how to use the app and what you will learn:

1. scan a printed marker QR code to reveal a 3D map inside the tablet device
2. explore the community and its surroundings
3. test your knowledge with the quiz

If you are ready, you can continue to the next screen or watch the video again.

Main Menu (Map)

Once activated with the marker, the 3D world presented is a map with four interactive areas. A soundtrack played across the duration of the experience featuring an upbeat song that keeps the user active. The Main Menu is always present in the top right side with a home icon and provides access to the areas.

4 Areas

Four interactive areas can be explored from the main map including: the lake, the home, the school and the hospital.

The lake

Learn about the lifecycle of the mosquito though a series of slides including images and text which can be easily scrolled through with navigation arrows.

The home

A section to learn where the mosquitoes are able to reproduce. To discover content you can navigate a house, outdoors and indoors, and tap into objects or characters to get information about the virus and how it can be transmitted. The messages also offer solutions to stop reproduction and transmission, for example clean the water tanks every week to eliminate mosquito eggs, or put a lid on your rubbish bins.

The hospital

In this content area you can learn about the symptoms of having Zika virus, by examining characters: man, woman and children. Each character has an interactive list of symptoms which can be selected to show how they affect different parts of the body.

The school

The school hosts an interactive quiz where you can test your knowledge. Questions have multiple answers with a timer (30 seconds per question); once the answers are selected, you can view if the results were correct or not, to get a quick understanding about the progress. At the end of the quiz you get a score from 1-5 stars and a message invites you to share your knowledge with other people in your community and family.

#5
Technology

ZIKA360 is an immersive experience combining augmented reality and virtual reality technologies which requires the use of hardware and software.

To experience the ZIKA360 AR the following technology is required:

- Tablet device with camera with the ZIKA360 app installed
- Headphones
- QR code marker printed in paper to trigger the app contents

The AR experience is recommended on a tablet device, to allow more screen space. The app uses marker-based AR technology to display its content, so the printed marker has to always be used along with the tablet's camera pointing at it. The marker allows to overlay the 3D object of the app and also provides the possibility to move around the 3D object to look at it from different views.

To experience the ZIKA360 VR video the following technology is required:

- Smartphone with camera. To open the ZIKA360 film there are 3 options:
    a. Download the film into your device and open it using the Global Vision app GV 360 Video player which is available on the Google Play store.
    b. From the ZIKA360 AR app, go to the main menu and click the ZIKA360 VR link.
    c. From the IFRC Youtube Video Channel (*not published yet).
- Headphones.
- 360 Virtual Reality Headset for Smartphone (MiniSo or similar).

The 360 virtual reality experience offers a monoscopic rotatable 360 film with sound and titles, which is best experienced on a smartphone virtual reality headset. For the project pilot, the selected headset was from the brand MinoSo, which is similar to a Google Cardboard, and costs about 15USD per unit. The film can also be accessed from the IFRC YouTube channel.

The ZIKA360 hardware was distributed with a "kit" purchased by the CAZ team and was then distributed to each National Society, who then became the project owners. The kit contains:

- 6 x Samsung Galaxy S3 tablets
- 6 x MiniSo VR headsets
- 6 x Samsung S7 mobile phones
- 6 x User guides
- 6 x AR markers printed
- All packed inside a pelican case for easy and safe travel

#6 Production

The CAZ project team worked with a Geneva based company Global Vision (https://globalvision.ch/), specialising in multimedia applications, in the development of the ZIKA360 experiences.

The production was launched as a consultation and planning phase, where members of the NS and Global Vision travelled to the communities to gather feedback, film people and conduct interviews in collaboration with El Salvador, Honduras and Colombian NS. Later, a second phase happened remotely, which consisted of the app design, development and compilation of the content. There was also a process of editing the filmed interviews into the 360 film. The production process was very intense, with multiple meetings between the NS and the agency to design, test and deliver the first version. It took about five months to make the experiences and a total of seven months to coordinate the pilots in selected schools.

Challenges identified

- The learning process was challenging for the NS as they had never worked in an immersive experience before, so they had to learn "step by step".
- The IFRC have reported challenges in buying and sending the technology through the logistics unit. Challenges were encountered around the transportation of the kits between countries as the goods were not classified as emergency response. In fact, in Honduras they had to pay tax, up to 30-35% of the cost. And in Colombia and El Salvador they had to wait weeks to receive authorisation for the transportation.

The Pilot

Three countries from the CAZ programme were selected to test the experience:

- Honduras
- Colombia
- El Salvador

Pilot Objectives

- Train volunteers and coordinators in the three National Societies on the use of ZIKA360, including both the app and the 360 video.
- Explain the contents of the ZIKA360 kit to ensure correct use during activities.
- Visit schools and communities to test and implement ZIKA360.
- Receive feedback by communities and volunteers on the tools.
- Gather audiovisual material for feedback on the implementation process and the perception by community members.

Outreach

The outreach plan focuses on three aspects: Local - targeting the CAZ project communities; Regional and Global - to generate interest in potential and actual donors. A detailed communication and distribution plan has been created, however at the time of writing this has not been possible to access or review.

#7
Outcomes and Future Planning

The feedback received from the RC team highlighted:

- AR would be best suited for students
- VR is so immersive that some users does not assimilate the messages as much as in AR, especially those that have never experienced VR before as they might be taken away by the immersion and pay less attention to the educational content. In the contrary, AR gives more time to interact, click, read etc. - it is a longer term experience.
- After the feedback session at the end of both experiences AR was more clear for the kids, although they enjoyed VR more.

The following are **key learnings** from the pilot projects across El Salvador, Colombia and Honduras during 2019. The pilots included participants from RC, CAZ programme coordinators, and Save the Children. As part of the piloting in the schools, extensive documentation material was gathered, including photos, videos and audio interviews with locals.

The importance of working with Red Cross volunteers

- The first activity was aimed at training volunteers and RC technicians and it was key to deliver the experiences. Working with volunteers was fundamental for smooth delivery and implementation.
- Volunteer organisation and management was very successful in making the use of the experiences easy and seamless for target users.
- The volunteers organised children in small groups use the tablets. At the end of the session, they organised a review of the contents by each group. They were able to see that the tablet is an easy, intuitive and playful way to show the content to a young audience.
- The activity at times was disrupted due to the lack of leadership from volunteers.
- For volunteers the main challenge was not using the technology but rather: organising the activity in the school; coordination; and how to deal with last minute issues.

Immersive experiences offer high engagement

- Both the students and community groups were highly interested.

- The experience was considered highly successful. The use of new technologies raised interest amongst the children who were queuing during their breaks to test the experiences.
- The use of tablets is more intuitive and provokes more interest amongst children than adults.
- Project volunteers and coordinators were highly satisfied with ZIKA360 as it is an innovative experience, attractive and applicable in the CAZ target communities.
- For those who participated in the filming of the 360 video, seeing the final piece was exciting and gratifying.
- The kids were highly engaged during the duration of the activity and they participated. The teachers expressed positive opinions and also participated in the activities.
- The volunteers were able to manage the technology well. The volunteer training was key to implement practices and obtain feedback.

Experience design and content

- The activity closed with a summary of the key learnings as well as a validation test in which both teachers and students showed they had acquired new knowledge and retained the basic knowledge for zika prevention through the content on both experiences.
- The community said that they were able to review the key messages for the zika fight outside the traditional channels, so this was positive.
- Students recommended adding more content around the mosquito life-cycle, which showed their high level of knowledge of zika.
- Students playing the AR app were interested in the app and in taking the quiz. Most of them obtained very high scores. This shows that the tool is made to validate and reinforce the key messages that the group have proposed in this project.
- After the experience was completed, key messages were validated during evaluation sessions, so it was confirmed that users retained information, reinforcing their existing knowledge of Zika.
- Volunteers highlighted that even if the VR video did not show their own country, it still was very representative of their communities and common situations they face.
- The VR film had more impact among adults who understand better the messages transmitted. This feedback follows the design of the experiences in which the tablet app is focused on a playful tool for schools.
- Some kids expressed that virtual reality was like travelling and they were grateful to be able to see other communities.
- VR content: students were able to retain some of the main key messages of the video including eliminating stagnant waters, consequences of zika during pregnancy such as microcephaly and the importance of visiting doctors during pregnancy.

Technology and space

- There were some technical issues with the headsets that were solved by the team at CRS.
- The technology is easy to use and transport, there were no issues in the socialisation.
- In the context of safety and security, coordinators decided to implement the activities only within the closed school doors. However they did not perceive security as a limiting factor for the use of ZIKA360.
- The VR film activity took place in the

school patio/courtyard. The space was more suitable to moving around freely. Children were very attentive of the video and the space facilitated a right environment for concentration and learning.

Future Planning

The CAZ team are aiming to take the pilot to more Spanish speaking countries in Latin America, to continue gathering feedback. However the project is expected to end in August 2019 and there will no longer be a dedicated team from IFRC. The NS's who own the technology kits are expected to continue using the technology to raise awareness at local events, in schools and during disease outbreaks. They will be given a dedicated plan with regional distribution and recommendations for use in collaboration with partners. Once the app and the film are published, engagement and a wider reach is expected throughout Spanish speaking countries.

#8
Internal Evaluation and Learnings

Process

The process of developing ZIKA360 was efficient and engaging as it included participation from different parties:

- National Societies
- Members of the communities affected by Zika including students, teachers and local orgs
- The multimedia agency

The interviews and testimonials provided unique insight for the project and they were well integrated in the VR film to generate empathy and cover advocacy goals. The process of the design of the AR app was difficult at times, given the lack of experience from the NSs to create a digital product. However the results were positive and the app met the goals of awareness and knowledge retention. The delivery of

the pilot tests was efficient thanks to the internal organisation with the National Societies and the schools. In the delivery notes, the key role of volunteers in delivering the experiences is made clear.

The relationship with the external agency Global Vision was key in helping the CAZ team design the experiences as they were new to these types of technologies.

Product and features

In having two separate experiences, ZIKA360 may seem like a complicated project to replicate, however both experiences are complementary: the 360 film was made during the research phase and served as a tool to collect feedback from the affected communities, and the AR app served as a central hub to deliver the messages collected from those communities.

One of the major strengths of the app is the gamification feature, the quiz, which proved to be engaging as mentioned in the feedback reports, and added an extra degree of participation and excitement for users to repeat the experience to get better scores.

The design of the app including common areas was effective and provided a base point to illustrate the key messages of the zika prevention from the home, the school and the relationship with the medical system.

Filming the 360 video in local communities was also very effective as it provided a reference point for neighbouring countries, who saw similarities with their own communities. However the film is limited to a context of the countries where it was filmed and it could not be exported in the same way to other countries. The fact that the experiences are also in Spanish is a limiting point for scaling this experiences to other non Spanish speaking countries either in the region or globally.

Effectiveness

Having examined evaluations from three pilot projects, it is clear that the experiences have met their goals of:

1. Raising awareness of the virus and potential risks amongst schools and local communities
2. Providing basic knowledge to prevent and stop the spread of Zika virus.

Scalability

Both the AR app and the 360 film are only available in Spanish language and have not yet been made public. The ZIKA360 AR app is planned to be published and made accessible on app stores (Google Play and Apple Store), however no dates have been confirmed. With the release of the app, new avenues for scalability will be unlocked, providing the possibility to scale the project to other Spanish-speaking countries in a scalable way through apps stores - however the language restriction will limit possibilities to scale.

Key Learnings of Relevance for SBDRR

ZIKA360 is an excellent example of a localised solution to enhance learning and awareness in schools and local communities using immersive technologies. Top key learnings of relevance include:

- The combination of awareness and learning activities with two different experiences was key to engage different age groups and community members.
- The AR app interactive features and the gamified quiz provided a strong result in acquiring new knowledge and increasing user engagement.
- The use of tablet devices was intuitive and playful for children and made the experience very easy to use.
- The choice of AR allows for younger children to experience the content, whilst full VR is recommended to +12.
- The 360 VR video provided an engaging experience to raise awareness and empathy, however it was limiting due to the localised context of the film footage.
- Localisation (for example through 360 video) improves user experience at the place of roll out, but limits scalability to other contexts.
- Working in collaboration with NS, communities and schools was key for the development of this tool, to integrate feedback and to deliver the experiences.

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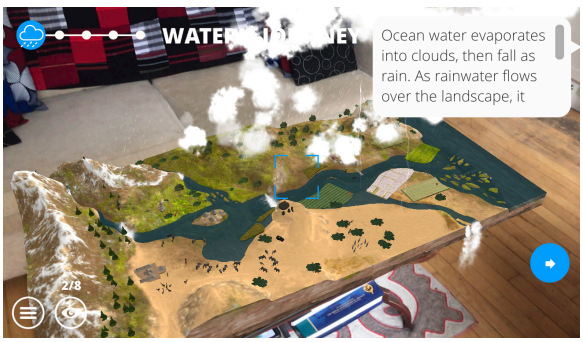
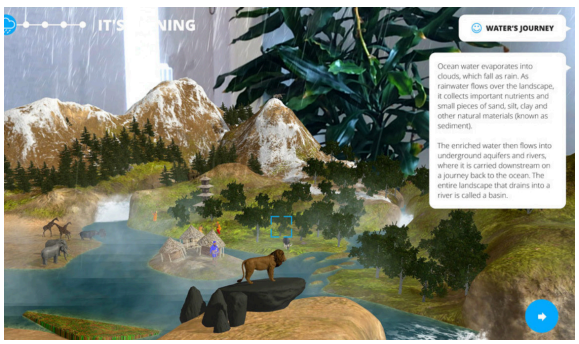
WWF Free Rivers

Mandy George and Estela Oliva

Date: Aug 2019

Project name: WWF Free Rivers
Project owner: WWF
Release date: 2018
Locale: USA, Global
Languages: English, Spanish, French, Russian, Hindi, Mandarin
URL: https://www.worldwildlife.org/pages/explore-wwf-free-rivers-a-new-augmented-reality-app
http://www.onebigrobot.com/work/wwf-free-rivers
XR medium: AR
Hazards: N/A
Activity: Awareness raising
Age group: 4+





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#1
Project Background

Free Rivers is an augmented reality (AR) experience which was born from the desire to illustrate what the future could look like if rivers are not kept free flowing and protected. This idea first came about when a World Wildlife Fund (WWF) team was visiting the Luangwa river in Zambia in 2017, where a dam was proposed that would have had negative consequences for people and the environment. As they were investigating local community perspectives on the dam, they noticed that while those living in close proximity to the river were more aware of the negative consequences it would have, those further away from the river but who would still be displaced by the dam project were unable to envisage how this would impact them. Immediately following this visit, Apple announced the AR Kit, and the idea of an immersive experience that could bring this intangible concept to life was born.

WWF collaborated with One Big Robot, a visual communication and design agency that works on scientific and social issues, to bring this idea to life, in a six month process that concluded just after World Water Day, March 27, 2018. The Free Rivers AR app was one of the apps featured in Apple's March 2018 keynote event in Chicago, and highlighted several times in the Apple store, increasing exposure and positively affecting download rates.

The App is described by the Apple App store as:

"WWF Free Rivers puts an entire landscape in your hands. Through this immersive, augmented reality experience, you'll discover a river that flows through the lives of people and wildlife, and how their homes depend on those flows. Dam the river to see what happens, and then try different options for sustainable development that keeps the river healthy and flowing. Collect stories of people and animals along the way!"

The app creates an entire river system in the users living room and gives a birds-eye view of habitats, such as a river basin, a rainforest, and a mountain region. Within the experience, users learn through navigation and narration about why free flowing rivers are so important, what happens when they are not well managed, and how development can still happen, but sustainably.

#2
Aims & Rationale

WWF Free Rivers was created to raise awareness on the following:

- To "make people care and think about rivers" as a critical but consistently undervalued part of our planet.
- To demonstrate that the protection of nature and development can go hand in hand, and that sustainable development is possible. For example, in the app when the user places the dam in a different location, and generates energy from solar as well as hydropower, the impact on nature is vastly reduced.

#3
Audience

WWF Free Rivers is targeted at the general public and at children and young people. The age restrictions stipulated on the app stores are 4+ on the Apple store and 12+ on the Google Play store. WWF have found that children under 12 are using the app, despite initially targeting users over 12. AR screen based gaming or fantasy experiences (mobile, tablet, computer or gaming console) are advised from 4+ if used for short periods (under five minutes).

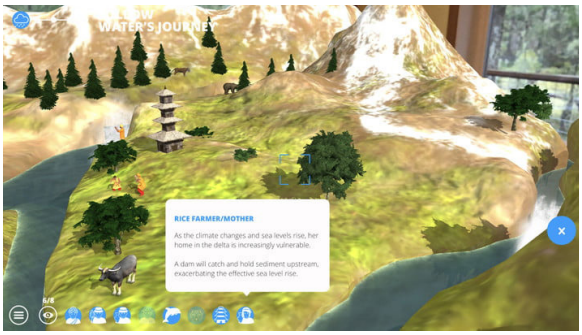
The app was initially designed to educate and inspire decision-makers such as government officials, river basin managers,and technical experts who weigh in on development that occurs on or near rivers. During the design process WWF recognised the opportunity to make it simple enough for students, and were pleasantly surprised when it also resonated with younger children.

#4
Experience

WWF Free Rivers was designed with a river system that incorporates features from across all continents, so that it could be representative of a river system globally. Designing an experience that was as accurate as possible was important for the WWF team and they worked closely with scientists from each of the real-world biomes that would be featured in the app to make sure all the plants and animals were truly based on reality. As you travel down the river you pass through the Himalayan mountains, tropical jungles, the African Savannah, South American grasslands and Southeast Asian deltas.

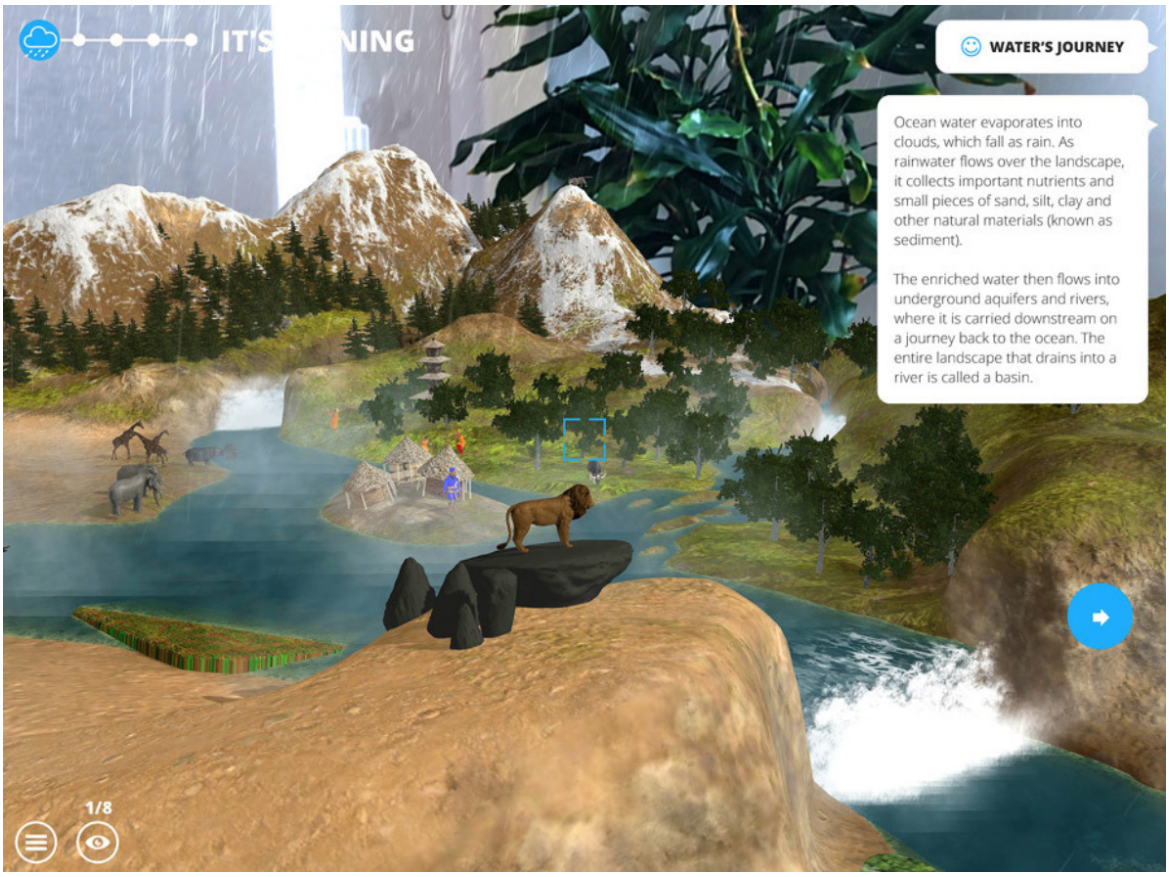
The set up and use process involves:

- Free app downloads from Apple or Google app stores.
- Find a flat surface that's well-lit so that the programme can recognize where you're placing the landscape.
- The scene then appears on the table and you're able to zoom in, move around.
- Tap on icons for more information, (via helpful floating tips that appear) for example bodies of water or different animals and people. Each scene along the course of the river has multiple things to see. At the end of reading about an icon, tap the check mark and the counter will go up.
- At the bottom of the app, there's a counter that keeps track of how many found throughout the time in the app.
- Learn about nature and people by clicking on the icons for example "Rice Farmer/Mother," whose home in the delta becomes increasingly vulnerable with climate change and sea rises.



Key functionalities include:

- Gamification: this increases engagement and also makes the user physically move around which has positive impacts on learning outcomes with a more immersive experience. Digital games have the potential to shift users and audiences from passive spectators to active participants who interact with the content.
- Decision making: The user can dam the river to see in accelerated time what happens, and then try a sustainable energy mix that keeps the river connected but still satisfies growing energy demands.
- Storytelling/narration: the narration element provides more detailed information on how wildlife, people and entire landscapes depend on healthy, flowing rivers. As users explore the AR view, a narrator explains how river dams affect farming, animals, and human inhabitants. The narrator also discusses solutions, helping to find a positive outlook.
- Simple interface: The user interface was deliberately kept minimal and markers over the object are used to lead people through the story. They followed the principle of "less is more" in the AR app design.
- Translation: the App is available in 6 languages: English, French, Spanish, Russian, Hindi and Mandarin.



#5
Technology

WWF Free Rivers was made with the Unity games engine. It is available for free on both the Apple's App store and Google Play store. It functions on iPhone, iPod Touch, iPad and Android and needs the minimum software requirements of iOS 11.3 or later and Android 8.0 and up. The experience on a tablet device is preferable as the larger screen improves the immersive experience. The app uses markerless AR technology to show its contents. Upon launch it requires to point at any flat surface to create an anchor in the real world to display 3D and interactive content.

It is currently at version 1.3 and has a size of 447.90 MB. WWF own the rights to the app.

One Big Robot, the agency who built the app, update it based on requests by WWF. This to date has included:

- Post-launch update on performance and for the translation into other languages.
- Five months after the launch, a completely new feature was added: map visualisation feature, that includes layers for free flowing rivers, and explains via the map feature information about protected areas and free flowing rivers. This also included adding in the big animals feature (to learn more about specific species).
- Future update planned: adding different scenarios of real rivers (Danube and Ganges).

#6
Production & Distribution

Production process

The production process began with an analysis of what the main aims were and where AR could add value towards achieving these aims (see aims and rationale below).

WWF decided to focus on AR for the following reasons:

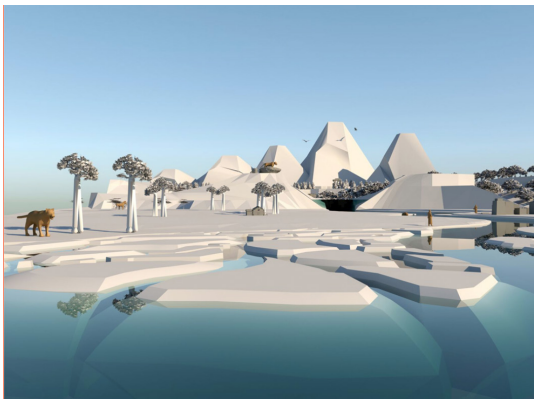
- The predicted impacts on awareness raising (not proven at the time of development because of AR being new)
- The “wow” factor of AR, being one of the very first AR apps produced
- More accessible than virtual reality (VR)
- Less expensive that VR to produce
- The timing with the Apple announcement of launching AR on iOS, as AR was now going to be in the hands of millions of people with iphones

Production in partnership with One Big Robot took place on an accelerated timeline, taking only six months from concept to delivery. This swift process was part due to the eight year relationship between WWF and One Big Robot. Notwithstanding it was a complicated process and a learning experience, as the One Big Robot and WWF team were one of the first explorers of AR.

The first model was made out of legos in a basement and then brought to life over the six month period. Feedback was given at various stages by WWF scientists to ensure accuracy of the content.

One Big Robot created a moodboard to find the right look and feel for the experience where they laid out references for every single element and then build a 3D storyboard to have an audiovisual approach to the experience. To design the landscapes, the used geometric mesh of the terrain and applied overlays of texture.

Working with One Big Robot was a positive experience for WWF, who have worked with them on many occasions. The agency specialises in science and social good so were better briefed on the issues, and they provided in kind development for some of the time they used, keeping costs lower than an AR experience of this caliber would normally take to produce. It was internally funded and approached as an experiment by both sides.



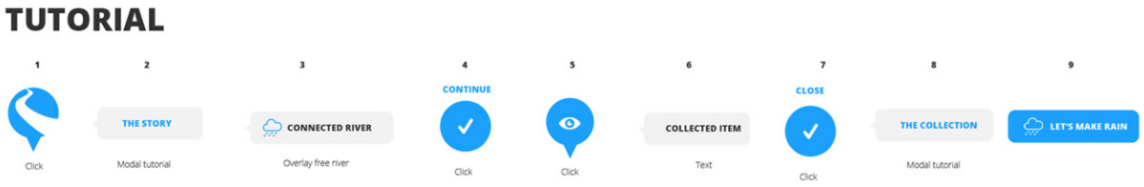
The production process coincided with broader work that the organisation was conducting to put together a list of non-sustainable development proposed for free-flowing rivers across the world. This meant that there was a range of learning coming from this project at the same time as the app was being designed that could be taken, embedded in the app, and then rolled out via a broader advocacy campaign. This allowed the content of the app to be more realistic and WWF staff working on the ground in these research locations could identify with the app and use it in their stakeholder engagement and advocacy efforts on the ground.

Challenges

From One Big Robot's side, the design process was challenging as it was one of the first educational AR apps. According to One Big Robot:

"One of the most complicated factors on the project was understanding how people were using AR when there were practically no educational AR apps created when we started.
Being a pioneer is fun, but it made us work and rework on all the flow of UI and UX."

One Big Robot worked intensively on the design of the user experience and the flow of contents to get it right, building wireframes of usability for the app:



[Images from One Big Robot's website: http://www.onebigrobot.com/]
There was an extensive iteration process to get the usability and design of the app right - this was more intensive for the Free Rivers team given the fact that AR was so new.

This iteration process was mostly absorbed by One Big Robot. From WWF's side, no major challenges were identified in the production process and WWF have said that they would not do anything different in a production process like this next time. They took steps back to evaluate and correct the app as they went through the process which resulted in a more polished and higher quality final output. For example, the first iteration of the app was too weighted because of the importance that everything be scientifically accurate, and had to reduced in size. This sacrifice on precision was necessary to make the product viable.

Launch and distribution

WWF Free Rivers was launched in the US by Apple at an event to highlight creativity in education, in Chicago in March 2018. A presentation of the launch is available[1]. This was the first time that Apple released AR applications on iOS and therefore there was a huge amount of interest in the launch. WWF launched the app after this initial event. Apple put a large amount of time and resources into the launch, and there was a huge advocacy campaign around it. It is now available on both Apple and Android phones and tablets, on the Apple and Google stores, and has been disseminated in 5 languages. The app is still featured on Apple.com's AR page (in the US). Free Rivers has received the highest number of downloads from the US and China[2].

In addition to distribution via the app stores, WWF distribute the app as part of their educational work, integrated into their Dolphin Classroom Toolkit[3] on freshwater and use this in significant, water-focused professional events such as the Stockholm International Water Institute's World Water Week, the International Rivers Symposium, and the World Water Forum.

1 https://www.youtube.com/watch?time_continue=7&v=uG2HiraKM-Y

2 According to One Big Robot, China is the global leader in AR

3 The Dolphin Classroom Toolkit is part of Wild Classroom is a growing library of species-focused toolkits produced by WWF, aligned to US national education standards, that can be used to enhance children's learning inside or outside of a traditional learning environment.

#7
Outcomes and Future Planning

The app has had a total of almost two million downloads. It receives feedback on the Apple app and Google Play stores in the form of user reviews. It is currently rated 4.8 out of 5 on the Google Play store (12 reviews total) and 3.7 out of 5 on the App store (131 reviews total). WWF points to these app store reviews as their primary source of evaluating the app, and based on this feedback that they track they have made updates to the app.

Most of the negative reviews have to do with negative opinions of AR more generally rather than with the app and content. For example, one user questions whether AR is adding anything to this experience when videos could be used instead. User suggestions for improvement include: wider breadth of content, both in the design of the habitats and storytelling; making the characters moving, to increase the interactive environment; enlarging the content and the font. User favourite features include the storytelling, being able to physically move around to explore the scenario and the vivid clear design.

Key learnings

The following are key learnings that the WWF and the One Big Robot team took away from the process of building their first AR app:

- *AR works well for the education community*. WWF was surprised at the uptake and amount of coverage that Free Rivers received, in teachers' newsletters and educational press. *"The decision makers of tomorrow"* were an unexpected audience. WWF have embraced Free Rivers as an educational tool as a result, and it is part of their Wild Classroom[4] Kit on water.
- *The technology is second nature for the new generation:* WWF were surprised at how easily it permeated young audiences. Although they created it more with middle and high schools in mind, they have found that much younger children are using it and that it resonates strongly with younger ages.
- *AR (and other immersive technologies)*

4 *Wild Classroom is a growing library of species-focused toolkits produced by WWF, aligned to US national education standards, that can be used to enhance children's learning inside or outside of a traditional learning environment.*

is a more creative way to get otherwise complicated or less interesting concepts out to the public

- *TThe attention from Apple made a big difference to the roll out and without Apple it might have had a much slower uptake.*

WWF and One Big Robot were at the launch of AR on Apple, and interviewed by the media in the days following the launch; Apple featured the app in the app store on their top lists.

Future planning

WWF aims to turn this experience into something even more immersive and interactive. Firstly, they would like to have a teacher model of the experience, where multiple players can interact using different tablets/phones in the same river basin in a mixed reality experience. They would like to be able to take this experience to specific locations and be able to show what they would look like when flooded, for example to the people in Zambia who originally inspired the production of Free Rivers. As technology progresses and AR headsets like Magic Leap become more accessible and affordable, WWF would like to turn the experience into a wearable one.

Content-wise WWF would like to build different customised river scenarios in order to personalise the experience, rather than using one generic one. They would also like to cut down on the amount of words used to improve the learning experience, as these were written by scientists not educators.

In the meantime WWF plan to continue to use Free Rivers as part of their education packages around the world, and at major conferences and events, integrated with their work on rivers.

#8
Internal Evaluation and Learnings

Process

The process of developing WWF Free Rivers was efficient and cost effective, however there were various factors that played in their favour, including pro-bono work by One Big Robot and the willingness of WWF to take risks on new technologies and ideas before they are tried and tested.

As the WWF project manager highlights:

"At WWF we get permission to test things to know if they will work, even if they might fail."

WWF Free Rivers is one of the first AR apps released by Apple and therefore there was no guarantee of success, but WWF did have the assurance of high distribution figures given the partnership with Apple and the resulting marketing and exposure.

The production team worked closely with WWF scientists and therefore there is a high level of scientific accuracy in the content. There was however no direct consultation with people affected by dams or living close to major rivers, despite the original concept of the app originating from community consultations and a desire to be able to better depict future scenarios of poor river management to them. Nor was there consultation with the education community or students, although this was primarily due to the education community not being the original target audience. The uptake by the education community was a surprise and a success and future plans include capitalising on this to provide a more immersive, multiplayer educational experiences.

One Big Robot found user testing to be challenging because AR was so new and it took some time to learn how to use it. They adapted the user testing process, that spanned a three month period, to be very instruction based. The user testing process shifted the app from an experience where the users discovers things to a sequential series of events that the user follows in order to explain the story. The final month of testing with Apple was a complicated but learning process for the team.

Product and features

Despite being one of the first AR apps on iOS, WWF Free Rivers is well designed, with high quality graphics, accurately designed people, plants, ecosystems and animals, and clear, vivid visuals. The narration feature and information bubbles guide the user through the experience and the need to physically walk around, contributing to long term memory retention. Together these functions increase the quality of the user experience, immerse the user in the learning and increase the impact on learning outcomes. AR has proven to have a positive effect on learning performance, visualisation skills and the learning experience[5] and the limited amount of feedback available on the user experience suggests that this is predominantly the case with *Free Rivers*.

The primary aim of the app is to raise awareness, rather than asking people to take any direct action or train them in a particular skill. However the gaming function allows for a higher level of interactivity and possibility to move the dam and see the consequences on people and the ecosystem adds a small decision making element to the experience, showing the consequences of unsustainable development. This in turn impacts the knowledge retention of users. AR is still new enough to provide user motivation and a "wow" factor to the general public and students.

Tablet or phone AR experiences with gaming or fantasy content are suitable for ages 4+ as long as restricted to short time periods under five minutes. AR is usually recommended for ages 7+ as long as the content is gaming, fantasy, low shocking realistic scenarios/simulations and it is used under adult supervision. Free Rivers fits into this 7+ category, so any use for children under seven should come with additional guidance.

AR means more freedom of movement with no cable, and greater awareness of the space around the user, making it safe for use in schools and with younger audiences. The gaming element allows users to interact with and shape the content to see the consequences of their decisions (for example placing a damn on the river). The range of options and branching storylines is minimal, with only a few options for the user. This was kept deliberately simple by the developers to deliver their key messages and this is effective in transmitting and retaining them.

5 *A Review of Research on Augmented Reality in Education: Advantages and Applications. Saidin, Halim, Yahaya, 2015.*

Content

WWF Free Rivers is successful in turning a serious and often negatively portrayed topic (global river problems) into something both hopeful and realistic between the beauty of the ecosystem design, the narrator's positive tone and proactive solutions embedded in the storyboard. The result is that the topic is light enough for children and other users to absorb the information without feeling overwhelmed. Additionally, showing sustainable energy and development alternatives is more realistic than saying no to all development. It is solutions focussed, which gives WWF Free Riv-

ers a more hopeful than catastrophic vibe despite the challenges rivers face globally. This contributes positively towards information retention and awareness raising.

The app was not specifically targeted at children, and therefore the content was not produced with education specialists, but with scientists. Although it has been a success with the education community, the app could have benefited from a content design process that involved students and teachers.

The app does not contain a specific call to action as an awareness raising tool. This could be seen as a missed opportunity not to have it tied to a specific fundraising or educational campaign. It is however integrated into the Dolphin Classroom Toolkit on freshwater.

Translation of the content from English into five other languages is a strong feature of the app, particularly because the languages that were chosen cover huge parts of the world that are experiencing major challenges to free flowing rivers. Future plans to customise the content by building river basins for the Danube and the Ganges with further increase personal connectivity to the content.

Scalability

Once the appwas developed in English and translated into five other languages, it became highly scalable in countries where these languages are spoken, due to its low cost and lack of technical expertise needed to use. It is free to download and works on any relatively new phones or tablets (iOS 11.3 or later and Android 8.0 and up). It functions on technology that schools in the US are likely to already have and is accessible to almost all ages.

This makes it highly scalable in the primary country of distribution (United States) but would not necessarily be the case in other parts of the world. The choice of AR over VR means sacrificing immersion for a technology that is more accessible financially and technically to the public and to a broader range of ages and is therefore more scalable

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Effectiveness

The main aim of the app is clear: to raise awareness of a defined set of key messages. It can be inferred that between the high number of app downloads and users and positive user feedback on the Apple and Google stores, this has been achieved with those who used the app. There is not enough evidence or formal evaluations to thoroughly evaluate if these downloads translated into measurable impacts.

Key Learnings of Relevance for SBDRR

This case study is of relevance to the future work of GDPC in XR despite focussing only on raising awareness because it is a highly successful example of an AR app that has been used extensively in schools. AR is proven to be effective with school children and this case study highlights that it is an affordable modality for awareness raising and communicating concepts that are not normally considered interesting, harnessing the wow factor that AR continues to hold. The app has been highly successful with the education community and had huge numbers of downloads - over two million - particularly in the US and China, although it is difficult to distill how much promotion by Apple impacted on this From the developers experience, they can see AR working well for school based disaster preparedness.

Top takeaways

- Organisational openness to taking risks on new ideas or technology is key to innovation. Joint collaboration between parties that understand the risks, the challenges and are willing to go where no one else has gone is key.
- AR can have excellent uptake by the educational community. This type of application supporting broader teaching outcomes is successful with children and young people.
- Appealing visuals plus gamified content increases use of application and positively impacts on awareness raising.
- AR apps downloadable on major app stores, with only a phone or tablet required increases uptake.
- The design process is lengthy, with good cooperation needed between developers and the owner, and multiple iterations to get the content right.
- AR app downloadable on major app stores, with only a phone or tablet required increases uptake
- The design process is lengthy, with good cooperation needed between developers and the owner, and multiple iterations to get the content right
- Having an established and ongoing relationship with a digital agency that can help to keep costs down and continue to update and refine as user feedback is gathered is beneficial. This is particularly the case with XR apps as they can be expensive to develop.
- ARas 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' real surroundings). In this case it allows users to virtually travel to and experience other parts of the world.

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VR Action Lab

Estela Oliva and Mandy George

Date: Aug 2019

Project name: VR Action Lab
Project owner: Harmony Labs
Release date: 2017
Locale: USA
Languages: English, Spanish, Portuguese, Japanese
URL: https://harmonylabs.org/vr-action-lab | https://vr.google.com/daydream/impact/actionlab/
XR medium: 360 VR
Hazards: Bullying
Activity: Awareness
Age group: 13-15

Table of Contents

#1
Project Background

Born in 2017 as a collaboration between Harmony Labs and Google Daydream Impact, VR Action Lab explores how virtual reality might activate young people as up-standers and address the precipitous drop in efficacy of middle school anti-bullying efforts. VR Action Lab united award-winning filmmakers with young people, researchers, experts, and middle-school practitioners across four US states. Three VR experiences were created and embedded in a pilot-tested six-lesson curriculum, along with other resources, including a design toolkit for VR media makers and organisations, a curriculum guide for teachers and an issue briefing book. The VR Action Lab was put into trial and results are collected in a paper which shows evidence that the virtual reality experiences increased empathy and willingness to intervene as an active bystander among those participating.

VR Action Lab Trailer:
https://www.youtube.com/watch?v=otE3f-siCY-8

Harmony Labs is a New York based organisation working at the intersection of media and social impact. For the VR Action Lab, Harmony Labs brought together a set of stakeholders including Screenwriters Colony, Sensorium Works and Institute of Play to collaborate with young people and practitioners. They followed a rigorous approach integrating research, strategy and user testing. Future iterations of the VR Action Lab would use the same multidisciplinary approach to prototype social impact uses for emerging media technology.

#2
Aims & Rationale

The aim of this experience is to engage students as "active bystanders" and help them take skillful action in difficult situations by producing powerful virtual reality (VR) experiences that develop the medium's capacity to make change on the important social issue of bullying. The objectives are to:

- To help young people gain greater knowledge of bullying and its components by understanding the different roles in the bullying dynamic: target, perpetrator, ally and bystander;
- To lower attitudes supportive of bullying and develop empathy for others;
- To promote a greater willingness to intervene in bullying situations, to learn how to become an ally and to intervene successfully;
- To support young people to take action by providing a space not simply to talk and discuss bullying, but to make them media creators;

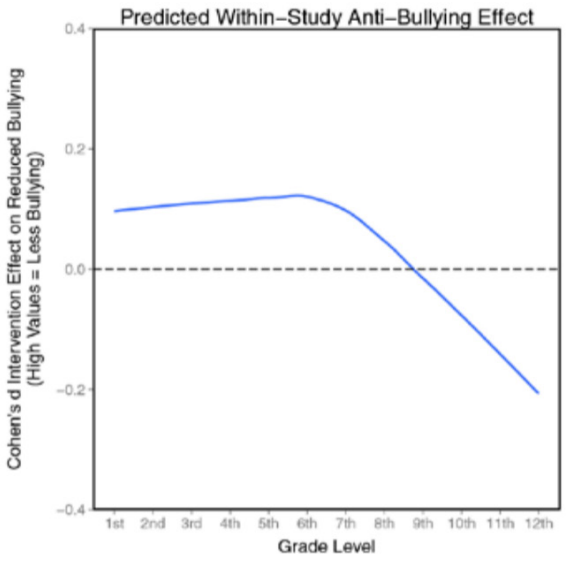
While directly impacting young people, the overall aim was to develop a process for creating content with a new form of emerging media that was geared towards social change, and that could be replicated in other cases. This process included research, production and toolkits, including a school curriculum created by Harmony Labs.

#3
Audience

The preliminary research performed by Harmony Labs included in the Briefing Book included evidence from a recent study by Yeager, Fong, Lee, and Espelage which shows that once middle school students reach 8th grade (age 13-14), anti-bullying programs drop to zero efficacy and, in some cases, even increase the incidence of bullying.[1] However, through the resources and curriculum, the project also extends to teachers, and school administration members, as well as to further organisations who would like to replicate this project.

1 Addressing the efficacy gap, Briefing Book evidence page 22.

Figure 3:
Drop in Efficacy of Anti-Bullying Programs



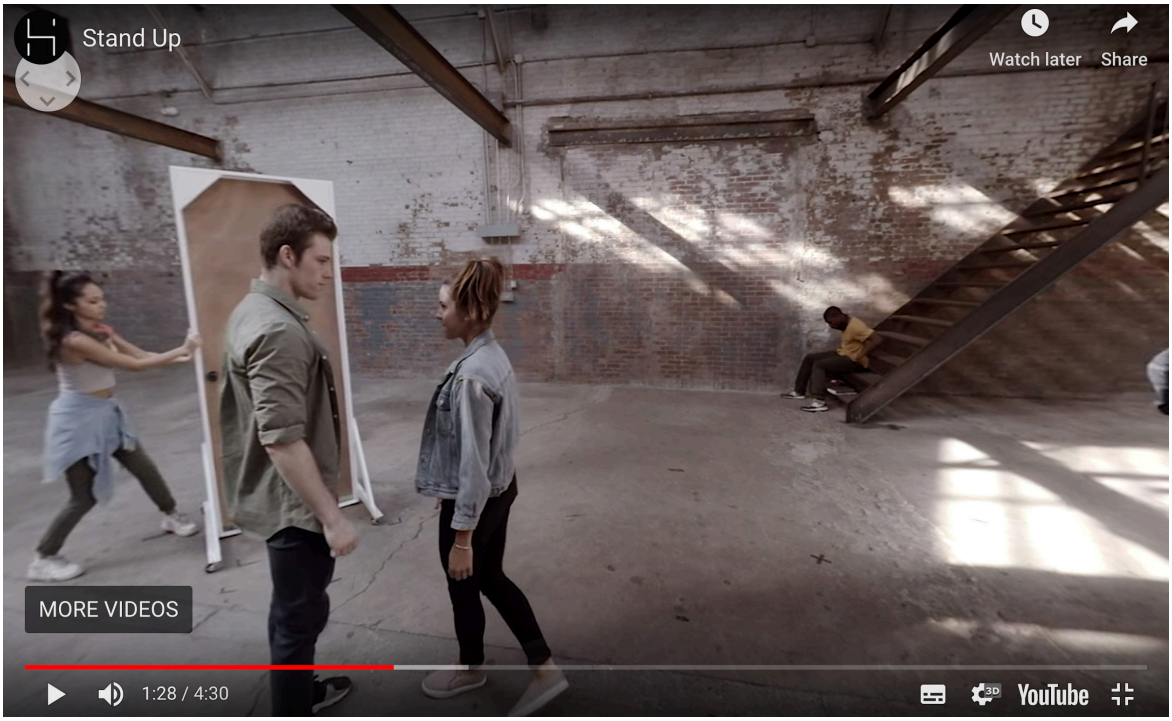
#4
Experience

VR Action Lab produced three different virtual reality experiments which can be enjoyed as 360 VR videos and are compatible with most virtual reality headsets combined with smartphone devices. The experiences can also be watched without headset as 360 videos in YouTube using a computer or mobile device.

Stand Up

Directed by Mary John Frank
Produced by Sensorium and Mary John Frank
Small actions make a big change in this dance-based rap musical
Duration 4:29 mins
https://www.youtube.com/watch?time_continue=1&v=v3oCbVvIGpU

Stand Up is a story told in rap of a case of bullying in school. The scene takes place in a theatrical set up with minimalistic decor and can be enjoyed in 360 by looking around at the characters moving and dancing. The story is performed by nine young performers and shows David, an introverted guy, and his best friend Casey, who become distanced and he is increasingly isolated in school. Casey made out with a guy during a party and was recorded on the phone. The photos were shared in the school, everyone laughed at her and she was bullied. Casey reported it to a teacher she trusted. The teacher gave her information and asked to contact her parents. The bullying doesn't stop and she gets even followed home. Her grades fall. Her friend



David finally reacts but she doesn't want to speak with him. He understands he has to stand up for her, and by showing her support the haters start changing and also stand up for her.

No Easy Answers
Directed By Aleem Hossain
Produced by Sensorium
Three satirical scenarios challenge prevailing attitudes on bullying
Duration: 6:18
https://www.youtube.com/watch?v=bvyHc-c7Iy5E

No Easy Answers presents a satirical 360 film of the "perfect school" where students and teachers avoid confronting the topic of bullying and harassment, pretending everything is fine. However some of the students react and they change the narrative by showing the user that they have to be aware and denounce bullying. The experience is also available in Spanish, Portuguese and Japanese.

FutureCIRCLES

Written and Directed by Adaora Udoji
Produced by Sensorium
A trip to a future without bullying
Duration 9:22
https://www.youtube.com/watch?v=iMb2SqP3578

In this film, the main character travels to a future without bullying in 2060, to get advice from students who have destroyed bullying. Together they analyse bullying situations that happened in school and understand how the characters could have acted differently to prevent harassment. The students from the future report that to stop bullying in the world, there was a trend of people being aware (students, teachers and parents), and that is how eventually it disappeared. The film provides a very positive angle as it shows that there could be a future with no bullying. The experience is also available in Spanish, Portuguese and Japanese.

Alongside the VR experiences, *VR Action Lab* also delivered a **curriculum**[2] including six lessons which can be carried out as a complete set or cherry picked according to needs. The curriculum booklet is aimed at teachers and also includes information about how to use VR in the classroom, best practices, exercises and recommendations. The six lessons included are:

1. **VR 101**
   In this lesson, students gain on overview of the curriculum and learn how to use the VR technology. The class creates group norms on using VR technology and practices using the tool through several tutorials.

2. **Stand Up**
   In this lesson, students engage with their first piece of anti-bullying *VR: Stand Up*. Students work individually

2 *VRAction Lab Curriculum, 2017*

and in pairs, with some whole class check-ins along the way, to "monitor for meaning" and to clarify questions and misunderstandings.

3. **No Easy Answers**
   In this lesson, students explore how schools (and society) deal and don't deal with bullying, addressing the fact that bullying is part of a larger societal problem.

4. **FutureCIRCLES**

In this lesson, students explore the question of whether bullying can ever be stopped and what people can do to help end it. The third and final VR piece asks to consider how small actions can lead to big results.

5. **Media Makers**
   In this lesson, students have a chance to synthesise and apply what they have learned in the previous lessons by creating their own piece of media. Students are invited to plan, rehearse and shoot a 30-60 second, "one-shot" video on their mobile phone about bullying. They are offered a menu of choices based on the three VR pieces they experienced during the programme.

6. **Showcase**
   In this final phase, students have an opportunity to share their media creations with their own and/or other classes.

Alongside these lessons, the curriculum includes a series of activities and tasks to be performed by students individually or in pairs, as well as homework.

STAND UP

PARTNER PAIRING ACTIVITY

2

You and a partner have been assigned the character of KACIE. While you experience "Stand Up" for the second time, please focus on Kacie and what she feels, thinks, says and/or does throughout the VR piece. After your viewing, you and your partner will share what you noticed about your assigned character and make a list together.

Things Kacie felt, thought, said and did (list as many things as possible):

You and a partner have been assigned the character of DAVID. While you experience "Stand Up" for the second time, please focus on David and what he feels, thinks, says and/or does throughout the VR piece. After your viewing, you and your partner will share what you noticed about your assigned character and make a list together.

Things David felt, thought, said and did (list as many things as possible):

You and a partner have been assigned the character of the OTHER STUDENTS. While you experience "Stand Up" for the second time, please focus on the characters of the "other students" (i.e. student not Kacie or David) and what they feel, think, say and/or do throughout the VR piece. After your viewing, you and your partner will share what you noticed about your assigned characters and make a list together.

Things the "other students" felt, thought, said and did (list as many things as possible):

#5
Technology

All three projects of VR Action Lab are 360 films made for virtual reality. They were filmed with rotatory cameras and built as 360 video.

The equipment used included[3]:

- 3 GoPro Odyssey cameras & Jump assembler
- Daydream View Headsets & Google Pixel phones

The GoPro Odyssey is a 16-camera panoramic stereo rig designed for Google's Jump platform. Together, Odyssey and Jump eliminate two of the most significant pain points in VR video storytelling: syncing cameras for easy control and capture, and automatically stitching footage for a seamless stereoscopic video, thus removing several days in post-production efforts. [4]

The films have been dubbed into three other languages including Japanese, Portugese and Spanish, and text elements of the film have been translated and edited in post-production.

To view the experiences using a VR headset, the creators offer direct integration with the Google Daydream viewer. The experience can be activated by accessing the Daydream app from a compatible smartphone, running on Android only. During this pilot Google Pixel phones were used.

3 https://vr.google.com/daydream/impact/actionlab/
4 GoPro website https://gopro.com/en/gb/news/here-is-odyssey

#6
Production & Distribution

Google and Harmony Labs decided to collaborate to show what virtual reality can achieve. After some initial ideas, they decided to focus on schools and bullying specifically, and the VR Action Lab idea was born. The production took place over nine months between April and December 2017 in collaboration with Sensorium Works and Institute of Play. After the launch there was a pilot period to test the programme in schools during January 2018.

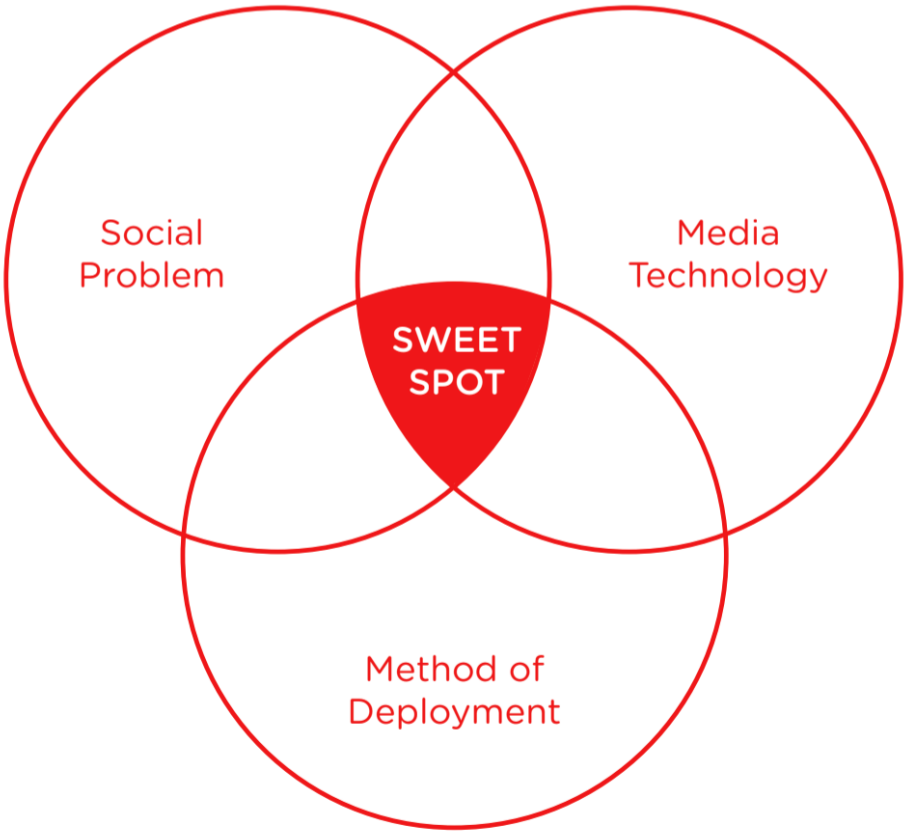
The design process is thoroughly documented by Harmony Labs in their Design Toolkit[5], where they explain their strategy of "Impact Design", a process containing feedback, testing and iteration with the aim of impact. It contains the following stages:

5 *Design in VR toolkit, Harmony Labs, 2017*

Landscaping

Understanding of the social context in which a social issue occurs, using a variety of research techniques, including media and network analysis, literature reviews,and interviews with experts and practitioners. Some hypotheses are made regarding how to solve the issue. The aim of landscaping for Harmony Labs is to discover what they call the project's strategic "sweet spot" which includes the overlap of the social problem (in this case the effectiveness drop-off of anti-bullying programs), the media technology (in this case VR) and their method of deployment (which was a curriculum designed for the classroom).

STRATEGIC MEDIA IMPACT DESIGN



Co-design:

Co-designing was collaborative process to co-create concepts for the VR experiences, including the audience, practitioners and experts to cover a wide variety of skills. In the *VR Action Lab*, some of these roles and skill areas were covered by core project partners, while others necessitated the occasional involvement of outside advisors and consultants. To ensure the goal of behaviour change in middle school students was achieved young people participated in different project stages. Four groups of young people were active participants in the project.

In the co-design phase Harmony Labs worked with Screenwriters Colony to select a number of directors and students to participate. The first activity was a briefing session that was used to unfold the problem of bullying and why the traditional school approach did not work. The students who participated in this event became advisors throughout the project. They received a crash-course on bullying prevention which was documented in the Briefing Book and were tasked to create VR pieces that together form a learning experience addressing teen bullying in middle schools. Their mission was to create a compelling narrative that was highly engaging on an artistic level, while also representing crucial information about bullying and its prevention.[6]

The next phase was a creative production phase, with script-writers and young people from different locations, and they worked together on the development of the scripts with the filmmakers that were then made into prototypes of the experience.

The co-design methods included: panel conversations, interviews, workshops to write early versions of the scripts and walk-throughs. Once the experiences had been filmed and the curriculum written, both were "play-tested" by a small group of students at a public middle school.

"Don't just get something from a movie or a book. Don't write a story. Show them real-life situations, because this is real life."

Grace del Corral, Youth Panelist, Discovery Workshop

6 *VR Action Lab Briefing Book, Harmony Labs 2017*

Production and piloting

The production started with the script and involved the audience and the experts who created and piloted. Testing early and frequently allowed the team to determine the extent to which the 'impact design' worked as planned, and to make changes and refinements as needed. During this process young people were also involved in the making, both as actors or giving feedback about the process. When the experiences were completed, the curriculum creation was put in place, tested and optimised. The final phase was to pilot the project in three schools, where 118 students students tested it, as documented in the pilot research paper.

#7
Outcomes and Future Planning

To evaluate the efficacy of the Lab's virtual reality experiences and anti-bullying curriculum, the experiences were piloted as part of a series of separate studies, conducted throughout 2017 and 2018, including:

1. A randomized controlled trial on student attitudes and behavior change on bullying and bullying bystander intervention in two middle schools in Illinois, involving 50 eighth grade student participants.
2. An individual intervention to compare the effects of VR versus video in altering student understanding of bullying and propensity to engage in bullying.
3. Also there was a trial of the Midwest United States of 118 students, which led to a documented research paper. This research study and trial evaluated *VR Action Lab* compared to a business-as usual control group, and proposed two different test models to evidence:

    → In the first test, students who received the VR intervention saw empathy increased. Additionally, receiving the virtual reality intervention was associated with decreases in perpetration of bullying behaviours.

    → The second test saw the VR intervention group showing increased school connectedness and willingness to intervene as an active bystander compared to the control group, through empathy as a mediating pathway.

These results suggest that manipulating empathy using a virtual reality enhanced intervention can positively influence constructs that often protect against a culture of aggression in schools.
The study notes that virtual reality provides a engaging solitary learning experience that allows students to absorb the material without distraction from social dynamics.

Legacy

Harmony Labs was hoping that the model would be replicated however this is the only pilot completed to date. For Harmony Labs, the production process was complicated to orchestrate, as there were many stakeholders. One of the hardest parts was to find a balance between creative freedom and user design focus.

The risk of traumatising or re-traumatising students is important to consider, given that VR is a powerful medium. There are ways to work around that, like not using animation rather than real footage, for instance.

Feedback from participants

One of the directors Mary John Frank speaks about the process: "It was one of the most creative processes that I've personally experienced. I was getting a lot of feedback - it was really helpful to get clear on how what is resonating and what is not, on top of that how do we bring the story into 360 in the most entertainment and effective way and stay on topic with bullying."[7]

Adaora Udoji, who directed the FutureCIRCLES experience said:

"Bullying has found a worthy foe in virtual reality. In VR, we can influence not only how we think, but also how we act, sparking new kinds of learning, discussion and transformation in students and adults."

"What's good about 360 video is that is real, and what's hard about it is that is also real. So the animated approach has some appeal in the sense of customisation of the scenes. But it depends on the resources available"

Harmony Labs

7 VR Action lab trailer https://vimeo.com/246703464

#8
Internal Evaluation and Learnings

Process

VR Action Lab is a complete project with an outstanding approach to design, integrating user centric strategies with testing in a multi-skilled environment.

Integrating the core audience in the design process meant the experiences resonated to young people, therefore achieving the goals of raising empathy and activating bystanders, as shown in the research papers. The challenges highlighted in the design process show that putting together a project of this scope might be difficult to coordinate, as there are many stakeholders involved which generated an important layer of work and coordination. In this case, the expertise brought by Harmony Labs was key to direct the project.

One of the most important elements of the process was the integration with the schools and the administration to be able to roll out the project. Perhaps as noted by Harmony Labs, more resources and time could have been added to this point to be able to achieve greater scale in the roll out of the curriculum integrated in middle schools.

Product and features

The three VR experiences cover different angles of the same topic, which allows users to receive different perspectives. The immersion as part of the 360 video is important however the user always acts as an observer rather than an actor. These experiences form about 50 per cent of the curriculum content, which includes lessons and activities for students to make their own media creation. This reinforces the need to integrate media experiences within the wider classroom context. Providing the experiences integrated in the curriculum gave students the means to achieve the goals of the project. This shows that VR experiences work best when integrated as part of the learning curriculum and not as standalone experiences.

The research documentation papers and toolkits provide a point for scalability, which is open to any organisation. From the Harmony Lab's website all the material can be downloaded for use and it has been offered with a Creative Commons non-commercial open license.

User testing

The process created by Harmony Labs involved a strong focus on user testing. This allowed for the students to offer feedback throughout the process and to create experiences that resonated with the language and the real life situations in schools.

Content & Technology

The content of the films combined actors performing and dancing. It also provided a good base of diversity so could be a good example for future projects. The use of the technology was a challenge, as the medium is not yet established. During the pilots there were bandwidth issues and a need for charging stations. This is a key point to consider for future projects.

The choice of 360 video offered benefits in making the experiences look very realistic, as well as involving real young people as characters.

Scalability

Since the experiences are available to most headsets, the project becomes highly scalable, however the scenes are very contextualised to the USA. The experiences and the curriculum were translated into three other languages, nevertheless. There is no evaluation available of the roll out of the project in other countries, which was undertaken by Google.

For Harmony Labs, one of the most important factors to consider is working with the school administration to be able to test and implement the programmes. They highlight that this would be one of the pillars of any project of a similar shape. For Harmony Labs, it is very important that there is support offered to the schools at several levels including support for teachers, administration and planning.

Effectiveness

Effectiveness was proved during pilots and documented in research papers, with positive results in achieving empathy and behavioural change to motivate young people to become active bystanders during bullying situations.

"Only if there is a confluence between your problem, the technology and distribution mechanisms should you consider using an emerging technology."

Brian, Executive Director Harmony Labs.

Key learnings of relevance

- The design process with a user-centered approach with people and not for people involved in this particular issue (bullying) allowed Harmony Labs to engage more young people in the process and to achieve better results.
- In creating new media experiences, there is a need to consider the right balance between creative autonomy among media makers and user centered design. It is important to factor in time to get everyone on the same page and to manage the process to achieve desired results.
- The integration with the school administration was key to roll out the project, hence it is highly recommended to put this as a priority.
- Collaborating with researchers and experts to generate papers and evidence was important to bring a scientific approach to the project, highlighting the potential of the project as well as to open new pathways for investigation.
- The translation of the experiences into other languages was not enough to engage other countries in integrating this curriculum and approach into their schools. Localisation of the experiences (including video footage and scripts) and resources in other countries' regions would have been needed to roll out the project to other locations.
- Creating a project with publicly available resources might be very beneficial to other organisations interested in the work. This kind of material could be shared by GDPC in a common hub or resource for organisations and practitioners.
- Following the research and testing, VR has proven to be effective in generating empathy and influencing behaviour change in young people.
- The power of VR in simulating real life events should be taken into consideration especially in working with sensitive people as it can recreate trauma. Alternative design methods can be used to overcome this challenge.

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Lifesaver VR

Estela Oliva and Mandy George

Date: Aug 2019

Project name: Lifesaver VR
Project owner: Resuscitation Council (UK)
Release date: 2017
Locale: Worldwide
Languages: English
URL: https://www.resus.org.uk/apps/lifesaver-vr/
XR medium: Smartphone VR
Hazards: Health
Activity: Training
Age group: 12+

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#1
Project Background

Lifesaver VR is an immersive live-action virtual reality (VR) training tool which puts the user into the heart of the action as three young people are faced with a life-or-death situation. By controlling their movements, users make crucial decisions and learn essential CPR life-saving skills.

Lifesaver VR is the latest innovation in the Lifesaver family of educational life-saving apps created by the Resuscitation Council (UK), a professional body set up in 1983 with the primary objective of promoting high-quality, scientific, resuscitation guidelines that are applicable to everybody and to contribute to saving lives through education, training, research and collaboration.

Following the success of the original Lifesaver CPR learning app, which is available for computer, tablet and mobile devices, the Resuscitation Council (UK) joined forces with award-winning production company UNIT9 to develop a new virtual reality version: Lifesaver VR, an innovative new way to learn CPR using immersive technologies. The VR version was written and directed by BAFTA award-winner director Martin Percy and produced by UNIT9. .

The original Lifesaver app was launched in May 2013 and contains three further scenarios, including a choking scenario, as well as one scenario featuring actress Daisy Ridley (Star Wars: Episode VII - The Force Awakens). In September 2017 it was updated to include a brand-new scenario focused on young people which is also a branch of the *Lifesaver VR* virtual reality version.

The project was produced in response to the fact that 30,000 people each year in the UK have an out-of-hospital cardiac arrest[1] where the ambulance services attempt resuscitation - and less than 10 per cent of those people will survive[2]. However if a bystander starts CPR they could double a person's chance of survival[3].

The *Lifesaver* project has received several awards including E-Learning Awards 2013, BAFTA Awards: Nomination, The Webby Awards: People's voice winner, IPA Best of Health Awards: Digital Media GOLD, Digital Media Best of Show and FWA awards Site of the Day.

1 Ambulance Service Association, National Out-of-Hospital Cardiac Arrest Project, 2006
2 2 BHF analysis of OHCA figures
3 https://resus.org.uk/publications/resuscitation-to-recovery/

#2
Aims & Rationale

Lifesaver VR aims to generate awareness about cardiac arrests issues and to teach emergency CPR skills to the wider public, especially to young people.

Specific goals to provoke behaviour change include:

- Call emergency services (911 in USA and 999 in the UK)
- Perform CPR
- Ask for an AED machine (automated external defibrillator)

Why Now?

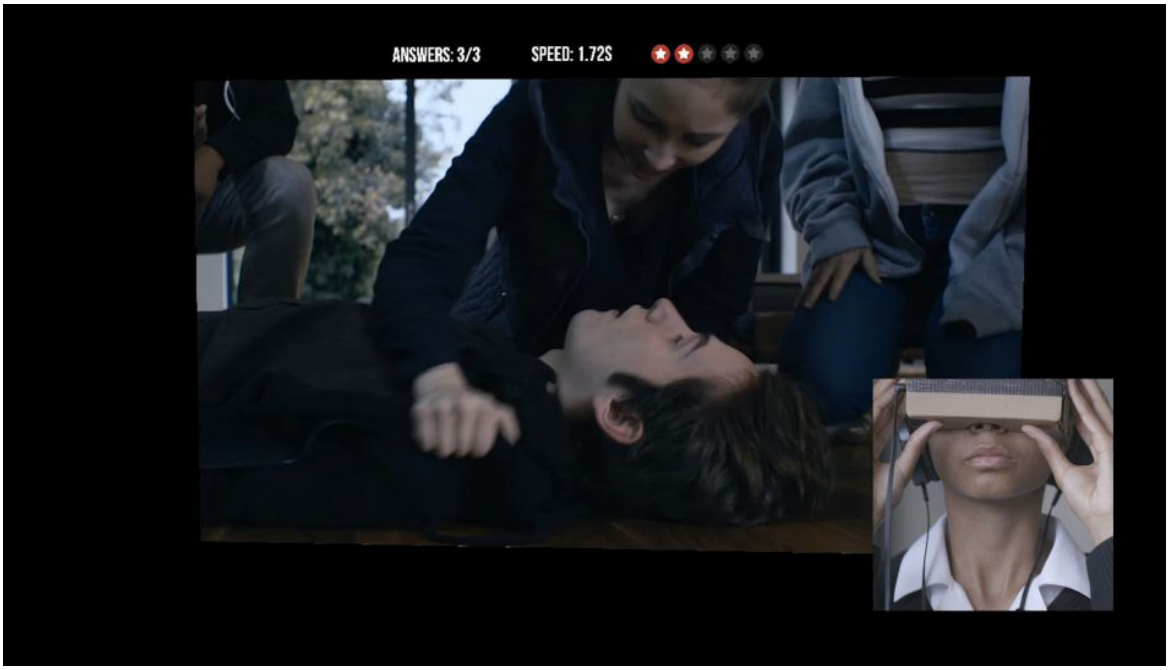
CPR training has remained largely unchanged in the last 50 years. One concern has been the lack of realism that a bystander would experience during a real emergency event. Resuscitation organisations such as the American Heart Association (AHA) have called for innovative solutions using new digital technologies including mobile apps and immersive technologies. The success of the Lifesaver mobile app experience proved the immense benefit of new technologies, and the refreshed virtual reality application provides more user immersion in reality.

#3
Audience

Lifesaver VR is aimed to be suitable for everyone, however it is specifically designed to help young people gain skills and the confidence to use them. The app rating on the Apple App store is +12 years old. This also matches with the standard rating of +13 for VR experiences. However the Google Play store, sets the rating to PEGI 3, this might be because generally AR games are usually classified like this.

The VR scenario is specifically designed to engage young people in life-saving education, and shows teenage characters coming to the rescue when their friend collapses.

The broader target audience is the general public. The Resuscitation Council (UK) believe that by promoting and increasing public awareness of cardiac arrest and the knowledge of how to respond, survival rates will improve.



#4
Experience

The virtual reality experience is presented as a film played like a game. It throws the user into a situation where someone will be dead in ten minutes unless they do the right thing. The user learns by doing. If it is done wrong, the consequences can be seen in the story.

As the app begins the user is requested to take something to push on, like a cushion or a blanket. It is also recommended to use a CPR mannequin if possible. Next, instructions are provided about how to push and a safety warning is presented to advise that VR might cause sickness. The beginning of the story is in VR Cinema mode, which shows a screen inside the virtual world. When the CPR starts, the screen goes into full interactive VR mode along with the headset; or alternatively VR 360 if used without a headset.

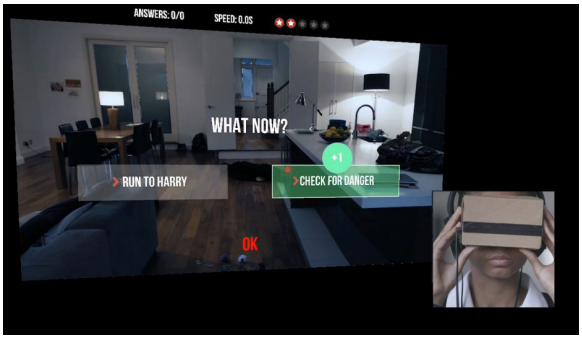
TRAILER: https://youtu.be/QuUavS3WSAI

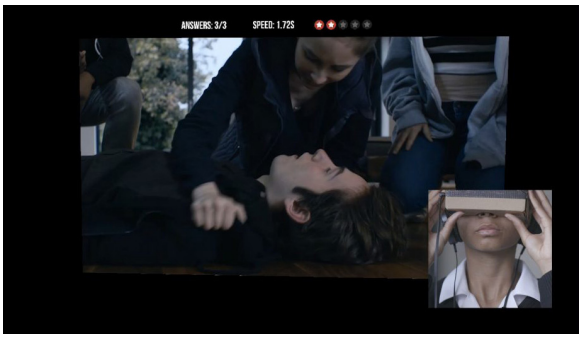
The initial scene depicts three teenage friends playing football in the garden. One of them suddenly feels unwell and goes inside the house. The affected person, Harry, has a cardiac arrest and collapses. His friends realise and go over to attend to him. At this point, the view goes into first person-view and the user becomes one of the characters in the scene. A voice over starts narrating and introduces the gamification features by asking the user to make a choice. This voice continues being the main guide through the rest of the experience. With the clock ticking, the user

has to start making choices about how to help Harry. Each option has two choices and provides a score which can be seen on screen. When you, as the user, start CPR, the camera points down and helps you perform real CPR movements on the chest, combined with breathing interactions. If you have a VR headset, you are invited to take a prop like a cushion to practice the chest compression movements. If you do not have a VR headset you can still go through the training by using your phone and moving it up and down to practice.

The training teaches you to count the chest compression, what rhythm to use and how to apply mouth-to-mouth. In the meantime, it prompts to call the emergency services and interact with them on the phone. After each CPR you get a score from 'Try Harder' to 'Good' or 'Excellent'. If you do not do well, the experience allows you to practice again until the learning goal has been achieved.

Once the emergency services arrive, the experience ends and a final score is provided ranging from 0 to 5 heart badges and verbal feedback is obtained from other characters. Harry is seen coming back to a normal state and the experience ends in a happy mood, with emotive footage of the friends hugging, as you have saved the affected person.





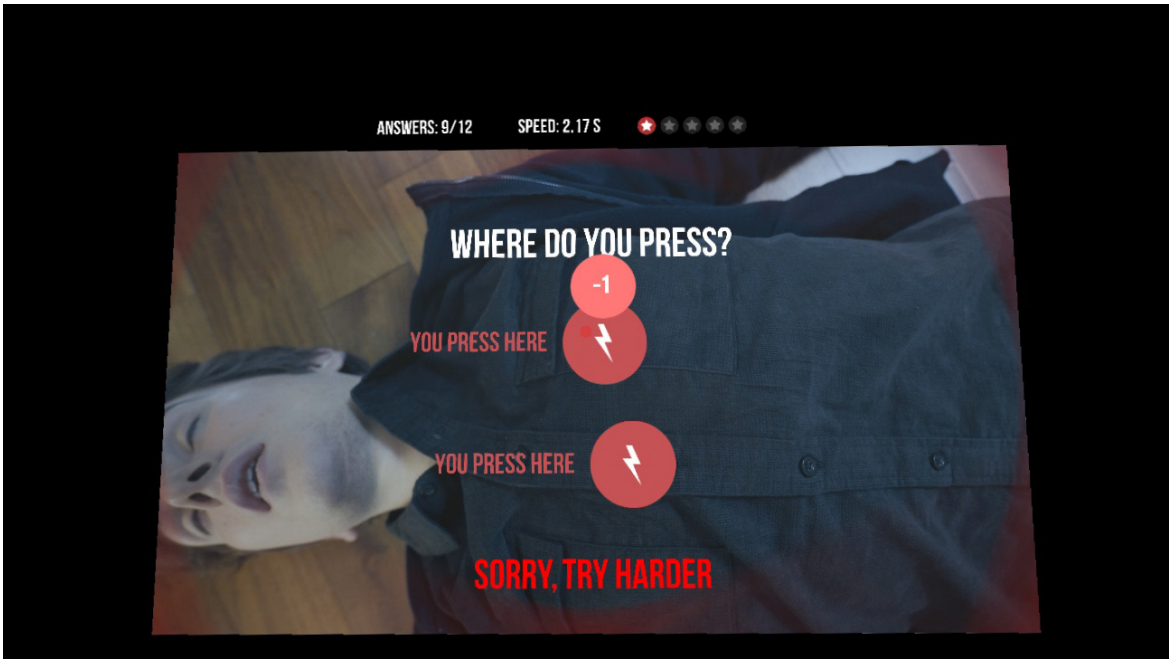
#5
Technology

The VR application integrates a smartphone with a VR headset viewer for a multisensory immersion. To scale this experience to as many people as possible, UNIT9 built it for Google Cardboard running both on iOS and Android devices. The app uses the user's mobile phone accelerometer, a sensor which measures the tilting motion and orientation of a mobile phone. This allows the app to track user movements and give them feedback on how well they are doing CPR to change the film depending on their performance.

The app is quite large and requires at least 1.4GB of free space on iPhone devices.

The app uses interactive gaze functionality to guide the user experience, which allows to make choices and select menus in real time by pointing the eye to a specific point on the screen. The interface is designed with a two choice question and it provides instant feedback on the choice selected. When the choice is correct a +1 green bubble appears, if the choice is incorrect a -1 red bubble shows.

The app is available to be downloaded for free from the Apple and Google Play stores. There is also a branded VR headset available for sale on the Resuscitation Council



(UK) shop for playing Lifesaver VR as well as other virtual reality games. The headset is a branded variation of Google Cardboard headset comes flat-packed and is simple to assemble. It includes foam nose and forehead protectors for comfort, and an adjustable velcro strap makes it suitable for different ages. It can be ordered from the online shop for 11.00 GBP.

#6
Production & Distribution

The production took a total of six months and involved different parties from the Resuscitation Council, UNIT9, paramedics and other contractors. Other parties involved were BAFTA award winning director Martin Percy, who directed the video. There were three clinicians involved in the development and production: RC (UK) Vice-President Dr. Andrew Lockey, RC (UK) Executive Committee member Dr. Jasmeet Soar, and paramedic Mike Smyth. Resuscitation Council contracted UNIT9 to produce Lifesaver. Dr Lockey and Dr Soar worked with Martin Percy (Director) to produce the script and sign off on the clinical accuracy of the content so that it met the UK Guidelines.

The distribution is managed by the Resuscitation Council (UK) via app stores for Apple and Android phones, and is currently available in English language only.

The Resuscitation Council (UK) are currently trying to ensure that the UK Department for Education includes *Lifesaver* in guidance for schools as part of the drive to include CPR in the PSHE curriculum. This piece of work is still in its infancy but they hope to have positive news soon.

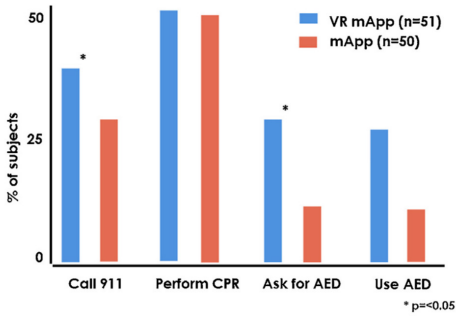
#7
Outcomes and Future Planning

Over a million people have accessed the *Lifesaver* platform (not just the VR app) since it was launched in spring 2013, but there are no stats correlating Lifesaver VR data and therefore number of app downloads is unknown.

Lifesaver is known to have saved a life[4]; 48 hours after playing Lifesaver, Adam Kelly put his recently learned skills into practice and saved the life of a man having an out of hospital cardiac arrest.

There are at least three academic papers related to the *Lifesaver* project, written by different researchers including university academics. In 2017 school Lifesavers study - a randomised controlled trial comparing the impact of Lifesaver only, face-to-face training only, and Lifesaver with face-to-face training on CPR knowledge, skills and attitudes in UK school children - concluded that Lifesaver use combined with face-to-face training leads to improved learning outcomes for several key elements of successful CPR.

Lifesaver VR has had different evaluation and feedback mechanisms. In 2019 a controlled trial of digital CPR training comparing the VR app with the mobile version without VR[5] included 105 subjects enrolled of which 52 took the VR app training and 53 the mobile app training. The results concluded the following:



VR m App Chain of survival response compared with mApp.

- Bystander response: call emergency services, perform CPR, ask for an AED. The percentage of bystanders who responded according the Chain of Survival was significantly higher in the VR app compared to the mobile app. The VR app improved the bystander response metrics for calling 911 and asking for, and using defibrillator, compared with standard video-only mobile app.
- CPR quality: chest compression rate

4 https://www.resus.org.uk/features/community-stories/lifesaver-saving-lives/

5 *Resuscitation. Comparing bystander response to a sudden cardiac arrest using a virtual reality CPR training mobile app versus a standard CPR training mobile app - Paper*

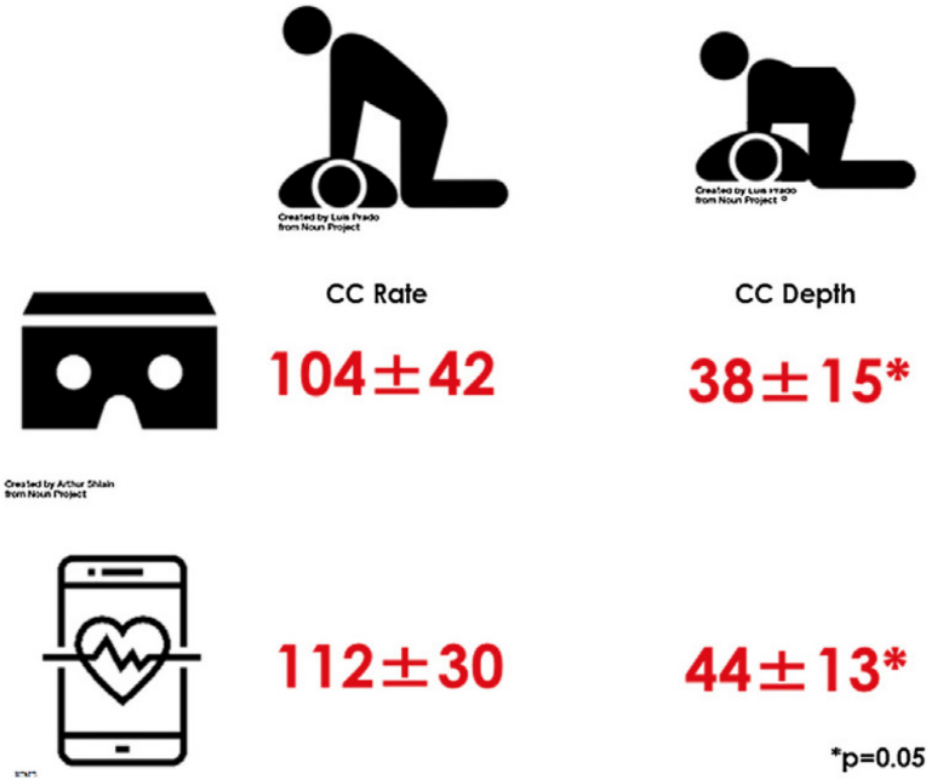
and chest compression (CC) depth. When examining CPR quality, the trial saw that the CC depth was significantly decreased in VR app arm.

In another test, *Lifesaver VR* delivered results, with a selection of schoolchildren, teenagers' confidence in performing CPR increased from 38 per cent to 85 per cent. All those tested said they were more likely or much more likely to perform CPR in a real emergency.[6]

The *Lifesaver* App has a good rating on the Apple Store of 4.9 (7 ratings only). It has one comment which with a positive review, however it claims that the app crashes.

Lifesaver is currently used as a CPR training tool by the South Central Ambulance Service (UK) as part of their paramedic training program, however there is no feedback about the current status.

6 *Unit 9 website projects section* https://www.unit9.com/project/lifesavervr/



CPR Quality based on randomization of VR mApp versus mApp

#8
Internal Evaluation and Learnings

The LifeSaver VR experience is an example of a high quality designed experience integrating storytelling, real film and interactive learning features. The production quality, along with the first person perspective and the gaming features make it a highly effective learning tool for users.

Since the experience is presented from a storytelling angle it engages with the user's emotions, as you feel close to the characters, generating empathy. The voice of the narrator provided also plays an important role to help understand the context and learn the skills while playing. The experience's technical capabilities are innovative and make excellent use of the accelerator features on smartphones to allow people to practice real CPR. The interface is simple yet very effective, providing quick feedback about performance in real time and generating a sense of urgency. The use of eye tracking features to allow users to make choices is easy to use and effective at providing an effective hands-free experience, to allow the user to practice real hands-on CPR. The sound design is very appropriate and it provides an important addition to the visual experience, generating tension and immersion in the scene. Overall Lifesaver VR will give you the feeling that you really have saved someone's life.

Scalability

The choice of using smartphone features to provide a full VR experience is very efficient and allows the app to have a high number of downloads, reaching a wider number of people.
Although the upfront cost of the app was relatively high, the exposure it has had so far has made it a successful case:

"we feel we have achieved rather well with its exposure thus far."

The app is offered for free on the app stores and also provides access to different versions depending on the device available, from immersive VR or 360 video if the headset is not available.

The combination of a free VR experience with an accessible VR viewer, makes the experience highly scalable, however it only is offered in English language.

Top key take-aways:

- Lifesaver use combined with face-to-face training leads to improved learning outcomes for several key elements of successful CPR
- The VR version is successful at providing more skills than mobile application as participants are able to interact and perform real tasks with instant feedback on their performance
- The use of a real life prop adds to the immersive experience
- High engagement is achieved through timed game-style decision-making activities
- Emotional connection is generated through strong storyboarding and scripting and user immersion into the characters
- Provides formative feedback at each decision level, hence contributing to knowledge acquisition
- The sense of emergency that maintains tension until the end makes the experience memorable
- Investing in a high quality app, partnering with renowned agency and director meant that the app got excellent feedback and wide distribution, making it scalable in relation to the cost per user.
- Research papers showing evidence prove the importance of the tool in improving people's skills. These can be used for advocacy as well as to further develop the tool.

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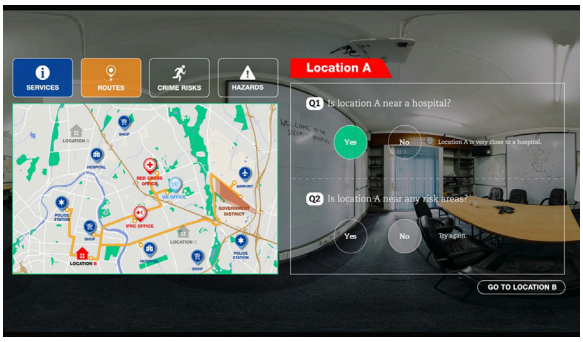
Stay Safe VR

Mandy George and Estela Oliva

Date: Aug 2019

Project name: Stay Safe VR
Project owner: International Federation of Red Cross and Red Crescent Societies (IFRC)
Release date: 2018
Locale: Geneva / Nairobi
Languages: English
URL: https://www.oculus.com/experiences/go/1732706276770632/?locale=en_GB
XR medium: VR with smartphone
Hazards: N/A
Activity: Training
Age group: 3+



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#1
Project Background

Stay Safe VR is a 360 Virtual Reality (VR) training application on a Residential Security Assessment (RSA) that can be purchased through Oculus[1] and Samsung Gear. The app forms part of the International Federation of Red Cross and Red Crescent Societies's (IFRC) global security training programme and is delivered by IFRC as part of a one hour security training package with a classroom component. The training module focuses on a location safety and security assessment set in Nairobi and is intended to support international Red Cross delegates choose accommodation that meets the security regulations. The goal of the app is to provide an immersive 360 degree environment with training exercises for IFRC staff to learn how to conduct an RSA in a realistic location.

Stay Safe VR is the first ever virtual reality learning environment for global security training. The app was commissioned by the IFRC's Security Unit in Geneva and created by Finnish agency Lyfta who specialise in immersive technology for education. The Finnish Red Cross (FRC) provided technical communication support for the filming.

The app was designed in 2017, tested at the end of 2017 and released in January 2018. It was internally launched at the Red Cross General Assembly in October 2017 where it was tested by 300 staff. To date, between 5,000 and 6,000 people have taken the full course. It is publicly available via Oculus and Samsung Gear and can be used by other organisations or individuals looking for interactive security training courses.

1 https://www.oculus.com/experiences/go/1732706276770632/?locale=en_GB

#2
Aims & Rationale

Aim

Stay Safe VR was designed in response to the need to better train staff to effectively conduct an SRA of IFRC premises, thereby enhancing their own safety and enabling the delegation to be minimum safety regulation compliant. The experience has a pedagogical aim and the learning objective is to enhance Red Cross Red Crescent (RCRC) staff capability to conduct an interactive security assessment on RCRC residencies within a VR environment. Stay Safe VR aims to provide staff and security focal points in both IFRC and National Society (NS) offices with a realistic simulation environment while emulating real life scenarios to the fullest extent possible.

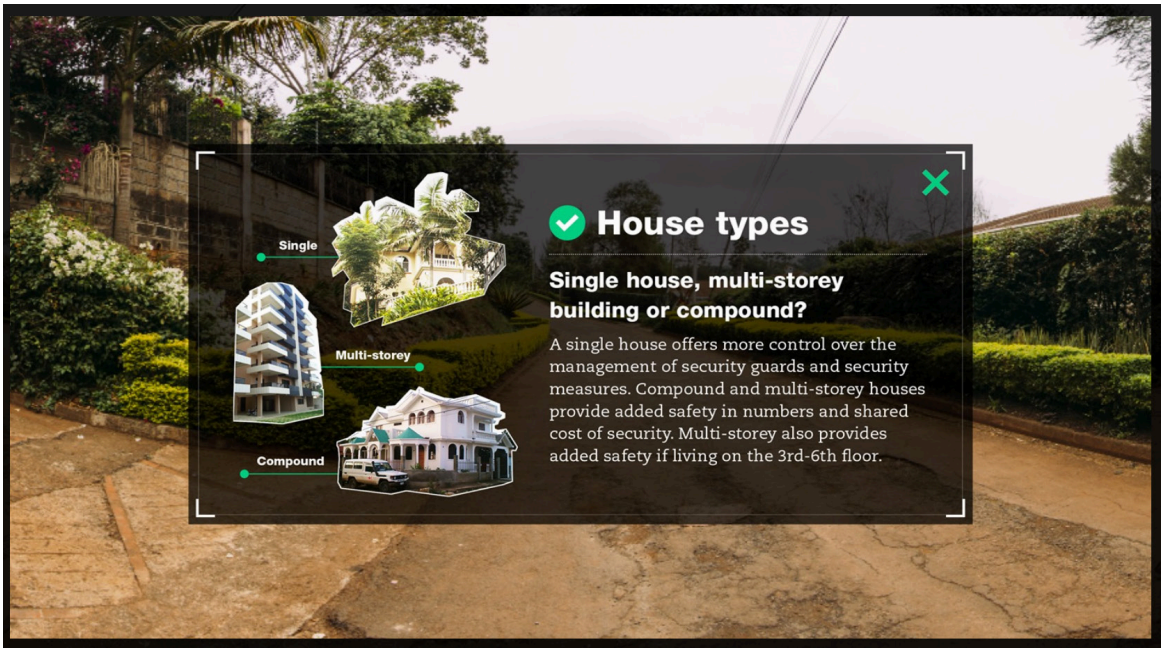
Rationale

Stay Safe VR was created because the current Stay Safe e-learning course of the IFRC - the main tool to train staff and volunteers in security regulations - is out of date in both content and format (Adobe Flash (Action Script), XML, and HTML). As part of the process of updating the online training Stay Safe courses, the Security Unit wanted to look at new forms of technology and how these could complement learning objectives.

In addition to the expiry of the technology, IFRC Security requirements on living premises of staff when deployed overseas changed in 2016 with a revision of housing policy. All IFRC premises must have appropriate security measures in place in accordance with the minimum safety regulations for that particular context and all premises must be approved from a security perspective by the IFRC Head of Country Office. Before 2016, a security risk assessment would be conducted by the IFRC's security focal point, but now this is only the case in non-family duty stations where IFRC provides accommodation. In other duty stations delegates must conduct their own RSA of the premises to be vetted by the organization.

#3
Audience

The primary target audience for *Stay Safe VR* is niche: mostly expat international delegates and IFRC security focal points. IFRC would like to roll the experience out to National Societies in the future. Given that the app is available publicly it can be used by anyone. The target age range according to the Oculus store guidance is PEGI 3+.



#4
Experience

Content description

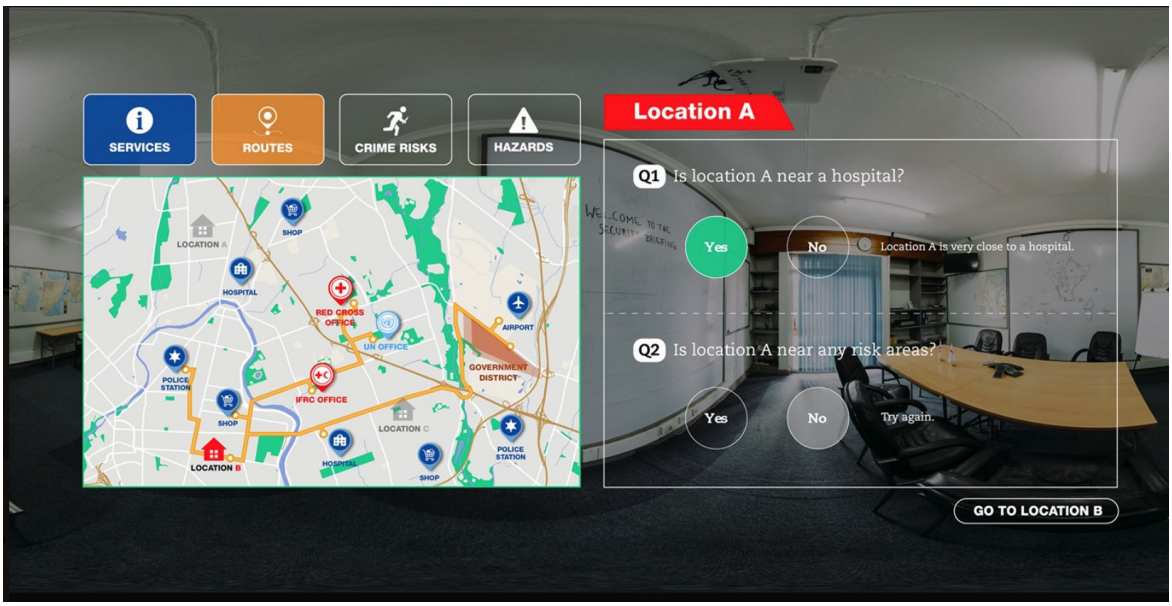
The experience takes place in Nairobi, Kenya. The user is tasked with conducting a risk assessment of a typical IFRC delegate residence. The experience is intended to be used as a one off, but is made so that a user can go in and out of the simulations or go into specific parts that they want to focus on. The security assessment in virtual reality forms part of a one hour training package. The user spends 22 minutes in VR with a 20 minute break approximately half way through.

The simulation consists of two parts:

1. **Introductory video:** This observational 360 video of a neighbourhood in Nairobi was included to give the user is feeling of immersion in the context where the simulation takes place. An area characterized by high crime was chosen. The video lasts approximately one minute.

2. **Training task:** This is the main part of the simulation and is set in a fictitious country. The training task is divided into two parts: 1) in the briefing room and 2) residential spaces.

    1. **The briefing room** (total time 4 minutes): The user is provided with the security risk context and asked to assess the best location of a residential house, based on proximity to the office, key services and considering hazard and crime risk areas



1 in the briefing room

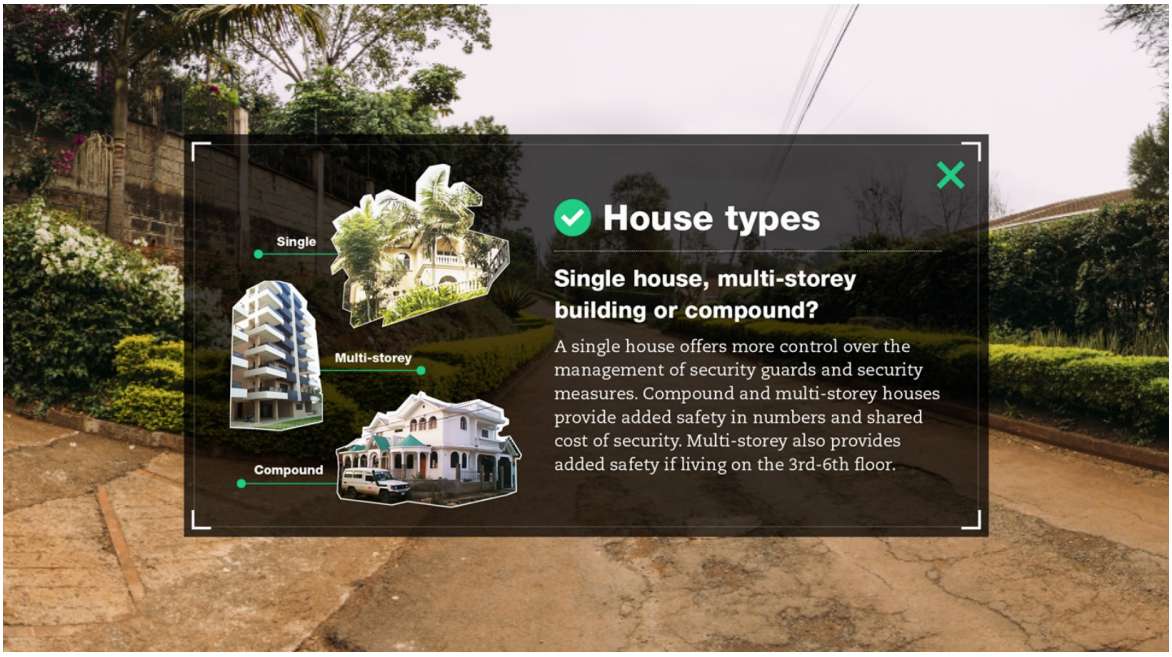
2. **Residential spaces**: The user is taken to the location they have chosen - a typical residential house. They are then tasked with conducting an RSA of the building and neighborhood. This is divided into seven scenes:

    1. Outside perimeter
    2. Driveway
    3. Living room
    4. Kitchen
    5. Bedroom
    6. Garden
    7. Rooftop

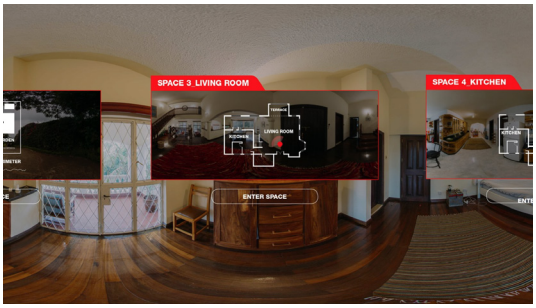
The RSA takes approximately four to five minutes per scene - a total of 28-35 minutes to complete all of the scenes. In each area, the user is asked to identify areas of key security interest or concern, such as perimeter lighting, locking mechanisms of doors/windows, deterrence signs that the residence is guarded by a security company, list of emergency contact numbers, alarm system, electric sockets and wiring, guard equipment. Messages are kept to a minimum.

A typical one hour training session has the following components:

1. **Introductory briefing** (in person) - 5 mins
2. **VR Intro video** (in VR) - 1 min
3. **Training task** (in VR) - 20 mins
4. **Group work** (in person) - 20 mins.
5. **Redo of original residential assessment** (in VR). During this stage certain security related aspects that the learner was able to zoom in on during the first assessment are highlighted to emphasise key learning points - 8 mins.
6. **Wrap up of assessment exercise** (in person, in plenary). The groups need to answer if the property is MSR compliant and give the rationale for their decision. During this group work, the users discuss with the facilitator why they selected certain options and on the broader risk assessment. At the end, the facilitator provides an IFRC residence/office/hotel assessment checklist to participants - 5 mins.



2 residential spaces



Nairobi was chosen for filming because IFRC had resources in-country that could be of assistance during pre-site/residence selection, pre-production support and support/resources available during the filming. However the RSA part of the experience is set in a fictitious country so that all the main learning points could be covered, that would apply to any context. The fictitious country scenario is based around a context where there is no armed conflict, but high crime in certain areas. It is prone to political instability, armed insurgency in neighboring countries which impact negatively on in-country stability. There has been an influx of refugees and the country has experienced economic downturn in recent years and certain natural hazard risks.

The original project proposal considered a home, a warehouse or an office for the RSA, but a home scenario was chosen in the end because of the change in IFRC Housing policy resulting in international staff now arranging their own residential accommodation, as well as the need highlighted for additional training support in this area. It was not possible to cover all sites, but the simulation stresses that a similar process should be conducted when conducting an RSA on other types of sites.

Integration into training module

The 360-degree immersion training is not a stand-alone product, but part of a one hour training module incorporating a classroom in person component to accompany the virtual reality. Exercises, group work, work plans and other supporting documents are used to enhance the learning experience and reinforce key learning points from the simulation.

The virtual reality part of the experience is long (22 minutes according to IFRC, at least 28 according to the GDPC test) and therefore it is essential to break this up into two parts with group work in the middle. The entire training package is structured to further the learning objectives and not act as a stand alone immersion tool. Support materials required for the training module include:

- Stay safe manuals
- Minimum Security Regulations policy
- IFRC Housing policy
- Country/area risk assessment
- Annex 1, residential security assessment checklist

#5
Technology

After reviewing various forms of technology, the IFRC Security team decided to test virtual reality by creating one module that is one small part of the overall Stay Safe course, and then decide if it was an approach that could be expanded to other parts of the course. They decided to start with a residential security assessment after analysing the areas of the course that would be most appropriate for a virtual environment. The project team explored other delivery modalities such as online version used through a tablet or desktop computer and/or using solely 3D imagery. They also discussed producing a fully immersive 3D simulation in partnership with the International Committee of the Red Cross, but decided against this because of the cost of producing a simulation with high quality graphics and the desire for a realistic scenario based on actual video footage.

Although Stay Safe VR uses 360 degree video that has been used extensively for awareness and fundraising campaigns across the sector, the Stay Safe VR team did not want to use 360 video with only observation by the user. They wanted to create an interactive experience and a learning opportunity, building off the video that immerses the user in a realistic environment. Therefore the 360 video setting the scene in Nairobi is only a small portion of the experience.

The *Stay Safe VR* is a virtual reality application designed in Unity that works on Android smartphones. It is available for free on the Oculus store, however the app supports only the Oculus Go and Gear VR headsets, so a compatible headset is required to experience it. The app combines real life footage with a layer of interactive menus which are triggered by fixing the view at menu items. A layer of sound adds to the feeling of immersion to the simulation.

The IFRC Security Team procured 25 headsets and phones (Samsung S7) + Samsung VR Gear that were distributed to all IFRC regional offices.

Within the Red Cross Movement, the virtual reality training is usually delivered by the security focal points in regional offices.

#6
Production & Distribution

Production

Stay Safe VR was a collaboration between the IFRC, the Finnish Red Cross and Finnish agency Lyfta. The production process took nine months. Finnish Red Cross provided the audio/visual hardware/software needed for all phases of the project (pre-production, filming and post production in Nairobi) and coordinated with Lyfta. Lyfta advised on the technical specifications of VR equipment needed and preferred and built the simulation, based on the script provided by IFRC. Lyfta specialises in educational training, have worked on humanitarian projects in schools in the past, and brought a strong pedagogical approach to the production.

IFRC led on the film script, in close collaboration with FRC and Lyfta. IFRC pre-identified a suitable residence to be filmed with support of IFRC Nairobi security team. IFRC identified and provided a suitable classroom to film the risk assessment briefing and arranged in-country logistical support at the time of filming.

Stay Safe VR was tested at the Red Cross Movement's General Assembly in 2017 in Turkey, where 500 people tried it over the four day event. Most feedback to date has been face to face, after the training session is delivered, and built into the course evaluation session at the end..

Distribution

Stay Safe VR has not yet been rolled out at scale, although it is already publicly available on the Oculus website. To date distribution has consisted of:

1. Testing at the General Assembly
2. IFRC has started to integrate it into the Security Training Unit's trainings conducted in Geneva
3. IFRC Geneva Security Unit team has distributed 6 or 7 headsets and phones to all of their regional offices (Aftica, Asia Pacific, MENA, Americas).

Stay Safe VR will be rolled out at scale across the Movement once the e-learning modules have been updated (see future planning section).

Challenges

Challenges in the production of Stay Safe VR included:

- Filming in Nairobi: for example securing permission to use drones, or film in certain areas.
- Equipment: the equipment needs to be loaned to National Societies if they are to use it, as they rarely have the equipment themselves, or have this as a priority.
- Production time and resources: The people involved had to work on this project on top of a full time job and it took much more time than expected, particularly ensuring the script was correct.

#7
Outcomes and Future Planning

Key learnings

Some key learnings and insights highlighted by the IFRC Security Unit:

- Stay Safe VR has been well received by those who have been through the course so far
- The production team learnt a lot about methods of delivery for e-learning courses in general as part of deciding which technology to use. This learning has been useful in the broader process of updating the e-learning Stay Safe Course
- Feedback should be collected more systematically
- More time should be planned in for the production process - it was much more time consuming than they had planned for, between the preparation, script writing and filming.
- Should have had a more structured production process.
- Not as good value for money as the e-learning courses. Stay Safe e-learning cost 300K USD for approximately 200K users, which works out at approximately 1.2 USD per user. The virtual reality equivalent is more like 8-10 USD pp to date.
- Overall more expensive and not as scalable.

User feedback online

The app has been rated with three stars out of five on the Oculus site, out of 14 ratings.

Future plans

Future plans for *Stay Safe VR* are tied to the roll out of the updated Stay Safe e-learning course, that will be completed by the end of 2019. The virtual reality training module will be rolled out and publicised much more widely at the same time as the broader course. The IFRC team will also roll it out to National Societies, as far as the limited number of headsets will allow.

The new e-learning course, being produced with agency Sweet Rush, will include be more interactive than the current version, with gaming features included, building on the latest in e-learning. The IFRC team is also considering turning Stay Safe VR into a desktop version with the same decision making features, that is less immersive but able to reach more people, given the technological restrictions that VR poses.

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Internal Evaluation and Learnings

Process

The design and production process used a combination of internal Red Cross expertise on both the technical area required (Security, IFRC) and AV (Finnish Red Cross communications team) and external digital and educational expertise. This combination brought a strong pedagogical approach but also capitalised on internal expertise.

The content was led by technical security experts and aligned with the security requirements of IFRC. The experience is easy to use, and the user can dip in and out easily if the entire training course is too long or there are motion sickness issues. Some motion sickness was reported in users but this is kept to a minimum as the user is not required to move around extensively in the simulation, but rather select items from menus through a pointer from the headset.

The production process worked well in terms of coordinating among the different parties, but was reported to be time consuming and the amount of time needed, particularly for the script writing and filming, was underestimated. The primary focal point in the IFRC is also the head of security with a demanding full-time job. The process would have benefitted from a focal point with dedicated time allocated to the script writing process. The use of internal resources did however keep production costs lower.

Lyfta managed the user testing process, and this was not conducted on Red Cross staff or volunteers as far as is known, until it was piloted at the General Assembly in October 2017.

Product and features

The combination of real life footage plus interactive menus places the user in a learning environment but with a sense of immersion in a real-life context that they might find themselves living in and conducting a security residential assessment in. This immersion adds a sense of reality to the experience that cannot be achieved in the e-learning desktop experience.

The content is full of decision making opportunities, as the user conducts the assessment and decides if a residence is safe to live in or not. Feedback is given to the user both in the virtual experience, and then in person if they are taking part in the full one hour training course - in the middle and at the end of the experience. During the second half of the simulation, the user is given more feedback on their choices. The app does not incorporate any behavioural analysis.

The developers at Lyfta will be responsible for updating and improving the app. The fact that this is not in-house and will require more budget could become a hurdle to the updating process.

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The content of Stay Safe VR is based on specific security protocol of the IFRC and on training materials that were already developed. This made the content design process easier, with the main challenge being the selection of what part of the Stay Safe content would be most suited for virtual reality. The team was ambitious to create a 28+ minute simulation - Stay Safe VR is longer than most VR experiences are recommended to be and therefore the menu that allows the user to re-enter specific scenes is particularly important. They also made sure to keep the messages to a minimum so that the user can understand the process and not have the simulation as a stand alone experience.

It is unlikely that young people would use the app, but if they do download it there is no major concern about the content, as most of it is a training module inside the house. The outdoor scene in an insecure part of Nairobi does not show any direct violence or disturbing scenes.

Scalability

The content filmed of a house in Nairobi looks similar to many typical residential locations that IFRC delegates would live in globally, and is therefore scalable across the Red Cross Movement as an illustrative residential example despite only detecting one location.

However overall *Stay Safe VR* is not as scalable as the e-learning course equivalent, given that the majority of delegates will not have the equipment. The regional offices supplied with headsets can use them in training, but only if the one hour training package is rolled out globally. At time of writing, the experience has not been widely rolled out and individual country delegations do not have the equipment, so either delegates would have to have regional office briefings that include the VR component, or conduct the e-learning module instead.

At time of writing, approximately 5.5k people have been trained with the VR experience, and over 200k on the Stay Safe e-learning.

In addition, *Stay Safe VR* is only available in English. The IFRC has four official working languages, so this will be a hurdle to global roll out. At the time of writing there was no plan to translate the app into other languages.

Effectiveness

The owners of Stay Safe VR have yet to roll it out across the Movement at scale, however they are questioning the cost effectiveness of a training method that it not accessible to all without the headsets, and that will always be a more niche market than the revamped e-learning courses. The reality is that most people taking the security training courses before deployments do so in their own time, from the office or from home, and a desktop/laptop setting is more likely to be used, and much more scalable. It is questionable how much value virtual reality adds to the learning outcomes.

Key Learnings

Stay Safe VR is very effective at immersing the user in a realistic situation and adds much value to the process of RSA training required of all IFRC delegates. It has been a positive experience for IFRC to take a new, innovative approach to training. However in the case of Stay Safe VR, this does not offer a scalable option for training globally, unless it is accompanied by a more robust roll out. Even then, for a training course that most delegates do in their home before or at the start of deployment and not as part of a training package, it is questionable whether virtual reality is the most effective method.

Key learnings include:

- Production time and resources:
  - There is a need to plan sufficient time for script writing and liaising between client and agency
  - Dedicate a focal point with time in their job description for managing the production process and agency liaison
- Virtual reality does not fit every training need and there needs to be a clear advantage for selecting this technology, that is not yet as scalable as other approaches
- It is difficult to fit an e-learning course into a virtual reality experience. It is essential to choose a small part, with a small selection of key messages, and mainstream into a broader learning curriculum
- VR with 360 video of real locations adds a level of immersion that increases the quality of the learning experience.

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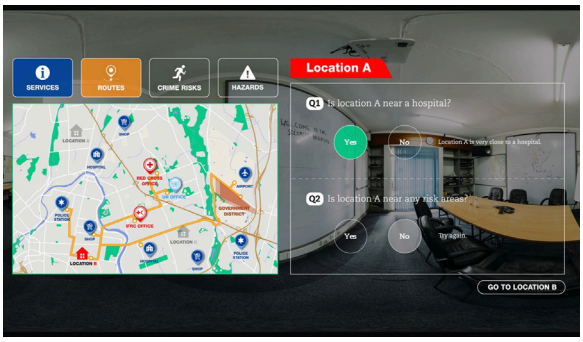
Stay Safe VR

Mandy George and Estela Oliva

Date: Aug 2019

Project name: Stay Safe VR
Project owner: International Federation of Red Cross and Red Crescent Societies (IFRC)
Release date: 2018
Locale: Geneva / Nairobi
Languages: English
URL: https://www.oculus.com/experiences/go/1732706276770632/?locale=en_GB
XR medium: VR with smartphone
Hazards: N/A
Activity: Training
Age group: 3+



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#1
Project Background

Stay Safe VR is a 360 Virtual Reality (VR) training application on a Residential Security Assessment (RSA) that can be purchased through Oculus[1] and Samsung Gear. The app forms part of the International Federation of Red Cross and Red Crescent Societies's (IFRC) global security training programme and is delivered by IFRC as part of a one hour security training package with a classroom component. The training module focuses on a location safety and security assessment set in Nairobi and is intended to support international Red Cross delegates choose accommodation that meets the security regulations. The goal of the app is to provide an immersive 360 degree environment with training exercises for IFRC staff to learn how to conduct an RSA in a realistic location.

Stay Safe VR is the first ever virtual reality learning environment for global security training. The app was commissioned by the IFRC's Security Unit in Geneva and created by Finnish agency Lyfta who specialise in immersive technology for education. The Finnish Red Cross (FRC) provided technical communication support for the filming.

The app was designed in 2017, tested at the end of 2017 and released in January 2018. It was internally launched at the Red Cross General Assembly in October 2017 where it was tested by 300 staff. To date, between 5,000 and 6,000 people have taken the full course. It is publicly available via Oculus and Samsung Gear and can be used by other organisations or individuals looking for interactive security training courses.

1 https://www.oculus.com/experiences/go/1732706276770632/?locale=en_GB

#2
Aims & Rationale

Aim

Stay Safe VR was designed in response to the need to better train staff to effectively conduct an SRA of IFRC premises, thereby enhancing their own safety and enabling the delegation to be minimum safety regulation compliant. The experience has a pedagogical aim and the learning objective is to enhance Red Cross Red Crescent (RCRC) staff capability to conduct an interactive security assessment on RCRC residencies within a VR environment. Stay Safe VR aims to provide staff and security focal points in both IFRC and National Society (NS) offices with a realistic simulation environment while emulating real life scenarios to the fullest extent possible.

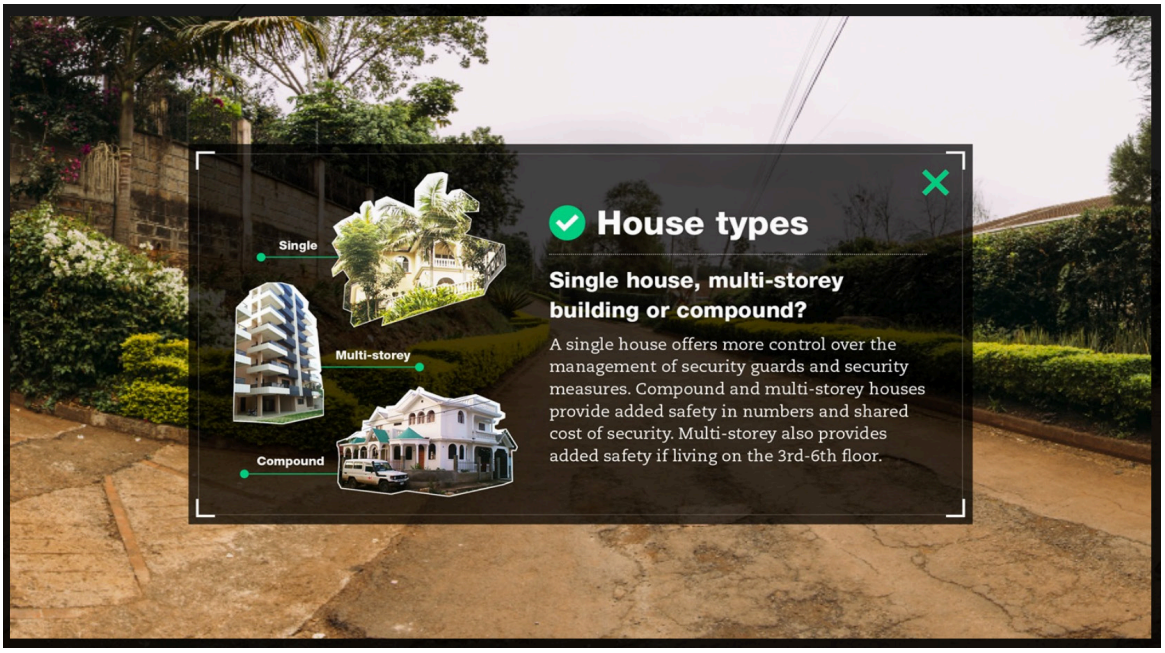
Rationale

Stay Safe VR was created because the current Stay Safe e-learning course of the IFRC - the main tool to train staff and volunteers in security regulations - is out of date in both content and format (Adobe Flash (Action Script), XML, and HTML). As part of the process of updating the online training Stay Safe courses, the Security Unit wanted to look at new forms of technology and how these could complement learning objectives.

In addition to the expiry of the technology, IFRC Security requirements on living premises of staff when deployed overseas changed in 2016 with a revision of housing policy. All IFRC premises must have appropriate security measures in place in accordance with the minimum safety regulations for that particular context and all premises must be approved from a security perspective by the IFRC Head of Country Office. Before 2016, a security risk assessment would be conducted by the IFRC's security focal point, but now this is only the case in non-family duty stations where IFRC provides accommodation. In other duty stations delegates must conduct their own RSA of the premises to be vetted by the organization.

#3
Audience

The primary target audience for *Stay Safe VR* is niche: mostly expat international delegates and IFRC security focal points. IFRC would like to roll the experience out to National Societies in the future. Given that the app is available publicly it can be used by anyone. The target age range according to the Oculus store guidance is PEGI 3+.



#4
Experience

Content description

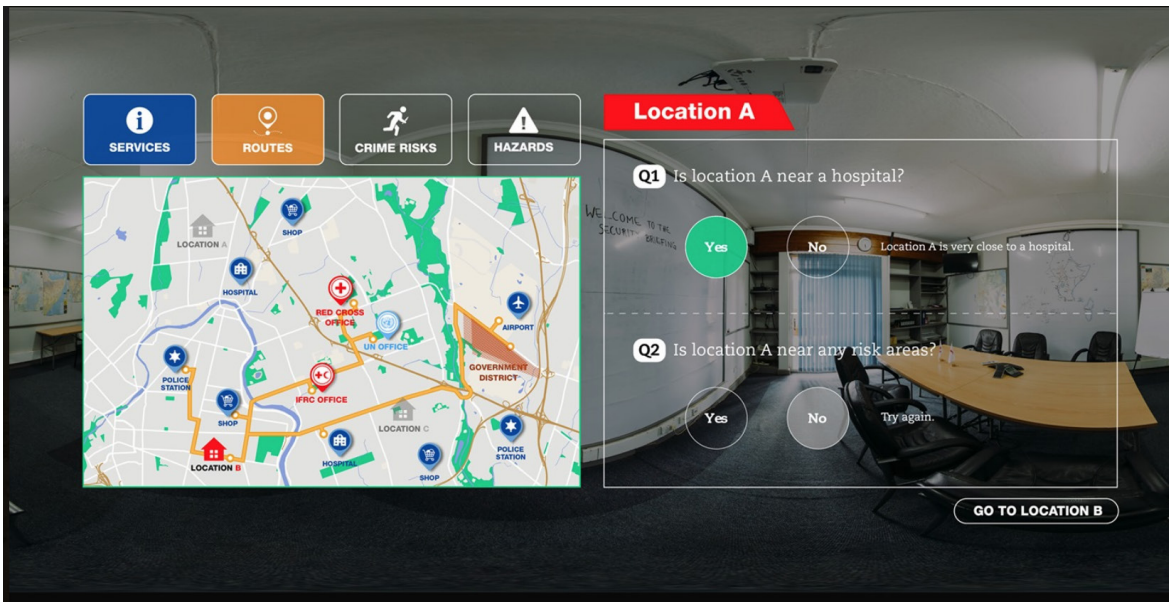
The experience takes place in Nairobi, Kenya. The user is tasked with conducting a risk assessment of a typical IFRC delegate residence. The experience is intended to be used as a one off, but is made so that a user can go in and out of the simulations or go into specific parts that they want to focus on. The security assessment in virtual reality forms part of a one hour training package. The user spends 22 minutes in VR with a 20 minute break approximately half way through.

The simulation consists of two parts:

1. **Introductory video:** This observational 360 video of a neighbourhood in Nairobi was included to give the user is feeling of immersion in the context where the simulation takes place. An area characterized by high crime was chosen. The video lasts approximately one minute.

2. **Training task:** This is the main part of the simulation and is set in a fictitious country. The training task is divided into two parts: 1) in the briefing room and 2) residential spaces.

    1. **The briefing room** (total time 4 minutes): The user is provided with the security risk context and asked to assess the best location of a residential house, based on proximity to the office, key services and considering hazard and crime risk areas



1 in the briefing room

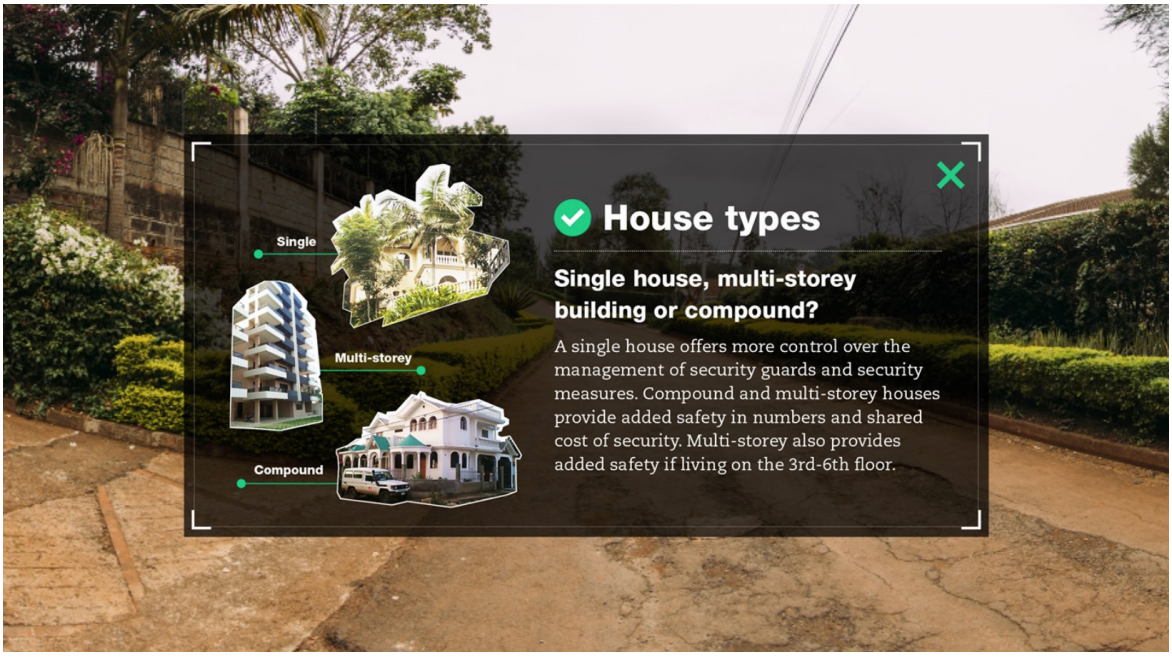
2. **Residential spaces**: The user is taken to the location they have chosen - a typical residential house. They are then tasked with conducting an RSA of the building and neighborhood. This is divided into seven scenes:

    1. Outside perimeter
    2. Driveway
    3. Living room
    4. Kitchen
    5. Bedroom
    6. Garden
    7. Rooftop

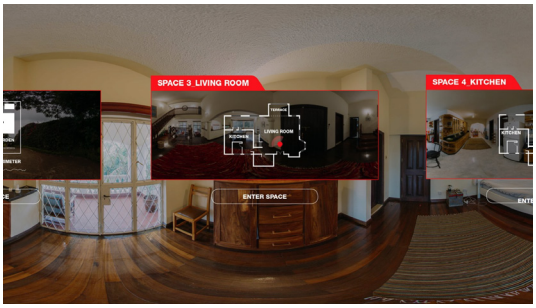
The RSA takes approximately four to five minutes per scene - a total of 28-35 minutes to complete all of the scenes. In each area, the user is asked to identify areas of key security interest or concern, such as perimeter lighting, locking mechanisms of doors/windows, deterrence signs that the residence is guarded by a security company, list of emergency contact numbers, alarm system, electric sockets and wiring, guard equipment. Messages are kept to a minimum.

A typical one hour training session has the following components:

1. **Introductory briefing** (in person) - 5 mins
2. **VR Intro video** (in VR) - 1 min
3. **Training task** (in VR) - 20 mins
4. **Group work** (in person) - 20 mins.
5. **Redo of original residential assessment** (in VR). During this stage certain security related aspects that the learner was able to zoom in on during the first assessment are highlighted to emphasise key learning points - 8 mins.
6. **Wrap up of assessment exercise** (in person, in plenary). The groups need to answer if the property is MSR compliant and give the rationale for their decision. During this group work, the users discuss with the facilitator why they selected certain options and on the broader risk assessment. At the end, the facilitator provides an IFRC residence/office/hotel assessment checklist to participants - 5 mins.



2 residential spaces



Nairobi was chosen for filming because IFRC had resources in-country that could be of assistance during pre-site/residence selection, pre-production support and support/resources available during the filming. However the RSA part of the experience is set in a fictitious country so that all the main learning points could be covered, that would apply to any context. The fictitious country scenario is based around a context where there is no armed conflict, but high crime in certain areas. It is prone to political instability, armed insurgency in neighboring countries which impact negatively on in-country stability. There has been an influx of refugees and the country has experienced economic downturn in recent years and certain natural hazard risks.

The original project proposal considered a home, a warehouse or an office for the RSA, but a home scenario was chosen in the end because of the change in IFRC Housing policy resulting in international staff now arranging their own residential accommodation, as well as the need highlighted for additional training support in this area. It was not possible to cover all sites, but the simulation stresses that a similar process should be conducted when conducting an RSA on other types of sites.

Integration into training module

The 360-degree immersion training is not a stand-alone product, but part of a one hour training module incorporating a classroom in person component to accompany the virtual reality. Exercises, group work, work plans and other supporting documents are used to enhance the learning experience and reinforce key learning points from the simulation.

The virtual reality part of the experience is long (22 minutes according to IFRC, at least 28 according to the GDPC test) and therefore it is essential to break this up into two parts with group work in the middle. The entire training package is structured to further the learning objectives and not act as a stand alone immersion tool. Support materials required for the training module include:

- Stay safe manuals
- Minimum Security Regulations policy
- IFRC Housing policy
- Country/area risk assessment
- Annex 1, residential security assessment checklist

#5
Technology

After reviewing various forms of technology, the IFRC Security team decided to test virtual reality by creating one module that is one small part of the overall Stay Safe course, and then decide if it was an approach that could be expanded to other parts of the course. They decided to start with a residential security assessment after analysing the areas of the course that would be most appropriate for a virtual environment. The project team explored other delivery modalities such as online version used through a tablet or desktop computer and/or using solely 3D imagery. They also discussed producing a fully immersive 3D simulation in partnership with the International Committee of the Red Cross, but decided against this because of the cost of producing a simulation with high quality graphics and the desire for a realistic scenario based on actual video footage.

Although Stay Safe VR uses 360 degree video that has been used extensively for awareness and fundraising campaigns across the sector, the Stay Safe VR team did not want to use 360 video with only observation by the user. They wanted to create an interactive experience and a learning opportunity, building off the video that immerses the user in a realistic environment. Therefore the 360 video setting the scene in Nairobi is only a small portion of the experience.

The *Stay Safe VR* is a virtual reality application designed in Unity that works on Android smartphones. It is available for free on the Oculus store, however the app supports only the Oculus Go and Gear VR headsets, so a compatible headset is required to experience it. The app combines real life footage with a layer of interactive menus which are triggered by fixing the view at menu items. A layer of sound adds to the feeling of immersion to the simulation.

The IFRC Security Team procured 25 headsets and phones (Samsung S7) + Samsung VR Gear that were distributed to all IFRC regional offices.

Within the Red Cross Movement, the virtual reality training is usually delivered by the security focal points in regional offices.

#6
Production & Distribution

Production

Stay Safe VR was a collaboration between the IFRC, the Finnish Red Cross and Finnish agency Lyfta. The production process took nine months. Finnish Red Cross provided the audio/visual hardware/software needed for all phases of the project (pre-production, filming and post production in Nairobi) and coordinated with Lyfta. Lyfta advised on the technical specifications of VR equipment needed and preferred and built the simulation, based on the script provided by IFRC. Lyfta specialises in educational training, have worked on humanitarian projects in schools in the past, and brought a strong pedagogical approach to the production.

IFRC led on the film script, in close collaboration with FRC and Lyfta. IFRC pre-identified a suitable residence to be filmed with support of IFRC Nairobi security team. IFRC identified and provided a suitable classroom to film the risk assessment briefing and arranged in-country logistical support at the time of filming.

Stay Safe VR was tested at the Red Cross Movement's General Assembly in 2017 in Turkey, where 500 people tried it over the four day event. Most feedback to date has been face to face, after the training session is delivered, and built into the course evaluation session at the end..

Distribution

Stay Safe VR has not yet been rolled out at scale, although it is already publicly available on the Oculus website. To date distribution has consisted of:

1. Testing at the General Assembly
2. IFRC has started to integrate it into the Security Training Unit's trainings conducted in Geneva
3. IFRC Geneva Security Unit team has distributed 6 or 7 headsets and phones to all of their regional offices (Aftica, Asia Pacific, MENA, Americas).

Stay Safe VR will be rolled out at scale across the Movement once the e-learning modules have been updated (see future planning section).

Challenges

Challenges in the production of Stay Safe VR included:

- Filming in Nairobi: for example securing permission to use drones, or film in certain areas.
- Equipment: the equipment needs to be loaned to National Societies if they are to use it, as they rarely have the equipment themselves, or have this as a priority.
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USA

Philippines Disaster Preparedness Simulator

Mandy George and Estela Oliva

Date: Aug 2019

Project name: Disaster Preparedness Simulator
Project owner: Ania Design Lab
Release date: 2019
Locale: Philippines
URL: https://www.facebook.com/aniadesignlab/
XR medium: VR with smartphone
Hazards: Earthquake, typhoon, flood
Activity: Disaster drills and evacuations
Age group: 12+

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#1
Project Background

The *Disaster Preparedness Simulator* is a virtual reality (VR) integrated disaster preparedness learning experience where users are immersed in disaster scenarios in a controlled environment. It has three experiences of different hazards - earthquake, flood and typhoon - and is specifically targeted at children as an integrated part of their disaster preparedness education in schools. It can also be used as a game to test disaster response knowledge.

The goal of the simulator, built in the Philippines specifically for the local context, is to enhance the disaster preparedness learning curriculum by using innovative learning platforms integrating reasoning and empathy in decision making. A pilot of the project has been rolled out, targeting eight secondary schools in rural communities up to 15 hours drive from Manila's city centre. The simulations were designed using a highly participatory approach involving schools and local government. The design is fully localised to the Philippines context.
The simulator was created by Ania Design Lab, a Filipino startup and learning innovation company that designs, develops, and delivers solutions working towards their vision of an educated Philippines. The project was funded by the Tuklas Innovation Lab, a Philippines startup implemented by a consortium of NGOs and funded by UK Aid, the Start Network, and the CDAC[1] Network. Ania Design Lab is currently looking for further funding to scale up the project, building on the results of the pilot that worked towards understanding how to implement low-cost learning innovation technologies in the classroom.

1 Communicating with Disaster Affected Communities

Typhoon Scenario Environment Prototype, Screenshot

#2
Aims & Rationale

The aim of the experience is to learn decision making skills linked to the most common hazards and to increase knowledge about the hazards.

In their initial research, the Ania team found that the current practices of disaster preparedness education in the Philippines - for example disaster drills - are lacking in certain key features for effective learning in content delivery, including:

- Students do not get to make decisions during a disaster simulations
- Drill scenarios are predetermined when role playing
- Students do not get to experience the full effects of the choices they make because many drills are not realistic
- Simulation drills rarely consider the various potential outcomes of a disaster and how decisions taken in response affect outcomes, as there is no practical way to do so in the current method of content delivery

In addition, when consulting teachers, the Ania team found that the education community was looking for something new that would allow them to employ more creative teaching methods around disaster preparedness and avoid repetitive content delivery. This coincided with a radical change in the Philippines educational system and a new K-to-12[2] curriculum implemented by the Department of Education that has opened up many opportunities for stakeholders involved to improve and innovate. Working together with schools to innovate in the education space was timely and of benefit to students, teachers and the Department of Education.

The above gaps of the current education system and capitalising on the recent changes in the education system led to the development of a virtual reality simulation through which a number of these shortcomings can be addressed. Key to this approach is the simulation of multiple possibilities linked to user decision making.

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K-12 students are the primary audience. Ania have targeted various age groups, but focus on grades 6 - 12 because at this age the students have disaster preparedness and risk management in their curriculum.

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Key design considerations

The two top simulation design considerations of the Ania Design Lab team were to:

- Use a problem based learning approach, that would add value to the current disaster preparedness practices in schools, normally done by drills or seminars, that do not use problem-based learning to the same extent
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The disaster preparedness simulator VR experience is highly focused on helping students' decision making skills in disasters, understanding the consequences of their actions and that different situations require different choices. As such, the three simulations have branching storylines that reflect different choice and decision options.

There are three virtual reality scenarios:

1. **Earthquake in a school**
2. **Flooding in a house**
3. **Typhoon in a barangay**[3]

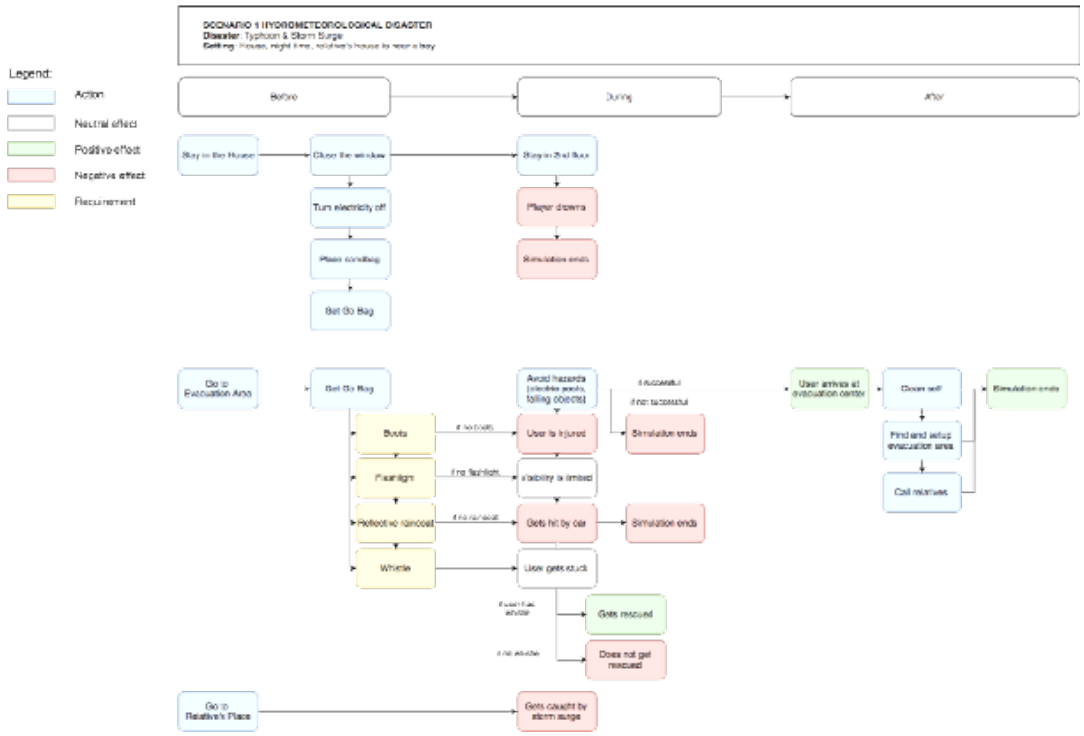
These disaster scenarios were selected based on the most common hazards in the Philippines. The design of the school for the earthquake simulation used actual school floor plans from a typical school. The house was built on a list of common themes identified in the co-design process and was redesigned during the pilot following user feedback in order to be more realistic.

The two hydrometeorological scenarios are divided into three parts - before, during, and after the disaster. Each part contains different precautionary measures taken from the Philippines' National Disaster Readiness and Risk Management (DRRM) manual and curriculum under K-to-12 program of the Department of Education. The earthquake simulation contains two parts - during and after - and is also aligned with national response protocol. The aim when playing is for the user to survive the disaster through the decisions they make along the way.

Detailed storyboards and decision pathways were designed for the simulations, that show how each precautionary measure taken in the simulation leads to a specific consequence and level of risk. For example, if the user in the typhoon simulation chooses to leave their home and go to a relative's house, they get caught by the storm surge and the game ends.

3 A barangay is the smallest administrative division in the Philippines and is the native Filipino term for a village, district or ward

Example scenario and decision matrix for typhoon and storm surge at home:



Example storyboard for earthquake scenario in a school:

Setup: The scenario is a school area. The starting point is inside the classroom on the second floor of the building.

Action	Narrative / Context	Outcome
BEFORE: Inside the classroom before the earthquake. AUDIO FILE. PROLOGUE: "Magandang umaga mga mag-aaral. Ngayong umaga para sa ating DRRM Class, ay ating pag-uusapan ang paghahanda para sa lindol. Sa panimula, maari nating tidnan ang mga "hazards" na makita natin sa ating silid-aralan at paligid ng ating paaralan".		
Check surroundings	Ceiling fan	1. User will see that some are not working 2. User will see that some are not in stable/good condition
	Tables and chairs	User will see that some tables and chairs are damaged
	Cabinets	Users will see the books, hardhats, whistle, go bag
DURING: Shaking starts. AUDIO FILE. Add music and earthquake intermittent sound alarm.		
Stay in the classroom	User chooses to not go outside the room	AUDIO FILE
Put book on top of head	User finds a book and clicks Use Book button	Book disappears from player view and is placed on top of the user AUDIO FILE
Wear hard hat	User finds a book and clicks Use Hard Hat button	Hard hat disappears from player view and is placed on top of the user AUDIO FILE
Stay under Student's Table	User chooses a table and clicks Go Under button	Animation of the player under the student's table and walking is disabled AUDIO FILE
Stay under Teacher's Table	User chooses the teacher's table and clicks Go Under button	Animation of the player under the teacher's table and walking is disabled AUDIO FILE
Get go bag	User finds and clicks Get Go Bag button	Go Bag disappears from player view AUDIO FILE

Action	Narrative / Context	Outcome
Go to another room	User chooses to leave the room and enter another room	Some falling debris hits user
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	If user gets hit by falling objects	User gets injured
Gets trapped	This applies only if the user goes to another room during the earthquake	Gets stuck inside the classroom
Use whistle	This will only be available to the user if he gets the go bag. User clicks Use whistle button	Whistle sound
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Ania Design Lab aims to make the Disaster Preparedness Simulator a complete learning experience and not a standalone tool. Therefore the virtual reality simulations are designed to supplement the Disaster Readiness and Risk Management modules of the Philippine basic education curriculum.

The learning package consists of three stages:

4. **Briefing**
5. **Simulation**
6. **Debriefing and feedback**

The briefing stage introduces the Disaster Preparedness Simulator learning experience to the users and tells them what to expect during the simulation process, instructs them on how to use the system, and explains the health and safety hazards involved with system use. Users go through a screening process for any health and safety issues and anyone categorised as unfit to use the simulation are identified and given an explanation.

The simulation stage involves allowing users to use the simulator individually. Instructors monitor users closely to avoid potential harm. The average duration is five minutes per user per scenario. The Ania Design Lab team recommends that one teacher supervise up to four users simultaneously. After the simulation module, users are assessed for any mental or physical impacts, such as motion sickness or negative psychological impacts from the scenarios.

The debriefing stage has two aims. Firstly, to disseminate further information on hazards and disaster preparedness, including IEC materials. Secondly, to assess, discuss and provide feedback to users on their performance in the simulation and issues that arose. Instructors are encouraged to allow users to interact and discuss with each other, sharing insights and experiences from the simulation with their peers. This allows the instructor to gather data via observation of the discussion.

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The VR simulation has been developed in Unity for Android phones and uses the phone's gyroscope sensors to detect the orientation of the phone. It can be experienced in virtual reality with Google cardboard v2 and headphones. Buttons on the Google cardboard are used to select and make decisions in the simulation.

Android Smartphone Requirements:

- Headphone jack (wired) or Bluetooth (wireless): for the audio features of the system
- Android Operating System latest version (8.1 Oreo as of November 2018), with the minimum not lower than version 5.1 Lollipop.
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The minimum cost for this specification of phone in the Philippines is 100USD. The cost of a Google Cardboard v2 headset is 15USD.

Delivery

To date, the experience has been delivered by Ania Design Lab directly while visiting the schools. No schools have used the technology on their own, although they have donated the cardboard headsets to the schools. Most of the schools visited can not afford the technology needed, despite it being at the lowest end of the cost spectrum for virtual reality. The budget did not extend to providing phones to the schools.

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Production & Distribution

The production process contained a high level of community engagement and participation. The simulation took eight months to produce and six months of this time was spent in a robust "co-design process" developing the scenarios, storyboards and decision pathways together with representatives from local government, schools (teachers and students) and community partners. Data was also gathered from resources from the National Disaster Risk Reduction and Management Council and in-house research on VR user experiences. Following the co-design process, it took one month to develop the scenarios and one month to roll it out to eight schools. After each test in the eight schools[4], the Ania team adjusted and updated the simulations based on user feedback. Patrick Naui, Ania Design Lab CEA says, *"We were constantly redesigning the Disaster Preparedness Simulator every time we visited a new school... to make sure that we were designing the best experience for our users." For example, "We redesigned the household setting to fit the Philippine context when our users said that the houses we built didn't look anything like the houses we had here in the Philippines."*

Challenges identified in the production process included:

- The intensively participatory approach was time consuming (75% of the overall process)
- Co-designing with communities that had very different perspectives from one another
- Limited time to do quality assurance as part of the development process

The major challenge facing the developers today is the lack of funding to scale up and roll out the project.

4 *Potrero Elementary School (in Malabon), Saint Mary's College Quezon City, the Center for Disaster Preparedness, the Far Eastern University, CENTEX School (in Bauan, Batangas), Siruma National High School, Governor Mariano Villafuerte Community College, and Sibaguan Agro-industrial High Schools.*

#7
Outcomes and Future Planning

Impact to date

Ania received good feedback from teachers and students on the simulation. The students were happy to try something new with the "wow" factor, and teachers liked having a more innovative way of showing their students about disaster preparedness and response in an interactive and realistic format. Local administrators had positive feedback, though some were concerned about scale up due to the cost of the phones. Feedback was gathered from students and teachers at the time of testing the simulations, but no formal evaluation has been carried out. The development of evaluation tools will come on the next cycle of the project if funding is secured.

1 Million PHP	8	405+	3	8
Initial Funding from TUKLAS Innovation Labs	Communities Visited	Activity Participants	Fully-developed Disaster Scenarios	Months

Future planning

Ania received the one-off grant from Tuklas labs and this pilot has now come to an end and therefore Ania Design Lab are currently looking for donors to be able to scale up the distribution of the simulations to more schools in the Philippines. They are working to identify how to sustain the project that they feel has the potential to support disaster education in the Philippines at a larger scale. Ania Design Lab's CEO Patrick Naui says, "*What we have in place has value and is driven by local information, given the long co-design process we went through*". Their aim is to build on this tried and tested model:

"Looking forward, we are looking into developing more scenarios, building partnerships with new communities and more users that can provide insights on how we can improve the system even further."

#8
Internal Evaluation and Learnings

Process

The Ania team adopted a strongly participatory approach to develop the disaster preparedness simulator, that took into account both government expertise and messaging on hazards, and community perspectives and realities. The bulk to the development time was focussed on this "co-design" and although it took time, resulted in a product that was approved by the local government and able to be taken by teachers and integrated into their traditional disaster preparedness education.

Patrick Naui, Ania CEO comments on the co-design process:

"The intensive co-design process is worth it. It takes a lot of time to co-design, but this allowed the developers to fully understand what kind of scenario they should be developing."

The technical development was done in house by the Ania team, who are university graduates and have other jobs as well as running the Lab. Production costs were low as it was all done in house, and the project kept within their grant budget of 20k. It was a resource efficient process overall. The roll out incorporated a strong feedback element, and after testing in each school substantial changes were made to the simulation based on user feedback. The simulation has been tested by over 400 people to date, as part of a pilot phase of the project. The result of the co-design and the user feedback and adaptation based on this feedback has resulted in a product that is well suited to the local context, based on government approved hazard messaging and has the ability to be integrated into the Philippines curriculum.

Product and features

A major strength of the simulator is how users can make decisions based on real disaster scenarios that impact on the outcome of the serious game. This was a key feature of the design process and aim behind the tool and is reflected in the "branching scenarios" for each of the simulations. The simulator gives feedback to the user by displaying if they made a right or a wrong decision in the simulation. The game doesn't start over if a wrong decision is made, instead the users are shown the consequences of their decisions.

There is no system in place for behavioural analysis or to suggest what they could have done better, but this is factored in to the debriefing and feedback section of the experience. In the current version this is left to the students to discuss among themselves and for the teachers to encourage the discussion. How this feedback is then taken by teachers to adjust how they teach disaster preparedness to students is not clear, because due to the time constraints of the project the Ania team were not able to look at this. More specific direction could be given to the teachers to facilitate a discussion on how to improve decision making more formally, as feedback and behavioural analysis is often overlooked in any kind of simulation.

The simulation is totally localised and customised to the Philippines, with Philipines school plans as the basis of the design and the local language used in the simulation as well as targeting the most relevant hazards and locations. This localisation allows for users to identify more strongly with the content and experience.

The Ania Design Lab team cited very low levels of motion sickness when in the simulation. However lower quality graphics and headset (cardboard) have limitations to how long users can remain in the simulation without experiencing motion sickness.

Content

Because of funding challenges, the disaster preparedness simulator is not yet available to the public and has only been tested in eight schools. However, the detailed storyboards and scripts show the level of detail of the content, particularly that went into the decision flow of the simulations, with the aim of getting students to think carefully about the decisions they would make in a disaster and the impacts those would have, allowing them to try different approaches in an immersive but safe space. The quality of the content is therefore high in terms of relevance and appropriateness, even if the graphics and delivery method are at the basic end of the virtual reality spectrum.

The developers of the disaster preparedness simulator state that the experience can be used by anyone from kindergarten to 12th grade, but that it is more used from 6th grade and up as this is the point when disaster preparedness is integrated into the curriculum. The official age recommendation for immersive virtual reality is over 13, particularly when realistic disaster simulation content is used. In the next iteration of the project it is recommended that this age restriction be made clear. There was one report of emotional disturbance after using the simulation, suggesting that the measures in place to identify participants not fit for the simulation could be improved.

Scalability

The Ania Design Lab team chose a low tech form of virtual reality using Google cardboard and smartphones, with the aim of being more scalable in a low income context. As a result the Disaster Preparedness Simulator is highly scalable across the Philippines. Despite complaints from local authorities of the expense, for a VR experience the costs are as low as is possible. At the time of writing the phone and cardboard package in the Philippines would cost approximately 120 USD total. Despite donations of the headsets, due to not always having the appropriate phones at the schools, the simulation is not currently being run by the schools independently.

Smartphone ownership in the Philippines is rising faster than in most countries in the world, but although around 40 per cent of the population own one to date, often these models are not advanced enough to run VR simulations because they are lacking gyroscope sensors or the hardware that analyses the position of the phone in the physical space. However this is predicted to change rapidly and make the technology used by the Disaster Preparedness Simulator more accessible to schools.

The simulator is also highly scalable because the content and design were developed in conjunction with local authorities and schools, and based on localised designs, with the aim of complementing the new K-12 curriculum. Targeting rural communities also means that the experience has the potential to scale up across the country, as most public schools have the same design and curriculum for senior high school. However the curriculum is undergoing massive changes at the time of writing and it may change drastically over the next year. Ania have been attempting to capitalise on this moment of curriculum reform to show how immersive technologies can be integrated and impact positively on the quality of disaster preparedness education.

The total budget for the project was affordable comparative to many VR simulation designs, making a continuation of the project - either development of more scenarios or roll out to more schools - highly feasible and scalable.

Effectiveness

There is very limited data on the effectiveness of the simulation and how it meets the goals of the project, although user feedback that was gathered from over 400 students and teachers was positive. Due to the limited timeline of the project, Ania Design Lab were not able to look at whether using this technology and seeing the decisions that students made, resulted in teachers making any changes to how they teach disaster preparedness. This is recommended for a future iteration of the project.

Key Learnings of Relevance for SBDRR

The disaster preparedness simulator is an excellent example of a localised solution to enhance the disaster preparedness education of schools using immersive technology, despite no formal evaluations on the impact being available from the pilot phase. Key learnings of relevance include:

- The importance of community and local authority participation in the design process and that the investment of time in a robust co-design process ultimately saves time in the long run, with less rounds of feedback and adjustment needed
- Community participation give the developers a better understanding of how to generate user-centric content
- The intensively participatory approach was time consuming (75% of the overall process) and sufficient time should be planned into the process to accommodate doing this thoroughly
- There are clear content relevancy and cost advantages of working with a local design company and through local partners
- Even the most scalable virtual reality option is not always scalable in low income or under resourced contexts
- There is an appetite from the education community in the Philippines for more innovative teaching practices

Contact information

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https://www.preparecenter.org/
email: gdpc@redcross.org
431 18th St NW
Washington, DC 20006
USA

Philippines Disaster Preparedness Simulator

Mandy George and Estela Oliva

Date: Aug 2019

Project name: Disaster Preparedness Simulator
Project owner: Ania Design Lab
Release date: 2019
Locale: Philippines
URL: https://www.facebook.com/aniadesignlab/
XR medium: VR with smartphone
Hazards: Earthquake, typhoon, flood
Activity: Disaster drills and evacuations
Age group: 12+

Table of Contents

#1
Project Background

The *Disaster Preparedness Simulator* is a virtual reality (VR) integrated disaster preparedness learning experience where users are immersed in disaster scenarios in a controlled environment. It has three experiences of different hazards - earthquake, flood and typhoon - and is specifically targeted at children as an integrated part of their disaster preparedness education in schools. It can also be used as a game to test disaster response knowledge.

The goal of the simulator, built in the Philippines specifically for the local context, is to enhance the disaster preparedness learning curriculum by using innovative learning platforms integrating reasoning and empathy in decision making. A pilot of the project has been rolled out, targeting eight secondary schools in rural communities up to 15 hours drive from Manila's city centre. The simulations were designed using a highly participatory approach involving schools and local government. The design is fully localised to the Philippines context.
The simulator was created by Ania Design Lab, a Filipino startup and learning innovation company that designs, develops, and delivers solutions working towards their vision of an educated Philippines. The project was funded by the Tuklas Innovation Lab, a Philippines startup implemented by a consortium of NGOs and funded by UK Aid, the Start Network, and the CDAC[1] Network. Ania Design Lab is currently looking for further funding to scale up the project, building on the results of the pilot that worked towards understanding how to implement low-cost learning innovation technologies in the classroom.

1 Communicating with Disaster Affected Communities

Typhoon Scenario Environment Prototype, Screenshot

#2
Aims & Rationale

The aim of the experience is to learn decision making skills linked to the most common hazards and to increase knowledge about the hazards.

In their initial research, the Ania team found that the current practices of disaster preparedness education in the Philippines - for example disaster drills - are lacking in certain key features for effective learning in content delivery, including:

- Students do not get to make decisions during a disaster simulations
- Drill scenarios are predetermined when role playing
- Students do not get to experience the full effects of the choices they make because many drills are not realistic
- Simulation drills rarely consider the various potential outcomes of a disaster and how decisions taken in response affect outcomes, as there is no practical way to do so in the current method of content delivery

In addition, when consulting teachers, the Ania team found that the education community was looking for something new that would allow them to employ more creative teaching methods around disaster preparedness and avoid repetitive content delivery. This coincided with a radical change in the Philippines educational system and a new K-to-12[2] curriculum implemented by the Department of Education that has opened up many opportunities for stakeholders involved to improve and innovate. Working together with schools to innovate in the education space was timely and of benefit to students, teachers and the Department of Education.

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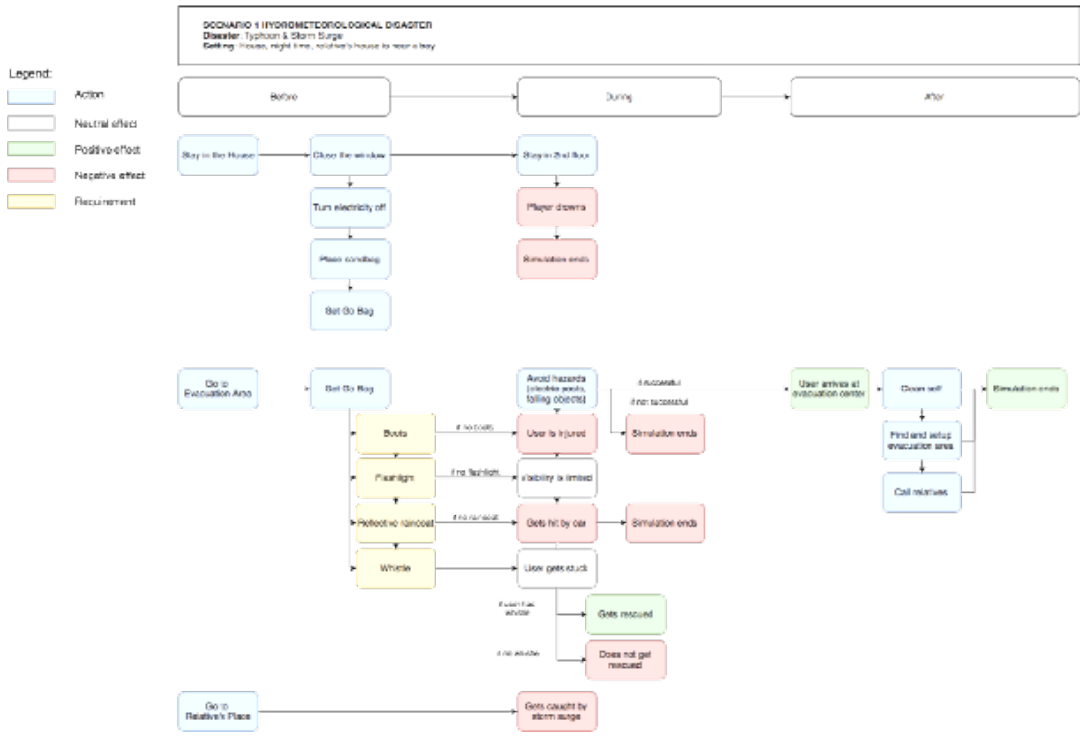

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The production process contained a high level of community engagement and participation. The simulation took eight months to produce and six months of this time was spent in a robust "co-design process" developing the scenarios, storyboards and decision pathways together with representatives from local government, schools (teachers and students) and community partners. Data was also gathered from resources from the National Disaster Risk Reduction and Management Council and in-house research on VR user experiences. Following the co-design process, it took one month to develop the scenarios and one month to roll it out to eight schools. After each test in the eight schools[4], the Ania team adjusted and updated the simulations based on user feedback. Patrick Naui, Ania Design Lab CEA says, *"We were constantly redesigning the Disaster Preparedness Simulator every time we visited a new school... to make sure that we were designing the best experience for our users." For example, "We redesigned the household setting to fit the Philippine context when our users said that the houses we built didn't look anything like the houses we had here in the Philippines."*

Challenges identified in the production process included:

- The intensively participatory approach was time consuming (75% of the overall process)
- Co-designing with communities that had very different perspectives from one another
- Limited time to do quality assurance as part of the development process

The major challenge facing the developers today is the lack of funding to scale up and roll out the project.

4 *Potrero Elementary School (in Malabon), Saint Mary's College Quezon City, the Center for Disaster Preparedness, the Far Eastern University, CENTEX School (in Bauan, Batangas), Siruma National High School, Governor Mariano Villafuerte Community College, and Sibaguan Agro-industrial High Schools.*

#7
Outcomes and Future Planning

Impact to date

Ania received good feedback from teachers and students on the simulation. The students were happy to try something new with the "wow" factor, and teachers liked having a more innovative way of showing their students about disaster preparedness and response in an interactive and realistic format. Local administrators had positive feedback, though some were concerned about scale up due to the cost of the phones. Feedback was gathered from students and teachers at the time of testing the simulations, but no formal evaluation has been carried out. The development of evaluation tools will come on the next cycle of the project if funding is secured.

1 Million PHP	8	405+	3	8
Initial Funding from TUKLAS Innovation Labs	Communities Visited	Activity Participants	Fully-developed Disaster Scenarios	Months

Future planning

Ania received the one-off grant from Tuklas labs and this pilot has now come to an end and therefore Ania Design Lab are currently looking for donors to be able to scale up the distribution of the simulations to more schools in the Philippines. They are working to identify how to sustain the project that they feel has the potential to support disaster education in the Philippines at a larger scale. Ania Design Lab's CEO Patrick Naui says, "*What we have in place has value and is driven by local information, given the long co-design process we went through*". Their aim is to build on this tried and tested model:

"Looking forward, we are looking into developing more scenarios, building partnerships with new communities and more users that can provide insights on how we can improve the system even further."

#8
Internal Evaluation and Learnings

Process

The Ania team adopted a strongly participatory approach to develop the disaster preparedness simulator, that took into account both government expertise and messaging on hazards, and community perspectives and realities. The bulk to the development time was focussed on this "co-design" and although it took time, resulted in a product that was approved by the local government and able to be taken by teachers and integrated into their traditional disaster preparedness education.

Patrick Naui, Ania CEO comments on the co-design process:

"The intensive co-design process is worth it. It takes a lot of time to co-design, but this allowed the developers to fully understand what kind of scenario they should be developing."

The technical development was done in house by the Ania team, who are university graduates and have other jobs as well as running the Lab. Production costs were low as it was all done in house, and the project kept within their grant budget of 20k. It was a resource efficient process overall. The roll out incorporated a strong feedback element, and after testing in each school substantial changes were made to the simulation based on user feedback. The simulation has been tested by over 400 people to date, as part of a pilot phase of the project. The result of the co-design and the user feedback and adaptation based on this feedback has resulted in a product that is well suited to the local context, based on government approved hazard messaging and has the ability to be integrated into the Philippines curriculum.

Product and features

A major strength of the simulator is how users can make decisions based on real disaster scenarios that impact on the outcome of the serious game. This was a key feature of the design process and aim behind the tool and is reflected in the "branching scenarios" for each of the simulations. The simulator gives feedback to the user by displaying if they made a right or a wrong decision in the simulation. The game doesn't start over if a wrong decision is made, instead the users are shown the consequences of their decisions.

There is no system in place for behavioural analysis or to suggest what they could have done better, but this is factored in to the debriefing and feedback section of the experience. In the current version this is left to the students to discuss among themselves and for the teachers to encourage the discussion. How this feedback is then taken by teachers to adjust how they teach disaster preparedness to students is not clear, because due to the time constraints of the project the Ania team were not able to look at this. More specific direction could be given to the teachers to facilitate a discussion on how to improve decision making more formally, as feedback and behavioural analysis is often overlooked in any kind of simulation.

The simulation is totally localised and customised to the Philippines, with Philipines school plans as the basis of the design and the local language used in the simulation as well as targeting the most relevant hazards and locations. This localisation allows for users to identify more strongly with the content and experience.

The Ania Design Lab team cited very low levels of motion sickness when in the simulation. However lower quality graphics and headset (cardboard) have limitations to how long users can remain in the simulation without experiencing motion sickness.

Content

Because of funding challenges, the disaster preparedness simulator is not yet available to the public and has only been tested in eight schools. However, the detailed storyboards and scripts show the level of detail of the content, particularly that went into the decision flow of the simulations, with the aim of getting students to think carefully about the decisions they would make in a disaster and the impacts those would have, allowing them to try different approaches in an immersive but safe space. The quality of the content is therefore high in terms of relevance and appropriateness, even if the graphics and delivery method are at the basic end of the virtual reality spectrum.

The developers of the disaster preparedness simulator state that the experience can be used by anyone from kindergarten to 12th grade, but that it is more used from 6th grade and up as this is the point when disaster preparedness is integrated into the curriculum. The official age recommendation for immersive virtual reality is over 13, particularly when realistic disaster simulation content is used. In the next iteration of the project it is recommended that this age restriction be made clear. There was one report of emotional disturbance after using the simulation, suggesting that the measures in place to identify participants not fit for the simulation could be improved.

Scalability

The Ania Design Lab team chose a low tech form of virtual reality using Google cardboard and smartphones, with the aim of being more scalable in a low income context. As a result the Disaster Preparedness Simulator is highly scalable across the Philippines. Despite complaints from local authorities of the expense, for a VR experience the costs are as low as is possible. At the time of writing the phone and cardboard package in the Philippines would cost approximately 120 USD total. Despite donations of the headsets, due to not always having the appropriate phones at the schools, the simulation is not currently being run by the schools independently.

Smartphone ownership in the Philippines is rising faster than in most countries in the world, but although around 40 per cent of the population own one to date, often these models are not advanced enough to run VR simulations because they are lacking gyroscope sensors or the hardware that analyses the position of the phone in the physical space. However this is predicted to change rapidly and make the technology used by the Disaster Preparedness Simulator more accessible to schools.

The simulator is also highly scalable because the content and design were developed in conjunction with local authorities and schools, and based on localised designs, with the aim of complementing the new K-12 curriculum. Targeting rural communities also means that the experience has the potential to scale up across the country, as most public schools have the same design and curriculum for senior high school. However the curriculum is undergoing massive changes at the time of writing and it may change drastically over the next year. Ania have been attempting to capitalise on this moment of curriculum reform to show how immersive technologies can be integrated and impact positively on the quality of disaster preparedness education.

The total budget for the project was affordable comparative to many VR simulation designs, making a continuation of the project - either development of more scenarios or roll out to more schools - highly feasible and scalable.

Effectiveness

There is very limited data on the effectiveness of the simulation and how it meets the goals of the project, although user feedback that was gathered from over 400 students and teachers was positive. Due to the limited timeline of the project, Ania Design Lab were not able to look at whether using this technology and seeing the decisions that students made, resulted in teachers making any changes to how they teach disaster preparedness. This is recommended for a future iteration of the project.

Key Learnings of Relevance for SBDRR

The disaster preparedness simulator is an excellent example of a localised solution to enhance the disaster preparedness education of schools using immersive technology, despite no formal evaluations on the impact being available from the pilot phase. Key learnings of relevance include:

- The importance of community and local authority participation in the design process and that the investment of time in a robust co-design process ultimately saves time in the long run, with less rounds of feedback and adjustment needed
- Community participation give the developers a better understanding of how to generate user-centric content
- The intensively participatory approach was time consuming (75% of the overall process) and sufficient time should be planned into the process to accommodate doing this thoroughly
- There are clear content relevancy and cost advantages of working with a local design company and through local partners
- Even the most scalable virtual reality option is not always scalable in low income or under resourced contexts
- There is an appetite from the education community in the Philippines for more innovative teaching practices

Contact information

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Virtual Reality Based Disaster Resilience Training

Mandy George and Estela Oliva

Date: Aug 2019

Project name: VR-based disaster resilience training simulations
Project owner: Asia Pacific Disaster Resilience Centre, Republic of Korea National Red Cross
Release date: 2018
Locale: Philippines, Nepal, Republic of Korea, Mongolia, Singapore, Thailand, Vietnam and Indonesia
Languages: Korean, English
URL: https://www.apdisasterresilience.org/vr-safety-training.html
XR medium: Full VR
Hazards: Fire, Sinking Ship, Earthquake
Activity: Disaster drills and evacuations
Age group: 13+

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#1
Project Background

The Asia Pacific Disaster Resilience Centre (APDRC) hosted by the Republic of Korea National Red Cross (KNRC) embarked on a virtual reality journey in 2018 because of the need for more realistic and participatory training in Asia Pacific, the most disaster prone region of the world. VR is one of various experimental disaster safety training tools used by ADPRC.[1]

Working with South Korean education company Tekville Education, and funded by the Red Cross Honors Club2, ADPRC disseminated ttwo virtual reality (VR) pilot disaster simulations of 1) a fire in a theatre and 2) a sinking cruise ship. These were then rolled out across five National Societies: Philippines, Nepal, Republic of Korea, Mongolia and Indonesia3. To date over 4,200 young people, Red Cross staff and volunteers have tried the simulations that are delivered as one-off experiences either with a leaflet at events and conferences, or as part of a disaster preparedness one hour training session. As of 2019 this training package is being rolled out in schools in seven countries: Republic of Korea, Mongolia, Nepal, the Philippines, Singapore, Thailand and Viet Nam. The APDRC is now working with the ICRC on a fully immersive urban earthquake evacuation simulation, following user feedback on simulation topics most in demand as part of an evaluation of the first two VR experiences.

1 Others include a fire extinguisher simulator, serious games and actual simulation exercises

2 A donors' club of the Korean Red Cross, consisting of donors who donate more than USD 100k per year

3 All countries were provided with the fire simulation. The Philippines and South Korea received the cruise ship simulation as well.

#2
Aims & Rationale

The aim of the VR-based disaster resilience training simulations according to APDRC is to:

"train people and raise general public awareness on disaster risks and make them learn, through disaster simulations, what are the proper emergency reactions and the step by step guidelines in each situation."

ADPRC decided to focus on VR because they wanted to improve learning outcomes around disasters and identified VR as an effective way to achieve this, stating that.

"This method (VR) has completely modernized theoretical learning and provides, in addition, a practical dimension and realistic scenarios that make the understanding and learning easier and more efficient."

Additional reasons cited by APDRC for this choice include:

- More realistic disaster scenarios give people a better chance to test how they would really react in a disaster and give greater awareness of how dangerous disasters can be, leading to people being better prepared for disasters when they happen and be more likely to take life-saving actions
- Action-based learning has been proven to increase learning outcomes: Combining traditional training with VR helps to retain learning. Physical "learning by doing" is more effective than showing films.
- VR makes the learning process more visual by immersing the user in the visual experience and allows them to learn how to handle a disaster situation while in a safe environment.

KNRC's PR team had previously developed a 360 video VR experience some years ago but APDRC found that although this as useful for building empathy and fundraising, it was not as useful for training as a fully immersive experience.

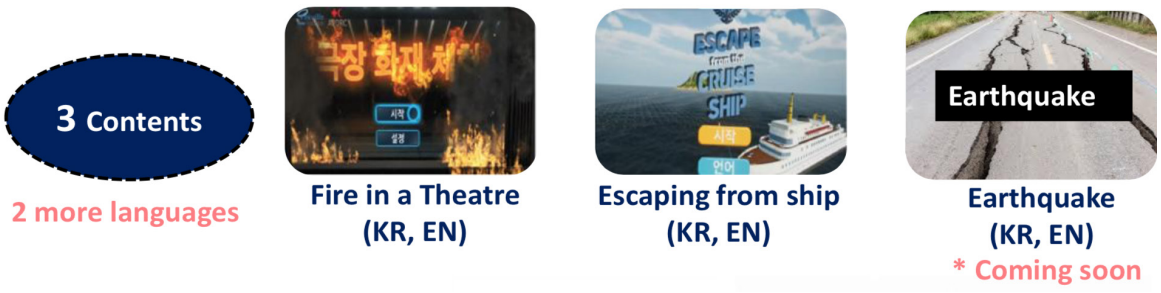
#3
Audience

The primary audience is the general public, as well as young people and RCRC staff and volunteers. As such, the simulations have been used with a large age range, from 13 to 60. There is no official age limitation imposed by the APDRC, although they follow what the headsets recommend (13+). They have tried using the simulations with elementary school children (6 - 13) who did not experience motion sickness.

#4
Experience

Content

APDRC have developed three disaster simulations, two that have already been rolled out and one that will be available by August 2019.



Videos of the simulations are available on the APDRC website: https://www.apdisasterresilience.org/vr-safety-training.html [*include YouTube videos in multimedia case study].

The topics were chosen because:

- Fire disaster preparedness is an obligatory subject in South Korea's school curriculum and is the most common disaster across Asia Pacific
- A major cruise ship disaster where 300+ highschool students died took place in 2014 and hence was a priority for the Korean public
- Evaluations of the first two simulations highlighted the need for an earthquake evacuation simulation

Both scenarios currently in use immerse users into the emergency situation and require them to escape safely from the burning building or sinking cruise ship.

The simulations contain a health and safety warning at the start: "Use only in a safe environment. Stop if you have dizziness, severe motion sickness, or discomfort." They are available in Korean and English.

Escape from the Cruise Ship

Duration: Seven - ten minutes

Storyline: *"Imagine being on a cruise trip and suddenly hearing the emergency alarm saying that the ship is sinking. What are you going to do? How are you going to escape safely?"*

The simulation begins The simulation contains a warning at the start that this is "experience oriented content" and that in the event of a real accident on a ship it is safest to follow the instructions of the crew. The passenger (the user) receives the normal safety instructions that would be delivered onboard to passengers, taking advantage to educate users on general safety information for disaster risk reduction. The ship then encounters a collision, and from then on the safety advice is focussed on how to respond to the ship sinking (e.g. get a life jacket, get on deck, avoid fires, activate lifeboats and use of emergency kit items). The user is asked to make decisions along the way.

The experience captures the adrenaline of a real event, even from simply watching a video of the experience. The simulation contains realistic graphics and uses small snippets of real videos to illustrate some actions, such as the lifeboat inflating once activated. The cruise ship has a generic look so is more broadly applicable than only to Korean cruise ships. There are no other people visible in the simulation and multiple-user interaction is not possible.

Fire Theatre

Duration: Five minutes.

Storyline: *"A sudden fire starts while you're comfortably sitting on your seat in the theater. Do you know how to protect yourself from the smoke? What actions to take?"*

The simulation starts when a fire breaks out in a theatre where the user is a spectator. The setting is a generic cinema or theatre view with a red curtain and seats that could represent an

urban theatre in multiple countries. When the fire breaks out, the user must carry out various safety checks as they try and escape from the burning theatre. For example, testing if the door handle is hot before opening; staying low on the floor as evacuating a smoke filled corridor, and using a fire extinguisher. The user is asked to make decisions along the way.

The developers deliberately kept the scenario simple with one theatre scene, because they wanted to focus on the safety messages communicated to the user and have simple and easy actions to memorise (for example, not to use an elevator in time of fire, check exit and temperature of door knob before opening, and use a fire extinguisher). At the end of the experience a list of safety tips are provided.

The experiences are not currently integrated into broader training sessions, though they are distributed as part of a one hour disaster preparedness training package (see Production and Distribution section) including in schools in some of the target countries.

#5 Technology

The fully interactive simulation was built by the education company in Unity, and both HTC Vive, Oculus and Samsung Odyssey headsets were used during the initial roll out, alongside gaming laptops. These headsets require room controller installation, which can be complicated as they require specific technical training. Instruction manuals and training of trainers was offered to be able to train team members to deliver the experiences.

With the new phase in development with ICRC, the recommended headsets are Samsung Odyssey, which include camera tracking in the headset, so they are easier to set up and require basic technical skills. However these headsets also work along with gaming laptops, which inflate the cost per kit, thought the new headsets can be used with the same gaming laptops. A side monitor was also recommended to be able to broadcast the experience inside the headset to other users around.

- Pros of the equipment: high-end experiences, quality viewing, interaction through controllers
- Cons of the equipment: expensive, tied to a gaming computer

In 2018, KNRC distributed one device kit each to the Philippines, Indonesia, Nepal and Mongolia and six to different KNRC chapters. In 2019, KNRC distributed two devices to each of the six NSs and an additional 9 to KNRC chapters, bringing the total devices distributed in Korea to 15 and other NS to 12. The simulations are implemented in National Societies by focal points trained by APDRC in three trainings of trainers held in 2018 and 2019, and NS staff and volunteers who they subsequently trained.

#6
Production & Distribution

Production

Production took place between 2016 to 2018. APDRC worked with an educational training company from South Korea, Tekville Education, who they had already worked with in the past to develop e-learning programmes. Tekville produced and continue to provide maintenance for the simulations. The production was done with occasional consultation with APDRC, although the bulk was done directly by Tekville. There were pros and cons to outsourcing the development, highlighted in challenges below.

Integration, dissemination and distribution

APDRC has rolled out the fire and ship simulations across five National Societies: Philippines, Nepal, Republic of Korea, Mongolia and Indonesia[4]. They developed an operations manual and invited focal points (HQ programme managers) from the Na-

4 All countries were provided with the fire simulation. The Philippines and South Korean received the cruise ship simulation as well.

1 (3) Hour	5 Minutes
• lecture + VR experience + leaflet • lecture (incl. serious game) + VR + Discussion	VR experience + leaflet
	

tional Societies to a Training of Trainers to learn how to use the devices and simulation. The focal points have then passed on this training to other staff and volunteers as some NSs provide this services at the chapter level.
The simulation is disseminated in two ways:

- **At exhibitions or conferences**, in booths, as a one-off experience complemented by a leaflet with more information
- **As part of a one-hour disaster preparedness training package.** Before the simulation is used, the audience is provided with disaster knowledge and concepts and after the simulation they share their reactions and feedback and have a discussion. Video clips are also shown. Sometimes this is combined with training in CPR and/or the disaster prevention serious game Riskland developed by UNDRR and UNICEF.
This approach is being used already in schools in South Korea and the Philippines. The training package was shared in the training of trainers session with the other NS this year and they will be rolling this out across schools in the other countries from April - December 2019.

Total distribution figures:

Country	Devices	Targets	Participants	Events	Duration
Rep. of Korea	6	2,520	2,977	51	June 2018 ~ March 2019
Philippines	1	100	512	15	April/May ~ November 2018
Mongolia	1	150	234	9	
Nepal	1	100	527	21	
Indonesia	1	100	27	2	
Total	10	2,970	4,277	98	

The simulations have been promoted through IFRC internal channels such as newsletters and APDRC has shared information with the other Red Cross Red Crescent Disaster Preparedness Reference Centres globally. The VR simulations have also been disseminated at events across the AP region, including:

AP FbF Workshop, KL


AMCDRR, Mongolia


Youth Exchange Program, Korea

National Youth Camp

Korea Baseball All Star Game

AP Regional Conference

Licencing

Tekville is a private company that also receives some public funding. APDRC were originally required to pay a licensing fee per month per user, which limited their ability to roll the simulations out more widely. They renegotiated to a flat fee per download, abolishing the monthly rental. This is per install per device and has no associated time restrictions. The copyright for the simulations remains with Tekville.

Challenges

The major challenge faced by APDRC in the production and distribution of the VR simulations was the restrictive licencing arrangement with the developer Tekville Education. The consequences of the arrangement have meant that it is too costly to roll out at a wider scale, in addition to the expense of the equipment. This also limits the experience to a one off.

Based on these challenges of cost and copyrights, the next simulation APDRC is working on (earthquake evacuation) is being produced in house[5] by ICRC (see future plans). APDRC felt that working with ICRC was more financially viable, as ICRC are able to absorb most of the development costs, excluding the script-

5 *To the RCRC Movement*

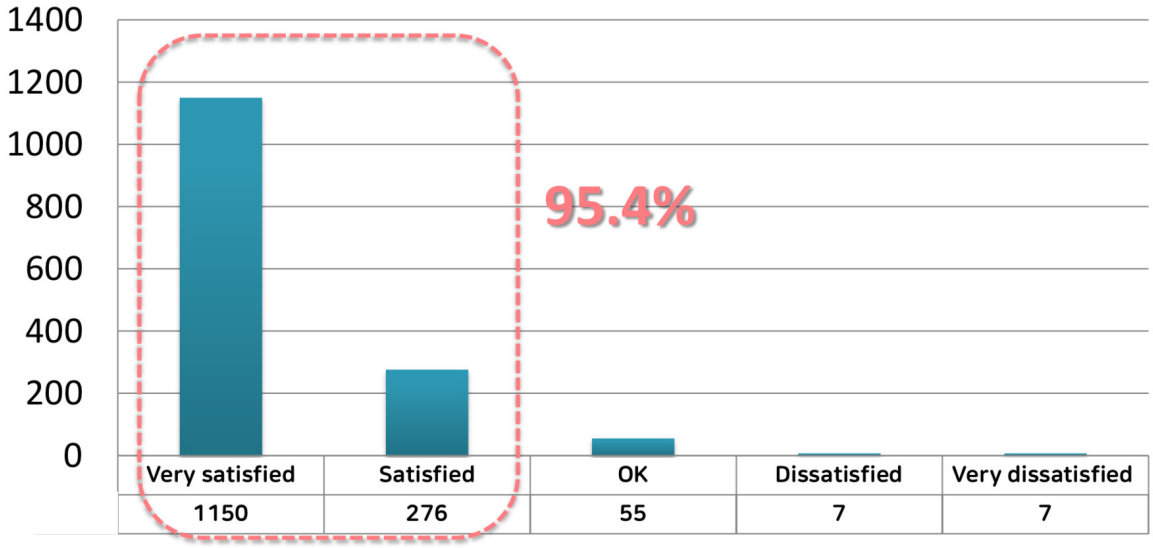
writing and voiceover. This is not however a model that would always be replicable in the future, given the expense for ICRC.

Other challenges included:

- Content development was led by Tekville, who have their own training expertise. It was not developed in partnership with KNRC or tailored to the DRR behaviour change communication campaigns of the NS it was rolled out to.
- Lack of qualified software operators in schools to be able to increase roll out
- HR constraints: APDRC has only two full time staff, and therefore they worked with other departments and chapters of KNRC and university student volunteers to provide training.

#7
Outcomes and Future Planning

A 2018 satisfaction survey of over 1500 users found that 95.4% were either satisfied or very satisfied with the experience. The surveys were carried out after several VR trainings in 2018 both at conference and events and as part of training packages delivered in schools. Occasionally APDRC conduct a pre and post test, although this is not formally built into the training package experience.



Feedback from National Societies included::

Positive:

- Interesting
- Very practical
- Interactive
- Realistic
- Fun and easy way to learn
- Nice graphic designs
- Perfect for emergency practice
- Effective

Difficulties:

- Understanding the English content
- Setting up VR tools
- Confusing controls (difficult to control the thumb stick)
- Some people felt dizzy afterwards, including elderly people

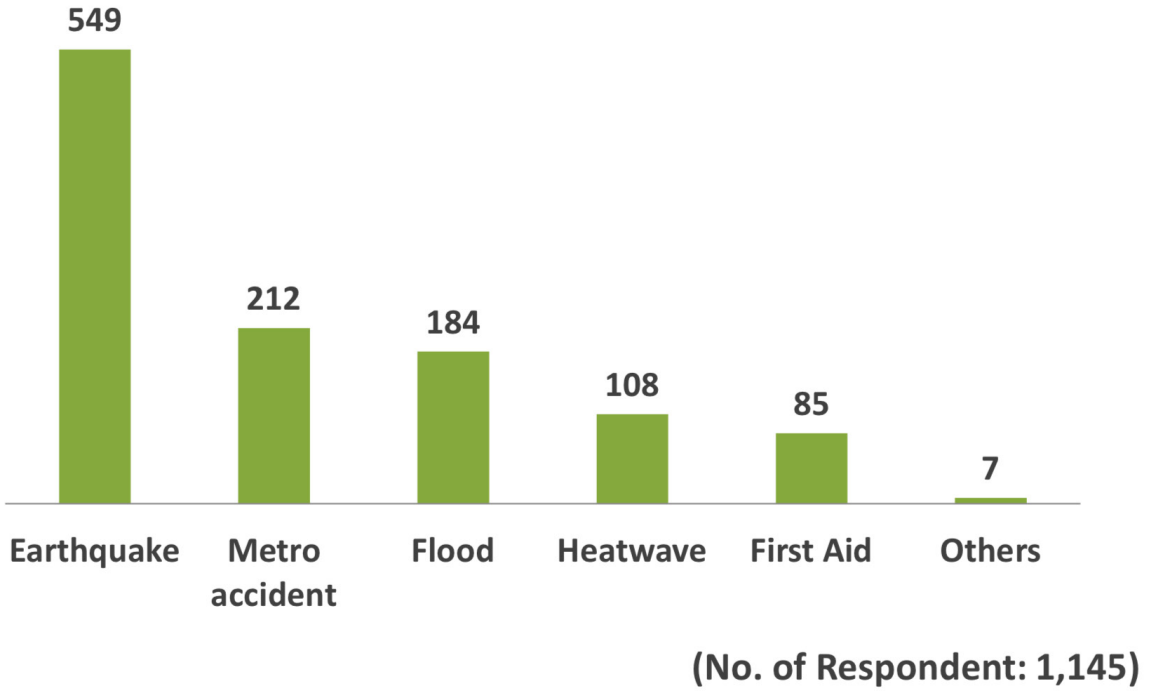
What can be improved or added:

- Need a Nepali version of the games
- Need to add more scenarios (earth-quake, flood, first aid)
- The fire scenario is too short[6]
- Add difficulty levels
- Make audio instructions
- Add more players
- Add more decision making elements
- Add motivational incentives
- Improve controls

6 *Though it is the recommended length for a VR simulation*

One of the most common suggestions was to have more types of content, particularly around earthquakes. A specific survey of over 1,400 people on new content development also confirmed this.

There have also been requests for a simulation of a fire in a rural setting, however APDRC feels that urban populations are better equipped to use the technology and are not planning to act on this feedback.



Future planning

In 2019, APDRC started to roll out the simulations out to an additional three National Societies (Singapore, Thailand and Vietnam) and 15 KRCS chapters bringing the total number of users to 14,060.

As of 2019 the simulations are only available in Korean and English but APDRC would like to translate them into the local languages of the NS they are working with, particularly in places like Mongolia, Nepal, Thailand and Viet Nam. As soon as they secure funds, APDRC plans to translate both the cruise and fire simulations into two more languages.

Building on user feedback, the APDRC team is working with the ICRC to build an earthquake evacuation simulation with a substantially different mode of production and delivery. It is planned to be ready for testing in the second half of 2019. In contrast to the fire and ship simulations where the training company led on content development, for this iteration APDRC put together an internal task force to come up

with detailed storyboards for the simulation that were provided to the ICRC. They are aiming to improve on the first two VR experiences and make the new one more interactive, for example by integrating a scoring system to motivate users. As the director of APDRC says,

"Interactivity is key, people need to learn by doing."

Caption: *ICRC / APDRC earthquake preparedness simulator in the design process: evacuation from a typical urban apartment during an earthquake, that also includes how to make the apartment safe before an emergency.*

#8 Internal Evaluation and Learnings

Process

The design process was entirely handled by Tekville Education, who consulted experts and academics on the content, with little input from KNRC. Although this alleviated the workload from an already stretched and small team, it meant that the National Society had very little say over the quality of content of the simulations. This led to some inaccuracies in the content, for example the fire simulation appears to allow users to get too close to the fire that would be advisable or possible to do in real life. Although no NS have reported issues with the safety advice provided in the simulations, it is a missed opportunity not to have worked with disaster management professionals to tailor the content to the first aid and disaster management messaging of the NS involved, particularly as the simulations are rolled out in schools.

The overall cost to APDRC was kept low despite the expensive equipment because of public funding received by Tekville. However the restrictive licensing features was a hidden cost not anticipated by the NS and has prevented wider roll out of the experiences, as has the expense of the equipment.

Design and content[7]

The content design integrates a basic level of decision making but without the complexity of branching scenarios. Tekvile aimed to keep the messaging simple and focussed on a few key safety activities. The simulation is therefore simplistic, but given that it is not recommended for more than five minutes, and that it is currently used as a one off, the simplistic approach is effective. Complex content is more suited to a repeated experience, or one that is part of a more extensive educational package.

Tekville incorporated user feedback into the design, but they managed this process themselves and it is not clear how extensive the testing was, who provided feedback, or how many changes were made based on user feedback. ADPRC was not at all involved in this process. It is not clear if young people were involved in the design or pilot. Several experts and academics were consulted on the detail of the content. The lack of a clear strategy to involve of school teachers or disaster management officials was a missed opportunity by Tekville to produce content more suitable for integration in curriculums and for wider roll out in schools.

The experiences come with a health and safety warning and is always accompanied by someone from the Red Cross. The simulation contains a warning at the start that this is "experience oriented content" and for the ship evacuation simulation - that in the event of a real accident on a ship it is safest to follow the instructions of the crew. There does not seem to be strict adherence to the 13+ age restriction suggested by the headset developer as the experienced has been trialed with elementary school children. Stricter guidance on age restrictions is suggested to be added to the roll out package, particularly for the ship evacuation that is more realistic and could be intimidating for smaller children who are not able to separate simulation from reality.

The training package mode of delivery is one hour long and incorporates some feedback to users and discussion on their experiences. However when the simulation is tried at conferences and events no feedback is given. Within the experience, given the low level of decision making, there is consequently a low level of feedback incorporated into the simulation. For example, if you test the door handle and it is hot, indicating fire on the other side of the door, but you decide to open it anyway, you are given a warning sign and told to use another exit.

There is no player interaction or other people visible in the simulation which detracts from the reality of the immersive scenario. Conversely, this makes it more accessible to a wider age range as the increased reality of other players or simulated people in distress could be disturbing for younger audiences.

The content is currently available in Korean and English. User feedback from NS requested translation into their local languages, which has not been possible given the restrictions for working with Tekville but should become possible with the ICRC earthquake simulator.

7 The licensing restrictions prevented a detailed testing of the experience and this review is based on videos of the simulation.

Scalability

APDRC have only been able to scale up the distribution of the kits to NS to a certain level because of the cost of the equipment, the licensing restrictions, and technical user requirements necessitating training. It is not clear how the NS are rolling this out, but with the technical skills needed to set up and use the simulations there could be some blockages to roll out at the NS level. This is not predicted to change as APDRC work with ICRC going forward, given that APDRC have purchased new Samsung headsets that have similar restrictions. Recent technological developments have been made in the field of standalone VR headsets that can perform without a laptop to a high standard, such as Oculus Quest. These headsets cost approximately 400 USD and are now available on the market and that would provide a more scalable option for National Societies.

ADPRC are only rolling out the simulations in urban areas as they feel it is more appropriate for urban contexts, but given the fast development across the Asia Pacific region, where the content is relevant, it could be beneficial to broaden out to rural or peri urban settings where many of the most disaster prone still live.

Effectiveness

The aim of the simulations is to improve learning around how to react in disasters through a "learning by doing" approach. As evaluation reports are not available in English it is difficult to tell if this has been successful. User feedback is very positive, but was gathered focused on satisfaction levels rather than impacts on learning. Pre and post simulation test results suggest an increase in learning but this has not been systematically integrated into how the experience is rolled out.

There are some limitations in effectiveness from the one off nature of how the simulation is used. VR is best used as part of a training package and not as a standalone tool, and so when the simulations are used at conferences they attract people with the wow factor, and act as a door opener to get people further engaged, but this is then not capitalised on in the same way as when VR is integrated into a broader training experience and complemented by other methods.

Key Learnings

The simulations deliver a set of key messages and safety advice for two emergency settings in a simple but effective way. The main learnings or relevance centre around, but are not limited to, the production process and barriers from working with an external agency with restrictive licensing and a non-participatory content development approach.

- Strong example of roll out of XR to multiple National Societies. The process of engagement with NS is effective and thorough, for example in training focal points and not just providing the equipment.
- Example of a NS not only rolling the technology out to their own organisa-

- tion (KNRC) but also focussing on NS that they support in the region.
- Lack of participatory design process can lead to lack of alignment with RC messaging and lack of ownership of content
- Limitations to scalability coming from working with a commercial company that issues licencing fees and retains the copyright
- Limitations of scalability using expensive and more technically challenging equipment, despite multiple country roll out
- There is an opportunity for GDPC to act as or create a hub to share and showcase ongoing XR initiatives across the Movement. APDRC was not aware of some of the other RCRC initiatives that could have provided useful insights and learning and informed their decisions on next steps.

Many of these learnings are being taken on board in the approach with ICRC, for example through the detailed establishment of a task team to develop the content and story boards in-house. However, scalability issues with National Societies are still predicted to be a barrier given the cost of the gear that is planned to be used.

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1979 Revolution - Black Friday

Estela Oliva and Mandy George

Date: Aug 2019

Project name: 1979 Revolution: Black Friday
Project owner: iNK Stories
Release date: 2016
Locale: USA, worldwide except Iran
Languages: English, Spanish, French, German, Russian, Turkish
URL: http://1979revolutiongame.com/
XR medium: Video game
Hazards: Conflict
Activity: Awareness
Age group: +17

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#1
Project Background

1979 Revolution: Black Friday is an award winning interactive video game created and published by New York studio iNK Stories, run by Navid and Vassili Khonsari. The game transports players to the Iran of 1978, where they become a journalist who gets involved in the intense events of the Iranian Revolution and are forced to make decisions to determine the narrative and the story. The game is based on true stories and historical events.

1979 Revolution: Black Friday was in development for four years, the first two years for funding and the next two years to develop it. Initially launched on Kickstarter in 2013, it did not initially achieve its funding goal.[1] A second round of fundraising proved more successful and funding was achieved thanks to donors and private investors. The game was released in 2016.

1979 Revolution combines elements from video games and documentaries with an engaging narrative. Game director Navid Khonsari, the mastermind behind renowned game titles such as Grand Theft Auto, was born in Iran and lived there during the time of the Revolution. He developed the game with the intention of making players understand the moral ambiguity of the conflict, in which decisions have to be taken on the go.

The project has been highly acclaimed by critics and has received many nominations awards including the Facebook Game of the Year 2017 and a nomination to the Bafta Games.

1 *https://www.kickstarter.com/projects/1817380887/1979-revolution-black-friday*

#2
Aims & Rationale

Created for mass audiences, *1979 Revolution: Black Friday* aims to create a gaming experience connected to real world events and historical milestones of the Iranian history. It was designed to act as a catalyst for creating awareness and positive social change.

The goal of the project, according to director Khonsari, was to both entertain and engage players. iNK Stories wanted to deliver an "honest depiction" of the Iranian Revolution, but also to put players who are not familiar with it in the shoes of a person who is experiencing that event themselves.[2]

2 https://www.kickstarter.com/projects/1817380887/1979-revolution-black-friday

#3
Audience

1979 Revolution was conceived as a game for mass audiences. The creators aim to reach as many people as possible around the world. From the nature of the game, which includes violence and conflict scenes, the game has been rated for +18 years in the Oculus Store, however the rating on the Apple App store is +17. The total number of downloads is said to be 500K by the creators, and there is a monthly download rate of 841 as of June 2019 as captured in Crunchbase.

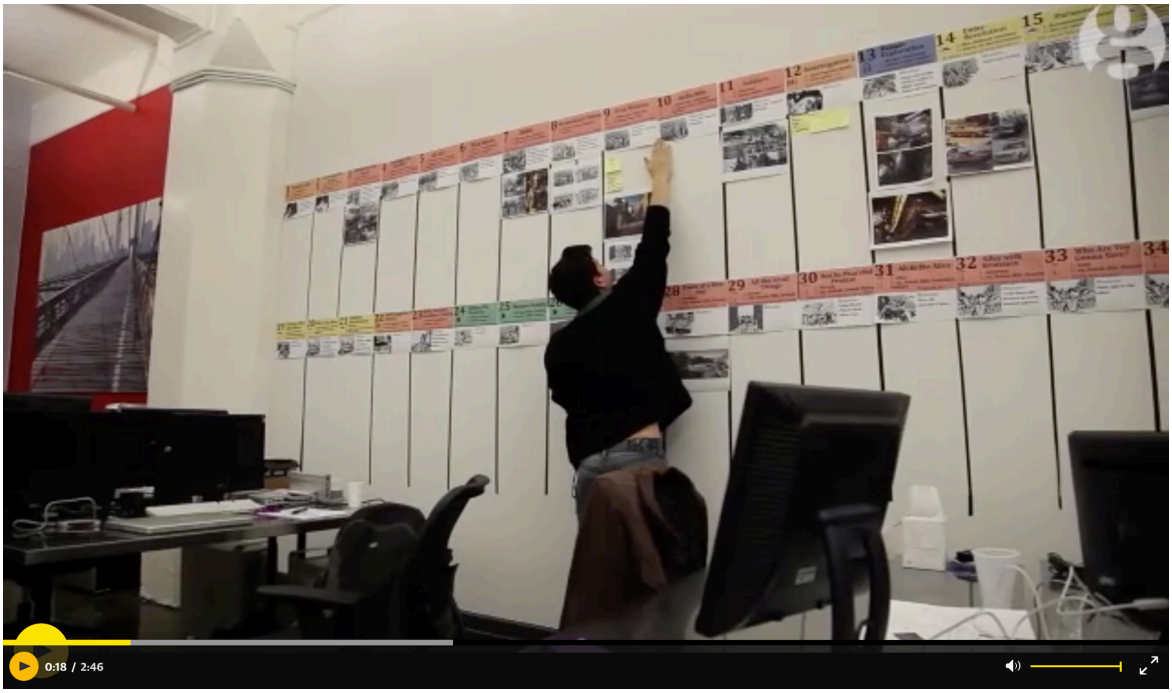
The game has been translated into six languages including English, French, German, Spanish, Russian and Turkish.

#4
Experience

1979 Revolution presents a single player, choice driven, narrative based interactive game that mixes cinematic scenes with highly interactive elements. Currently available on PC, mobile and console platforms, the experience lasts for about three hours and can be played in chapters or in one go.

The game is based on the choose-your-own-adventure books, that were popular in the 80s and 90s, and later gamebooks, in which stories are presented in multi-sequential layers, providing several narrative branches along various paths, typically through the use of numbered paragraphs or pages. In 1979 Revolution, the story reveals itself interactively in the form of individual choices, where every choice made influences the story and impacts the following steps and possible endings. The gameplay consists of walking around, talking to people, interacting with objects, and making decisions.

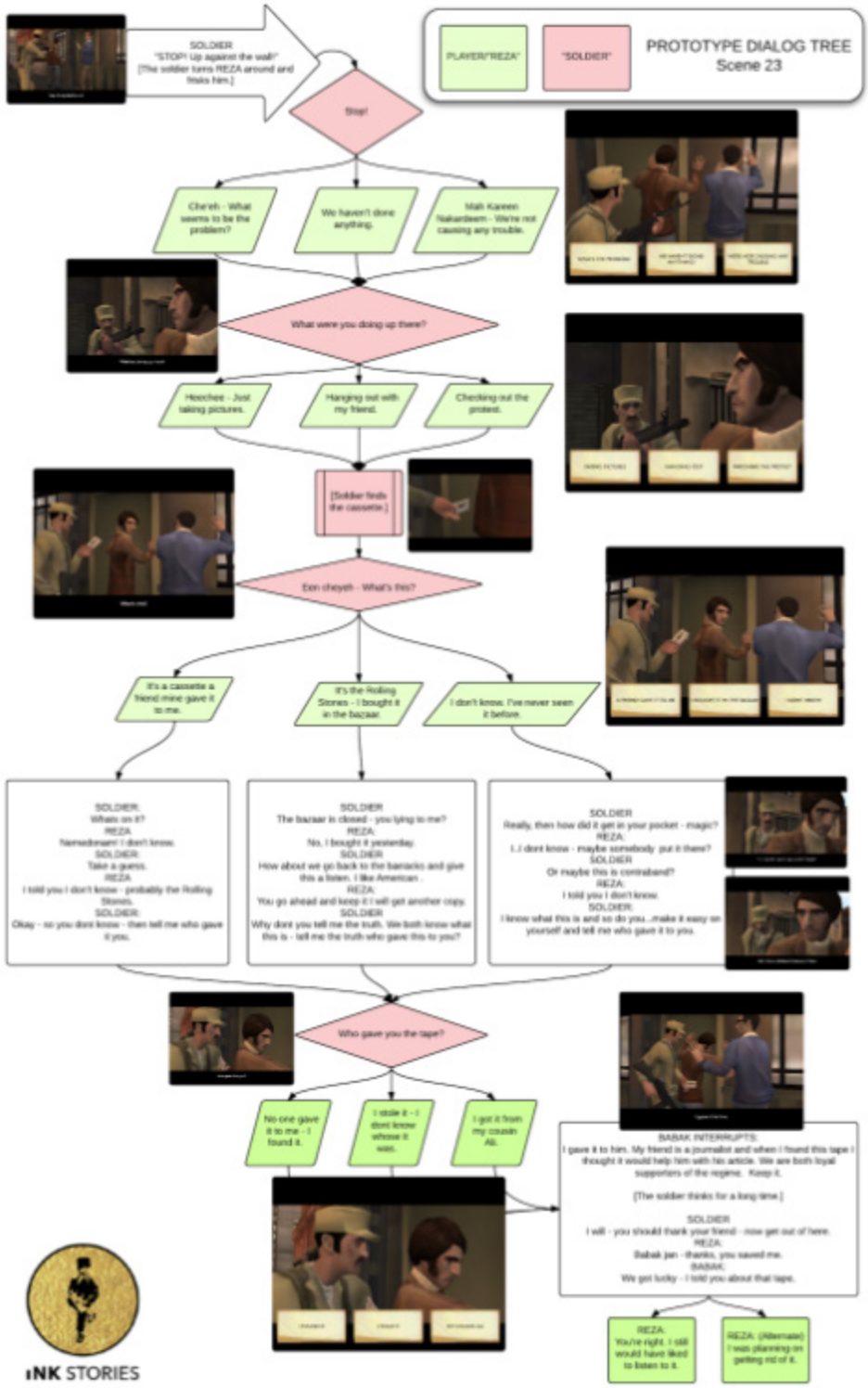
The game follows the story of Reza, a student who returns home in Iran from Germany to find the streets of Tehran full of people protesting. Reza is also a photographer and he gets involved in life threatening situations which affect his friends and family, as well as his own safety in the middle of the political turmoil. By making key decisions, the story develops in



Still of the making of 1979 Revolution, Guardian online

19 individually named chapters and lead to a set of connected stories. Each chapter develops and features characters as well as extras and mini games.

One of the techniques used is the dialogue tree or conversation tree, which is a game-play mechanic used throughout many



Prototype of a dialogue tree scene, courtesy of iNK Stories

adventure games and role playing video games. When interacting with a character, the player is given a choice of what to say and makes subsequent choices until the conversation ends. This technique allows games designers to reiterate information about a topic, allowing players to replay parts of the conversation that they did not pay close enough attention to the first time.

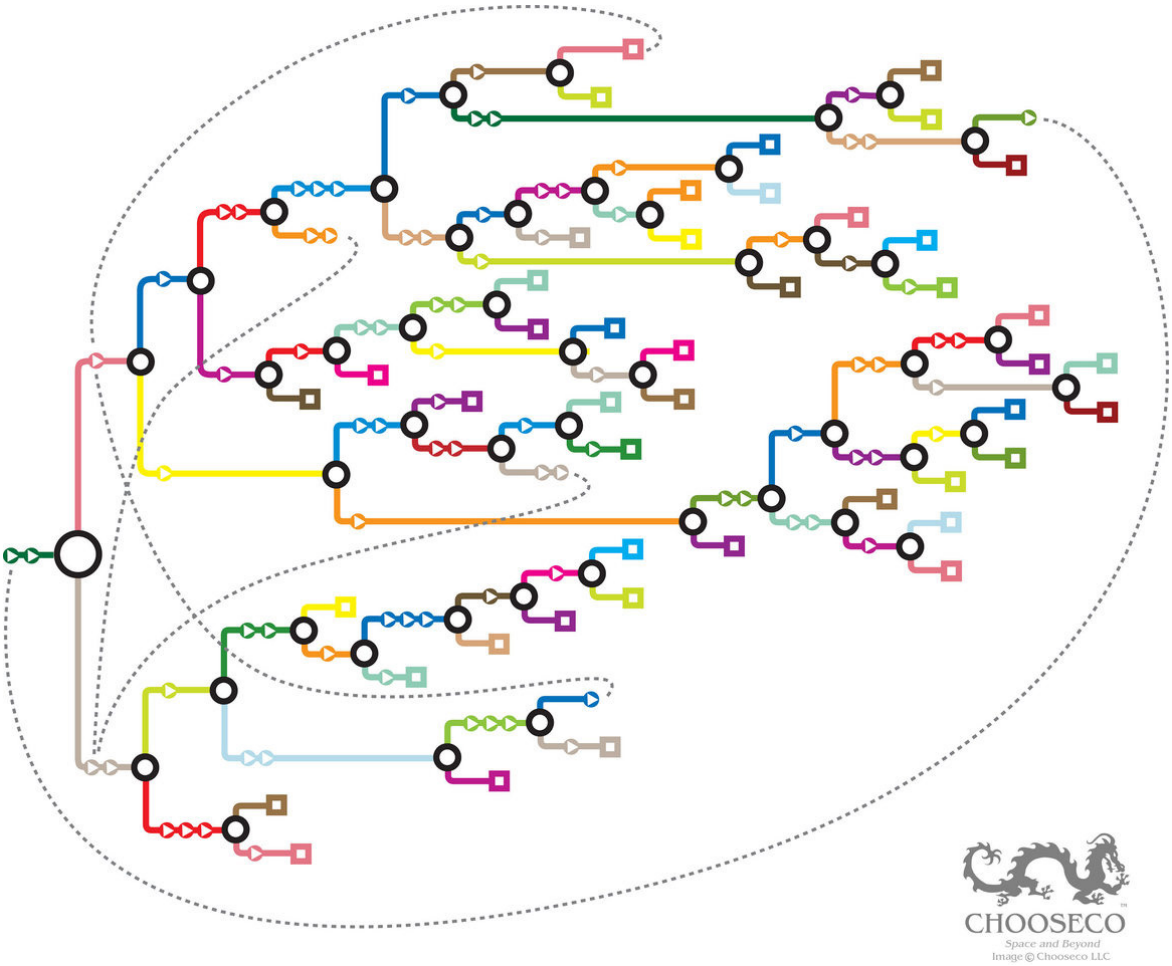
These conversations are designed as a tree structure where players decide between each branch of the dialogue to pursue. Also players might be prompted to earlier parts of the conversation tree and repeat them if they haven't achieved the selected goal. With an extensive narrative and a large number of scenes, the game includes many different features, including:

- Making Critical Choices

The choices players are forced to make will shape the experience, and the fates of other characters, both in the present and the future.

- Presented as a cinematic experience

Branching cinematic story told through motion captured animation and voice over performances allows the discovery of the world of Tehran in the 1970's, through a striking visual style.



Example Visualisation of a Choose Your Own Adventure narrative: Space and Beyond, Choose Your Own Adventure #3

- Explorative content

Using the navigation features players can explore the world of the collapsing city: covert headquarters, rioting protests, bustling city streets and more.

- Photography within the game

Players can take photos in-game and compare them to the original archival photos captured by celebrated photojournalists.

- Collectibles and parallel stories

There are over 80 unique stories that run in parallel with the main story: including primary sources like archival videos, home movies, graffiti, photographs and more.

- Based on historical events

The game is based on first hand testimonies of witnesses and casualties of the revolution, as well as those who were imprisoned in Iran's notorious Evin Prison. It contains in-game dossiers on the real people and events upon which it's based.

- Meticulously designed environments

The game creators have paid great attention to creating the environments and characters to be authentic and historically accurate. By sourcing a number of photos, public and private, and hearing personal testimonials, they pieced together what they proudly say is a "conscientious depiction of the Tehran of 1979."[3]

3 *https://www.kickstarter.com/projects/1817380887/1979-revolution-black-friday*

#5
Technology

1979 Revolution: Black Friday runs on the Unity games engine. It has been made compatible with most platforms including: Windows, Mac, Android, iOS, Playstation, Nintendo, XBox. It is available on most games stores for purchase. Prices range from 5 USD for the PC version to 11.99 USD for the console version.

The character's performances were mostly recorded using motion capture technology, with remaining audio elements recorded later in a studio. The motion capture studio —House of Moves, in Los Angeles— used over 70 cameras, synchronised to capture the full-body motion of each actor. This captures were then integrated into the game characters providing a realistic feel to the game.

Since the game is dense it requires enough space on the devices to install, it varying from 2GB to 5GB.

Following the success of the game, iNK Stories developed Blindfold, an interactive VR experience which is set in the same story, within a prison and presents characters from the game. The VR experience is available for Oculus only. The VR experience doesn't use interface menus but allows the user to interact with their own moves (nod, shake your head, or remain silent).

#6
Production & Distribution

1979 Revolution: Black Friday was in development for four years; the first two years consisted of seeking funding, and the game was developed over the following two years. The game was developed and published by iNK Stories created with support by N-Fusion Interactive who are Unity developer specialists.

Navid Khonsari was one of the main creators behind "Grand Theft Auto III", "Vice City" and other shooter games. But after leaving his career game developers, he started working with his own team at iNK Stories, an independent studio in New York City, to develop *1979 Revolution: Black Friday*.

The iNK Stories team included his partner Vassili Khonsari who is a graduate in visual anthropology as well as a documentary filmmaker. She brought a lot of knowledge in that experience, planning and conducting extensive research for the game, using an anthropological approach, where they interviewed a total of 90 people including historical scholars and Iranians who lived in Tehran during the Revolution. They also gathered numerous archival photos and historical speeches. "We had academic, religious and cultural advisers on board. We needed to make sure that we got everything accurate. We did over 40 interviews from a huge spectrum of background, culturally, social class, and just had a huge research team that just went [sic] endless".[4]

4 https://www.ibtimes.com/why-1979-revolution-creators-built-game-based-iranian-revolution-2358632

Funding

1979 Revolution was initially launched in Kickstarter as a prototype with alongside a crowdfunding campaign however the project fell short of its Kickstarter goal of $395,000 after bringing in $304,741 from 1,653 backers. It achieved extra $90,000 via their website. Following the failed campaign, the team partnered with the New Frontier Story Lab at Sundance in 2014 and 2015, the Museum of the Moving Image in New York, and the Doris Duke Foundation.

Controversy

Since Navid Khonsari began work on the game, called *1979 Revolution*, it was labeled as "Western propaganda" by an Iran government-run newspaper and some members of his team used aliases to protect themselves from the repercussions of creating a video game based on a controversial event that has persistent reverberations today.[5]

The game is banned in Iran. "Iranians will quickly realize the hostile intentions and objectives of the developer if they see the game," National Foundation for Computer Games Director Hassan Karimi said in a statement, the Tehran Times reported.[6]

5 *https://www.theguardian.com/technology/2013/nov/13/iran-1979-revolution-video-game-kickstarter*

6 *https://www.tehrantimes.com/news/300689/Iran-plans-to-block-websites-offering-1979-Revolution*

BLINDFOLD

The second project by iNK Stories is Blindfold, a VR experience which branches out from the *1979 Revolution* game story. For this project iNK Stories partnered with the Committee to Protect Journalists (CPJ) and the Center for Human Rights in Iran (CHRI) to provide information and fact check to make sure Blindfold was as realistic as possible.

#7
Outcomes and Future Planning

1979 Revolution: Black Friday has been very well received by critics. Review aggregator Metacritic [7]calculated an average score of 80 out of 100 based on 25 reviews. It also calculated a user score of 7.7 based on 69 reviews. Reviewers liked the game's narrative, characters, and historical representations, though some criticism was directed at its quick-time sequences, and visual quality.

1979 Revolution has been engaged by UNESCO to help in conflict resolution. In a statement, UNESCO-MGIEP director Anantha Duraiappah told CBC News that when it comes to evoking empathy, "video games have an edge over traditional classroom teaching".

Research was initiated by Unesco to study how digital games can support peace education and conflict resolution. The research includes learnings from *1979 Revolution* and other games[8]

Summary of key learnings:

- Interactive virtual environments can provide safe spaces for contact and collaboration, encourage perspective-taking, produce empathy, help negotiate ethical and moral dilemmas, stimulate intercultural understanding, facilitate the acquisition of historical and cultural knowledge and, occasion reflection on one's own passive complicity when faced with instances of suffering and injustice
- Much work remains to be done before this emergent, complex, and rapidly evolving medium can be more effectively leveraged for the ends of social good.
- Design and implementation must proceed cautiously, as digital games are powerful tools whose mismanagement can backfire and achieve unintended consequences such as cultural appropriations, emotional manipulations and "emotioneering". As the field progresses, designers will be challenged to negotiate the fine lines that distinguish the complicated from the complex and representation from misrepresentation.
- A critical approach must underpin the successful use of digital games as instruments of social justice. Games are subject to the same interrogative process that underpins all media.

7 https://www.metacritic.com/game/pc/1979-revolution-black-friday

8 *Empathy, Perspective and Complicity: How Digital Games can Support Peace Education and Conflict Resolution by Paul Darvasi, 2016.*

Recommendations for Policy

- Integrate programs to instruct in the use of digital games for education, peace education, and conflict resolution in college and university curriculums.
- Train and encourage educators to implement commercial off-the-shelf games (COTS) in addition to games designed specifically with educational goals.
- Provide direction and resources to model how digital games can be modified and repurposed from their intended use to meet specific learning outcomes.
- Develop and disseminate ancillary material and resources to contextualize gameplay to better achieve desired learning objectives.
- Create online forums and/or opportunities for face-to-face discussions to contextualize gameplay with dialogue, collaboration, and reflection.
- Leverage shared virtual spaces and multiplayer game environments to enable intergroup contact and enact virtual peace education (VPE).
- Organize workshops, conferences, and symposiums where scholars, experts, and practitioners can share ideas, models, and practical experiences.
- Ensure that digital games used for the work of education and peace do not include elements of cultural appropriation, trivialize important issues or essentialize race, ethnicity, practices, and beliefs.

Potential Future Research Questions:

- How can digital games be designed and implemented to effect sustainable and positive changes in the attitudes and behaviors of ingroup members involved in prolonged and intractable conflicts?
- What are the affective and cognitive responses to the various perspectives players can take in digital games?
- How can empathy generated through gameplay lead to action and pro-social behavior outside the game?
- How do moral dilemmas negotiated within digital games affect or influence a player's real-world ethical conduct?
- What are best practices and strategies for harnessing digital games for the work of peace and education by practitioners who have little to no experience in this area?

Learnings from the Empathy, Perspective and Complicity: How Digital Games can Support Peace Education and Conflict Resolution paper by Paul Darvasi, 2016.

The Khonsaris coined the term "Vérité Games" to describe 1979 *Revolution* and their future projects, which could potentially explode into a new gaming genre. This is a form of interactive storytelling that combines advanced video game technology with elements from documentary film, and a flexible fictionalized narrative. [9]

9 https://www.theguardian.com/business/2014/nov/09/1979-revolution-video-game-documentary-launch

The creation of the *Blindfold VR* experience was an imminent result from the game. Following the story, and set in one of the games scenes, the prison with more research on characters and stories. *Blindfold* was added into the Committee to Protect Journalists Free the Press campaign, which aims to raise awareness around journalists who have been imprisoned.

Navid Khonsari thinks video games are the perfect way to put players in those sort of challenging situations that have no clear, conventionally heroic decision. And he aims to show that games can make history come alive, too.[10]

Khonsari on games: "This medium is too powerful for us to just squander it in those ways," he explains. "We should be expanding … we should be exploring it, you know? This should be an educational tool. This should be a way for us to create cognitive empathy by being in someone else's shoes." Khonsari also says he thinks his games can connect people with history in a new way.[11]

A review from a user reinforces the possibilities of games as learning tools for the present and the future:

"There are lots that people could learn and video game is just the right platform for that. You are experiencing it, feeling it, getting awed and shocked by it—not just being told. Endless possibilities and massive immersion."[12]

10 https://www.gamasutra.com/view/news/269815/How_1979_Revolution_Black_Friday_drops_players_into_a_real_crisis.php

11 https://medium.com/war-is-boring/iran-has-tried-to-kill-this-video-game-ba1b22710236

12 *User comment from Alexandre Canuto, 2016* https://medium.com/@alexandrecanuto/i-for-one-love-the-idea-of-truth-based-or-at-least-truth-inspired-games-v%C3%A9rit%C3%A9-games-a03898fcf6cd

#8
Internal Evaluation and Learnings

Process

The design was carefully thought through, and included an intense research period to collect data both from historical sources as well as from witnesses and experts. This research is visible in the richness of the materials presented in the game, which include real footage, audio and photos.

The choice of storytelling, through decision making situations is very effective in keeping the user engaged whilst providing an individually customised experience.

The game has been widely adapted to most platforms and technologies available since its inception in 2016 so it can be accessed by as many people as possible. This is possible thanks to the work iNK Stories are doing to keep the game up to date.

Product and features

The game varied features and mechanics including cinematic scenes, interactive storytelling, extras and mini games make it a very rich game to play. The use of mini games within the main narrative is also very effective at engaging during the course of the main narrative and adds an element of gaming.

There are also violent and psychologically intense scenes in the prison, which can become too harsh at times, making the story very realistic and emotional.

The dialogue system is dense yet it provides a way to explore the characters in depth.

The choice of building a game using a games engine such as Unity 3D allows the creators to make choices later of continuing the story, such as with the VR experience Blindfold which is a branch story of the game.

Content

The focus on storytelling makes the game very engaging. The dense plot is the core, with all its complex branches, the relationships with the other characters and the detail of the context history make the game truly rich and realistic.

This level of historical detail and information make the game apt for learning, however so much detail could also affect negatively making it difficult to retain.

Scalability

The initial fundraising through a crowdfunding platform was ambitious, however it reached a high level of funding 305K. This proves to be an interesting fundraising method to explore, however at the same time understanding the potential challenges of not reaching the goal.

Thanks to private donations the target was reached, and the game was able to enter into production.

Key Learnings of Relevance for SBDRR

Educational games can tend to be less praised than entertainment games, however 1979 Revolution challenges any statement by providing a unique experience blending educational games and historical thriller, connecting with players all the way until the end. It is a unique example for the humanitarian sector and SBDRR work to take learnings from, including the focus on storytelling, strategies to engage users and attention to detail.

Top takeaways:

- Digital interactive games can provide a balanced space between gameplay and learning which could be very useful for teaching disaster preparedness - particularly for awareness raising and knowledge.
- 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 initial research including interviews and contextual analysis was key to the development of a realistic story
- 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.
- Well thought and well executed scenes

offer a more credible experience.

- Creating a solid and well developed game allows for the development of second phases where stories branch out of the main story, in other formats such as VR. This is particularly important when working with technologies that are evolving rapidly over a short period of time, to provide options to remain relevant.
- Video games have a wide reach and distribution, allowing to reach a large number of users.
- It takes a lot of funding to produce this level of quality experience - this may not be accessible to the humanitarian sector.

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Disaster Scope

Estela Oliva and Mandy George

Date: Aug 2019

Project name: Disasterscope
Project owner: Itamiya Laboratory
Release date: 2019
Locale: Japan
Languages: Japanese

URL: https://www.youtube.com/channel/UCXAuPhmD_a0q1Q2f_Qtg0uw/videos

XR medium: AR with Smartphone
Hazards: Floods and Fire
Activity: Training and Awareness Raising
Age group: +8 years, adults

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#1
Project Background

Disaster Scope is an augmented reality (AR) application which contains flooding and fire smoke simulations built by Itamiya laboratory, an organisation lead by Dr Tomoki Itamiya, a professor at Aichi University of Technology (Japan). Itamiya laboratory specialise in image processing and computer graphics technology, and have been working in the immersive technologies space for the last ten years.

Demo video
https://www.youtube.com/watch?v=jjuzH-geV8Uo

The 2011 Japan earthquake was the country's most powerful earthquake recorded[1] with a magnitude 9.0 and which also caused floods and a major tsunami. During this event over 300 elementary school-aged children died[2] because they did not realise the risk of the tsunami and floods or they could not escape, although warnings were broadcasted to them (for example radio and TV reports). The children and adults were not able to imagine what a tsunami was like and did not understand the necessity for a rapid evacuation. The case of the Okawa elementary school was particularly tragic as students and teachers died because their tsunami evacuation plan was not defined and the teachers committed negligent acts.[3] After these tragic events in Japan, Dr Tomoki Itamiya decided to focus on developing digital tools for DRR education using smartphones, VR and AR.

Disaster Scope can superimpose a virtual disaster situation such as flooding with debris and smoke in the actual scene where the user is located, by using a smartphone and low-cost paper viewer. With the aim of

1 *https://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami*
2 *Japan Times, 2011.*
3 *The School Beneath the Wave, The Guardian, 2017. https://www.theguardian.com/world/2017/aug/24/the-school-beneath-the-wave-the-unimaginable-tragedy-of-japans-tsunami*

improving awareness and people's understanding of disaster risk, the Disaster Scope has been used alongside a one hour DRR lecture in evacuation drills organised by public schools and municipalities in Japan. With an estimated time of three minutes per user experience, up to 500 school students can be trained per day by using a total of ten smartphone + AR viewer kits which are available for purchase or rental from the Lab.

"This is the only application of its kind in the world. We utilised this system in evacuation drills organised by elementary schools and municipalities. As a result of the survey and verification, it is very useful for improving crisis awareness of students and citizens."

Dr Itamiya

#2 Aims & Rationale

Natural disasters occur frequently in Japan and there are systems in place for preparedness. Japan is said to be the best prepared country for earthquakes and tsunamis[4], however the great east Japan earthquake in 2011 was very extreme and many people did not have the crisis consciousness enough to evacuate quickly and safely. In response to this tragedy, the Itamiya Lab developed an augmented reality smartphone-application *Disaster Scope* that provides a unique immersive experience to improve crisis awareness of disasters during peacetime.

Evacuation drills are commonly conducted as traditional disaster education to reduce damage from natural disasters. However participants are not always interested in or committed to such drills.[5] Numerous studies of flood simulations have been conducted, but there is a challenge for ordinary people to understand them, especially for young students. Elementary and junior high schools and local governments host disaster preparedness seminars, using hazard maps and photos of past disaster areas to educate about potential risks. To understand the risk, participants select a house or school from the hazard map, read the depth of the flood, and using a numer-

4 https://www.telegraph.co.uk/news/worldnews/asia/japan/8375591/Japan-earthquake-country-better-prepared-than-anyone-for-quakes-and-tsunamis.html

5 *Tsunami Evacuation Drill System Using Smart Glasses, 2015.*

ical value, calculate the disaster scenario. These tasks are difficult to complete, especially for young students.[6]

Disaster Scope was developed as a smartphone application to respond to the need to train young people in recognising the risks of flooding, even in low level waters under 1 meter. In addition, the app also provides a fire evacuation scenario.

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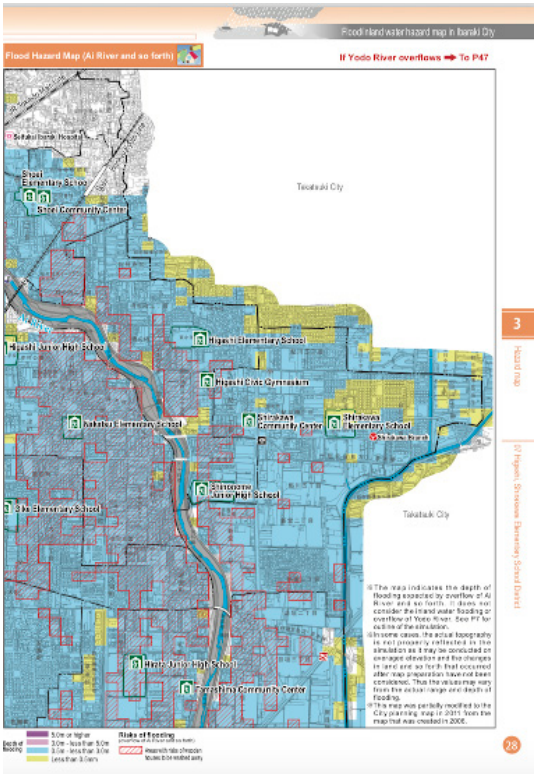
6 Disaster Scope paper, Dr Tomoki Itamiya

Examples flood hazard map indicating food depth levels:



Overflow of the Ai river, Ibaraki City Japan.

Large scale flood projection map, source Tokyo Metropolitan Government

#3
Audience

Disaster Scope is primarily aimed at school children over eight, and can also be used by adults. The app has been tested with younger students under seven, however the response observed by the Lab was that the students under 7 could not properly differentiate between fun and risk. Therefore the Lab recommend to offer *Disaster Scope* to +8 year olds.

#4
Experience

Disaster Scope puts the user inside a disaster scenario by using augmented reality to overlay computer generated simulations into the real world. The application can superimpose two virtual disaster situations including a flood situation with debris, and a fire with smoke. To experience the application a smartphone with special 3D scanning technology must be used alongside an augmented reality headset viewer.

Below is a description of the two main experiences. The average user experience engagement is approximately three minutes.

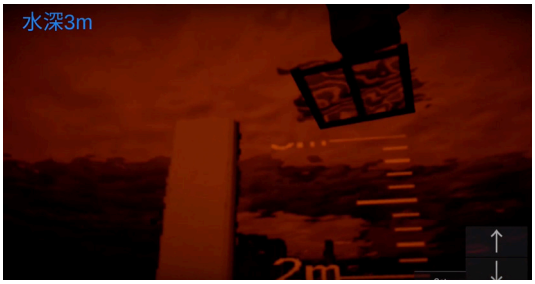
1 Virtual Tsunami and Flash Floods.

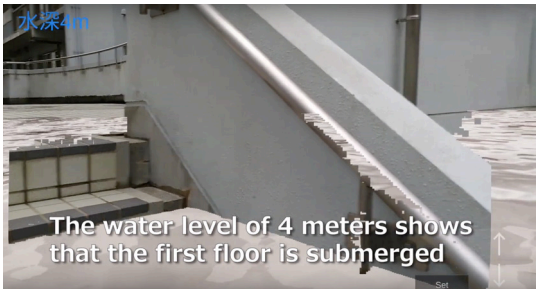
On entering the experience, water in the form of rain and flood is superimposed on the actual place the user is located and water levels start rising. The field of view is about ten meters, and users can also view other people integrated in the scene.

There is a scale to show height in meters

which allows to measure the impact of the flood and the flood's height can be customised to increase or decrease water levels through the menu. The user can both experience impact above and underwater. When the user is above water, the water speed can also be controlled through a menu to simulate flash floods, and there are objects and debris impacting with real physical objects, such as tables or walls. This allows for a very realistic view of the disaster.

If the water level height is situated higher than the smartphone, an underwater scene appears. This view is coloured in dark red and objects floating around. The water surface can be seen along with the scale by looking up. If the user walks up, for example using a staircase, they can instantly view the point above the water surface and return to the above water scene. This allows for instant understanding of the risk of flooding in the current location.

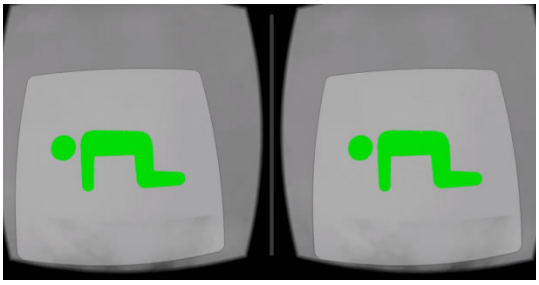




2 Fire Smoke Scenario

In this scenario, a fire appears and smoke starts filling the room (indoors). The computer generated smoke is superimposed on the image of the real location. Depending on the height where the phone is placed, the density of the smoke changes. If standing up for example, the smoke is dark, very dense and the visibility very poor.

The app prompts the user to go on hands and knees and crawl to escape. When crouching or crawling on the floor the smoke becomes clearer, thinner and the surrounding area can be viewed. Therefore the user understands that the safest way to evacuate is by crawling on the floor.

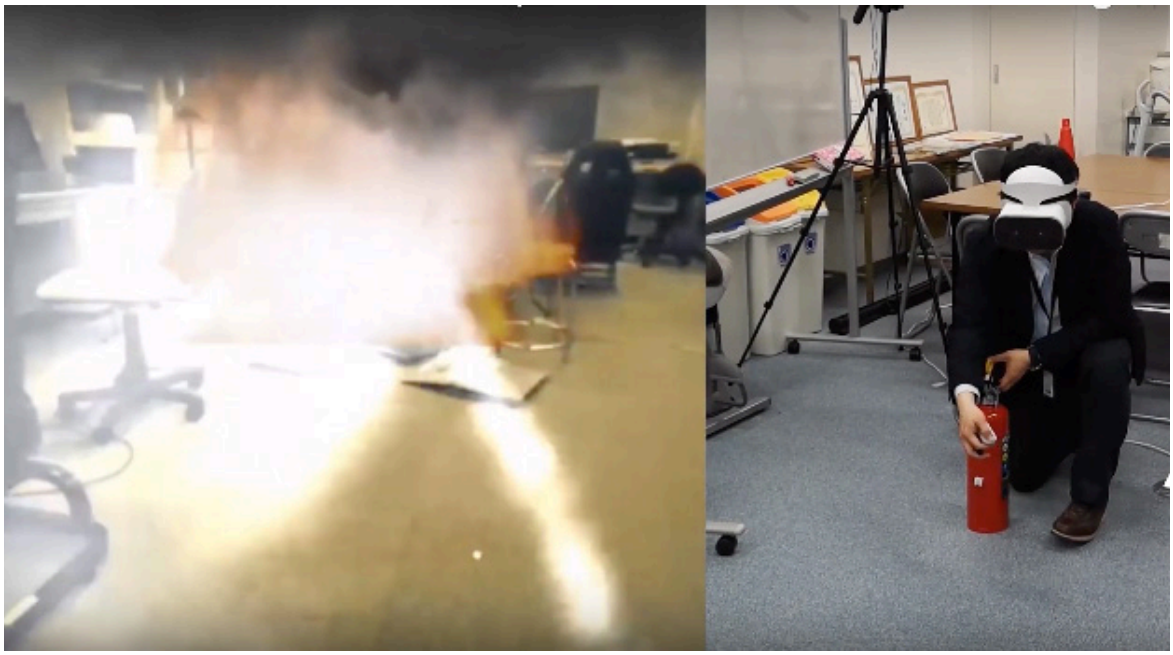


The representation of smoke was created with technical input from firefighters and is based on a video taken by the author of the appearance of smoke indoors at a real firefighter's training room in Kyoto Multifunctional Fire Fighting Centre. The low height of the smoke is 0.7 meters.

A recent test[7] documented by Tomoki Itamiya Laboratory on their Youtube channel shows a new variation of this scene with another headset, the Lenovo Mirage Solo Head Mount Display with Google VR see-through mode enabled. This iteration allows for a more realistic simulation of the smoke on walls and also coming out of specific points as well as including a fire extinguisher simulation using the headset's controller.

7 23 July 2019 https://www.youtube.com/watch?v=L9LyzZZsLwQ

Demo video: https://www.youtube.com/watch?v=L9LyzZZsLwQ



#5
Technology

Disaster Scope is an application developed with Unity's game engine which can superimpose a virtual disaster simulation using computer graphics (CG) on the view from a smartphone to reveal floods, debris and fire smoke in the actual scene.

The Itamiya Laboratory selected a specific smartphone the Asus Zenfone AR, which is equipped with 3D depth sensors and is powered with Google Tango (currently replaced by newer code Google ARCore) and Daydream technologies. Using the Tango SDK, this device is able to sense the height from the ground and recognise surrounding objects. One of the goals was to obtain real-time occlusion[8], and it was achieved using the smartphone technology. This means that for example, in the tsunami and floods simulation, users cannot perceive what is beyond the water surface until they reach the right height to be above it.

Other key features that make the simulation more realistic include:

- flooding streams with accompanying drifting objects
- detection of real world objects and collisions with CG debris
- flow speed variations
- rain falling
- smoke and fire propagation

As a result, it is possible to more realistically understand the danger of floods and fire.

Both simulations are recommended with a headset viewer, to allow better immersion in the scene. The Lab's recommended headset is a version of Google Cardboard for AR called Docooler 3D AR, which can be purchased for about 12.99 USD. In the case of the pilots performed in schools, this cardboard headset was chosen as it is easy to use and very affordable.

Dr Tomoki also recommends using the Lenovo standalone headset as the simulation looks more realistic with this device. When wearing a paper viewer and launching this application, the CG smoke is displayed superimposed on the image of the real-time scene. Since the height position of the smartphone from the floor can be precisely sensed from a 3D depth sensor, when standing up, the smoke is very dense and the surrounding visibility very poor. But when taking a crouching low posture, the smoke becomes thinner and the real scene becomes easier to see and users can fully understand how to avoid smoke during a fire.

8 AR Occlusion: hiding virtual objects behind real things.

#6
Production & Distribution

Production

Production is managed by Itamiya Labs. This includes mainly work by Dr Tomoki Itamiya, other members of the lab as well as external parties including schools. The laboratory has ten students who are part of the undergraduate programme and contribute to the research and development of the applications.
The Lab provide equipment kits which include Asus smartphones and an augmented reality paper viewer for rental to schools and municipal governments. In some cases school staff can manage the smartphone applications themselves, along with the DRR training lecture, and in other cases Lab members go to the schools to implement the training. The copyright of the app is owned by the Lab.

The Lab has estimated that they can train about 500 students in one day by renting ten kits. This includes DRR training and evacuation drill including both simulations. Schools participating in the experiences have recommended to repeat this training once per year.

Distribution

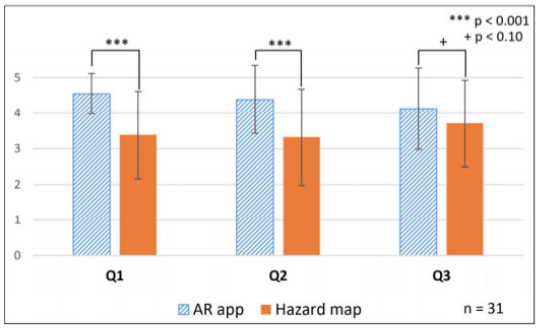
The experiences have been demoed at events such as the Global Platform for Disaster Risk Reduction organised by the UN Office for DRR.

The Lab are partnering with NTTDocomo to release and license the application for schools and local governments. The cost for a single license is about 1500 USD plus the cost of the devices - approximately 500 USD. Another option is the rental service in collaboration with NTTDocomo which offers a single kit daily rental for 200 USD, or a set of ten units for a cost of 1500 USD per day.

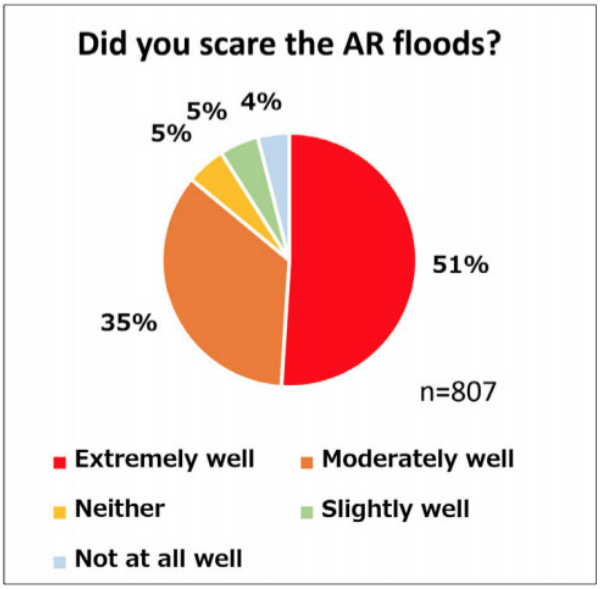
#7
Outcomes and Future Planning

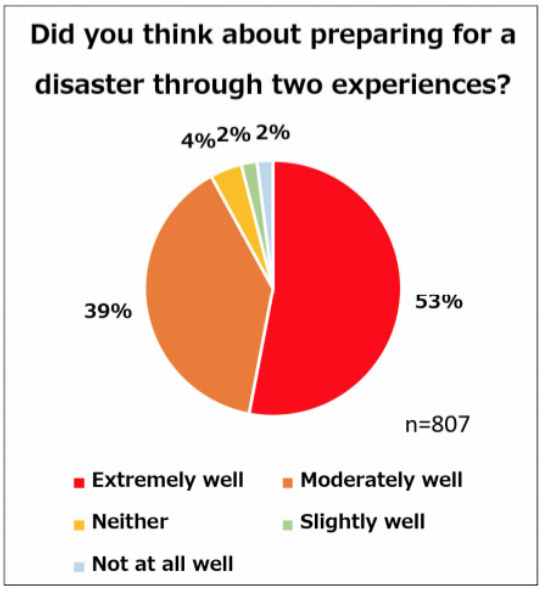
Evaluation

The Itamiya Laboratory have conducted a series of pilots in several schools and municipal governments in Japan, as well as one pilot was tested in Samoa. A survey was made to assess the impact of the drill evacuation training on 807 people aged seven to 70 in elementary and secondary schools, as well as during disaster prevention events sponsored by the municipal governments. Results include:



Contents of question	
Q1	Did you accurately understand the floods depth?
Q2	Did you feel a sense of crisis due to floods depth?
Q3	In the event of an earthquake or heavy rain, will you think about evacuating yourself by thinking of tsunamis and flooding?





- The experiences produced a high level of impact however 51 per cent of users were frightened. Further investigation should be done regarding the response amongst age groups.
- The experiences meet the goal of raising awareness of preparedness with 94 per cent of respondents saying they would think of preparing for a disaster after completing the experience.
- The experiences perform better than a hazard map, as shown on the right hand graph. In particular, users respond better to understanding floods depth and provoking a sense of crisis due to the flood depth.

Future plans

The Lab would like to spread this education programme worldwide. In Geneva they demoed the experience and got interest from organisations globally. Currently the interface is only in Japanese, however it was also piloted in Samoa at an elementary school. Since the application is not text heavy it would not need much language customisation. However the educational curriculum would have to be localised.

The Lab are also developing a VR experience for earthquakes. Some early stages of this experience are published on the Lab's Youtube channel. The VR experience shows an earthquake simulation, which can be experienced using the Youtube 360 / Stereoscopic simulation with Oculus Go. For earthquake simulations they have decided to use VR rather than AR, as it is very difficult to replicate the motion of an earthquake in AR. However Dr. Tomoki thinks in the near future (one to two years), if pictures of a location are taken with the phone and then animated, AR would be possible for earthquakes. For this to happen AR libraries would have to develop new features.

Through the Lab resources, all their applications are being developed and researched using the latest technologies and following academic practices.

#8
Internal Evaluation and Learnings

Process

There are benefits in working within an academic environment: to generate partnerships with schools, governments and commercial brands; to use internal resources to generate research; and to develop applications in a cost effective way.

Involving schools and local governments was a strength in developing the application, getting feedback from this range of stakeholders as well as distributing it to them.

Responding to an actual need highlighted by a disaster killing school students means that the experience will be tailored to actual needs and gaps identified. This ensures the technology is working towards an identified gap in traditional methods of DRR education. In the case of the floods simulation, awareness of the depth of a flood was one of the achieved results.

Design

The design of *Disaster Scope* is simple and its strength lies in the power of the disaster simulation. Even a simple design can provide a high level of efficiency given that the simulation is overlaid in the users' actual location. It tackles some of the most important shortcomings of traditional flood drills including showing a simulation of the flood in the exact location with a scale to assess how the surrounding woul be affected. The design of the application does not respond to the question of what to do, but it effectively illustrates what is happening. The interpretation how to act during the crisis situation is provided by the DRR lecture, which can be targeted to different audiences, including students, teachers and other adults.

Product and features

The application does not offer additional learning features above and beyond experiencing the flood or smoke in a realistic way, therefore the content of the accompanying lecture is key to reinforce the learning element, and provides children with more resources to be equipped for responding to disasters.

Both experiences provide a very efficient

and realistic view of the disasters:

- The flood experience shows the scale at all times, providing an instant and efficient reference to users of the impact of the flood.
- In the case of the fire, the use of realistic smoke with layers from top being thicker to bottom being lighter allows the user to get a sense of the reality of a fire and how to escape.

Survey results indicate that the augmented reality version of the app provides a more realistic picture of the flood depth than the traditional hazard map. This is a great achievement given that during the 2011 disaster this was one of the key reasons why people were not able to save their lives. It is expected that this training would allow people to be safe during crisis, however there is no evidence of this recorded yet given how new the experience is.

Content

The realism of the simulations, combined with the use of the real location make the experience highly effective in achieving its goal of raising awareness of the disaster. This means that the app can be used in any location and it will always be customised to that location. The use of simple visual messages, such as the scale and the crawling alert, make it very simple for users of all ages to understand. However the lack of guidance in the experience and the lack of targeted learning features makes the project difficult to understand without the accompanying lecture.

In the case of the fire evacuation experience, the main learning presented was simple and effective, to train children that below the fire there is a safe route to escape by crawling. However there is no evidence that this goal has been achieved.

Scalability

The rental system is an innovative approach to provide an affordable system which is suited to schools and government to allow them to focus on training rather than maintaining the technology. With the estimated 500 students per day of training and the cost of 1500 USD for rental, the cost per student works out as 0.33 cents. This is expected to be considerably cheaper than physical disaster simulations in Japan.

In order to scale up the distribution of this simulation to other countries, translation into other languages would be required. However the computer animations would not have to be localised as they can overlay on any scenario. This would save cost in relation to other XR media like 360 video which is more resource intensive to localise, as the content is filmed in a specific location.

Effectiveness

The results from the customer surveys showed that using the application was useful in the context of improving awareness amongst students and citizens. However further evaluation would have to be performed to identify the potential opportunities and challenges of the experience.

Key Learnings of Relevance for SBDRR

- The potential of augmented reality for SBDDR is immense and is yet to be discovered.
- AR can come with limitations to knowledge acquisition. The immersive experience will not achieve all the desired learning goals. Any immersive experience is recommended to be used alongside a curriculum module in which students can learn and retain DRR knowledge.
- 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.
- Language customisation is necessary for full scalability.
- AR is effective and impactful but should be used with caution as the high level of realism can be frightening, particularly for younger audiences. Further investigation is recommended to assess the impact of this experience in relation to a control group.
- The age groups have to be considered carefully when showing disaster content, as it can trigger traumatic experiences. More research is needed to assess the impact of disaster simulations on all age groups, as well as on sensitive groups who have already experienced trauma.
- Simplifying the experience's features to the minimum can be very effective in achieving targeted goals. For example in the fire evacuation training, children learn to evacuate the premises by crawling.
- Teachers have to be targeted as much as students, particularly given that they are responsible for managing the students during crises. Further research is required on how to best target teachers.
- Offering flexible distribution options to schools such as the rental service could be very beneficial model for schools and local governments. This method takes away the difficulties of updating and maintaining the technology, whilst saving costs per trained user.
- Working with academic research groups could be beneficial to pilot test experiences that could further developed and be scaled following extensive user testing.
- A commercial partnership with a technology provider might be beneficial to scale the project as well as to maintain the technological standards and maintenance.
- In approximately one to two years, the augmented reality technology tested in this experience is expected to become more powerful, affordable and available at a wider scale. This will be an immense opportunity to further investigate and develop new lines of work.

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Immersed: a VR experience about flood and resilience

Mandy George and Estela Oliva

Date: July 2019

Project name: Immersed: a VR experience about flood and resilience
Project owner: Federal Emergency Management Agency (FEMA)
Release date: 2016
Locale: USA
Languages: English, Spanish, French, German, Russian, Turkish
URL: https://www.fema.gov/immersed
XR medium: Virtual Reality: fully immersive
Hazards: Floods
Activity: Simulation
Age group: 13+

Table of Contents

#1
Project Background

Immersed is the Federal Emergency Management Agency's (FEMA) flood risk visualisation immersive virtual reality tool targeted at US local officials. It helps to educate community leaders about the value of flood preparedness by fully immersing users at the center of a flood crisis, allowing them to assess damage in a community and see the benefits of mitigation actions. It is the first large-scale virtual reality tool developed by FEMA and was produced in 2016 in partnership with Resilience Action Partners, a Michael Baker and Ogilvy joint venture, and Brightline Interactive[1]. FEMA's communications team led on the project and used the expertise of behavioural scientists and designers.

Immersed puts the viewer in different flood situations including a flooded home, a washed-out busy traffic intersection and a flooded school. The simulation plays through these scenarios, showing what happens to an unprepared community when a flood hits. It then replays the three scenarios, showing the user how flood-mitigation steps could have prevented each situation. The goal is for community officials to walk away inspired and armed with the information needed to start mitigation action projects, such as installing proper drainage systems or porous pavements in areas with a flood risk. Users can act out scenarios in the virtual environment like directing traffic on a flooded road or walking around a home flooded with three feet of water.

Immersed is part of a larger community-engagement program on flood mitigation that also includes community meetings, informational materials, partnerships, and training sessions. It contributes to FEMA's mission to *"lead America to prepare for, prevent, respond to and recover from disasters with a vision of "A Nation Prepared."*[2]

1 https://www.brightlineinteractive.com/

2 https://www.fema.gov/about-agency

#2
Aims & Rationale

The aim of *Immersed* is to change behaviour by urging local officials to take steps in flood preparedness. Flooding is the United States' most common and costly natural disaster and the one that FEMA receives the most funding from congress for - this is the rationale behind the focus on flooding. They recognised the necessity for community leaders to be equipped with the information, tools and skills needed to take mitigation action and that doing so can provide a positive return on investment in terms of lives, property and money saved[3].

Virtual reality (VR) was chosen as a medium for this message delivery in order to create a more visceral reaction and emotional connection to the issues linked to flooding. Flood risk is difficult to visualise and to understand, and Immersed allows the user to experience a major flood event in a real, personal way. Virtual reality was also chosen, according to FEMA, because *"VR helps us to create and control the story."*

3 Every $1.00 spent on mitigation saves a community an average of $6.00, according to the Multihazard Mitigation Council

#3
Audience

Immersed is specifically targeted at community officials because they are the people that decide funding levels and drive action across the country to combat flood risk. In future versions of the project, FEMA aim to target the general public.

The age range of 13+ was established by following HTC Vive's age requirements for VR experiences.

#4
Experience

Immersed takes a constructivist learning approach, one in which learners are not passive receivers of knowledge but instead interact with their environment to construct new knowledge. It is a six minute long VR experience set in four different virtual locations:

1. School
2. Home
3. Road intersection
4. Emergency operations centre

From the perspective of a community leader in a flood-affected town the user can:

- Explore the damage in a flooded neighborhood
- Witness the challenges of an evacuation
- Lead a stranded teacher to safety at a flooded school
- Experience mitigation decisions being made and the impact that they can have
- Discover which preparations can lead to positive results

As the community official user goes through the experience, the experience encourages them that they are able to make a difference and that it is in their power to take meaningful action and effect change.

The experience has three different stages:

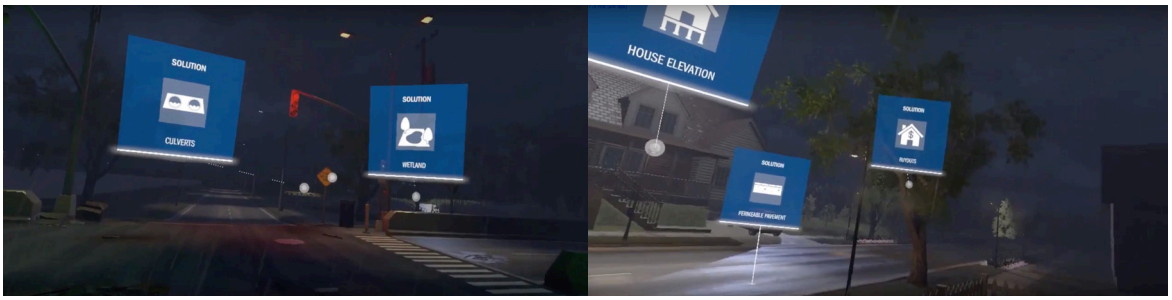
1. The user goes through the three scenarios (home, school, intersection) for the first time
2. Users explore additional information about mitigation action from the virtual emergency operations centre, including:
    - Descriptions of and specifications for the different types of action

- Details on grants and other programs that are available to support communities in taking action
- Information about a variety of related topics, including the National Flood Insurance Program, hazard mitigation planning and community engagement.

3. The user is then taken back to the three scenarios where mitigation actions have happened to show the impact of these actions.

The user makes choices and selections by using a menu controller, which is represented as either a flashlight or a traffic cone.

The experience is fully immersive, with basic 3D graphics. However FEMA states that users forget about the quality of the graphics once they are in the simulation and the immersive experience continues to work well. The graphics are generic enough to look like a typical US school, home and road intersection. *Immersed* is only available in English.



#5 Technology

Immersed is built in Unity. To play it, a gaming computer is required along with HTC Vive headsets. The audio comes through headphones that users wear. The poles that are stationed around the experience hold the sensors to create the 3D environment.

At the time it was designed in 2016, it was cutting edge.

FEMA is working on a smartphone app version on Samsung Gear to make it more portable and accessible and available on the Google Play and Apple App stores.

FEMA would like users to be able to download and use it themselves without being reliant on them to deliver the experience. At time of writing the experience is only delivered by FEMA to community officials, never independently.

FEMA fully owns the content and therefore has no licensing issues. The app does not gather or store information on users. Maintenance is conducted by external contractors.

#6
Production & Distribution

Process & team

Immersed was produced over the course of 2016 by a team comprised of FEMA and contract support in a joint venture called Resilience Action Partners. Agencies Michael Baker International and Ogilvy lead the creation of the experience, including cultivating the narrative, behavior science principles it is based on, storyboarding, national roll out and promotion. Brightline facilitated the technical design elements of the experience. FEMA was responsible for the technical storyline development and used experts from their insurance and mitigation, external affairs and community engagement teams. The storyline process was an iterative one lasting approximately four months. FEMA field staff reviewed the script for accuracy. Non-technical decision makers were able to provide feedback during the initial stages of the development through user testing.

Distribution

Immersed is delivered by FEMA staff who take the equipment (computer, headsets and sensors) on the site, most commonly at national and regional events and conferences. It is not integrated into any specific training sessions or curricula.

The experience is often used as part of discussions on updating national flood maps to take people beyond merely looking at the map to understanding what it really means. FEMA uses the experience to start a dialogue and then to discuss how to empower flood management actors at the regional and local levels.

After users experience *Immersed* they are given a flyer to take away to support next steps and turning the new knowledge into mitigation actions. The flyer lists some of the options such as installing flood warning signs, protecting or restoring natural

wetlands, and using permeable pavement.

Immersed is part of a larger FEMA community-engagement program on flood mitigation that also includes community meetings, informational materials, partnerships and training sessions.

User feedback

FEMA do not currently have feedback mechanisms built into *Immersed* above and beyond gathering anecdotal information post-delivery and have recognised that this is an area for improvement. FEMA is currently in discussion with their measurement team to decide how to build a monitoring and feedback system into the new app version of *Immersed*. This will include both passive feedback, for example based on how long users stay in the app, and active feedback, for example a post-experience survey of five questions.

Challenges

FEMA identified various challenges in the production of Immersed.

- *Scalability:* The current version of Immersed on HTC Vive is hard to share given the software and hardware requirements, and need FEMA to deliver it. Building a new version in an app compatible with Samsung Gear will overcome this issue, however performance might be compromised
- *Privacy and security issues:* This was the greatest challenge in the production of Immersed. Government privacy laws have restrictions and there is a need to limit data exchange. FEMA were required to find ways for the app to only gather minimal user data and not interact with internal servers or data. No information on the user is stored by FEMA. This issue is predicted to delay the release of the app.
- *Challenges between HQ and regional level:* FEMA reported some internal challenges between HQ and regional levels that impeded the roll out of the tool.
- *Reputational issues:* One of the drivers behind the production of an app version of Immersed is to allow use without FEMA being involved. Reputational issues have been a barrier to more widespread dissemination of the experience.

#7
Outcomes and Future Planning

Future plans

Immersed

For the current version of *Immersed* for community officials, FEMA plans to:

- Continue the roll out of *Immersed* at the regional level in conferences and events and as part of the delivery of the updated flood map and continue to empower community. officials to have conversations about flood risk mitigation.
- Put a monitoring and measurement system in place.
- Work on a mobile app version for Samsung Gear VR to make it more portable and accessible, that will be available on the Google Play stores.
- Provide each of the ten FEMA regional offices with headsets to allow more autonomy of roll out from HQ.

New VR and AR experiences

FEMA has two new XR experiences: *Floodwalk*, an augmented reality application that has already launched, and *Immersed* 2.0 that is intended to be released at the end of 2019. The new VR and AR experiences are targeted at the general public.

This shift in audience is based on work with behavioural scientists that highlighted the need to create a demand for change at the community level because the largest barrier to meaningful change is convincing community members to make those changes. Once FEMA had decided to target the public, in 2018 they conducted studies to see what the public would find most useful out of a virtual reality experience. The results indicated a desire for more gamification features, such as a points system or to be able to compare scores with neighbours. However FEMA's behavioural scientists cautioned against too much emphasis on gamification given that this is not what drives action or outcomes, as key message(s) can be lost. As FEMA explains, *"The danger with gamification is that it becomes more about doing damage than about what to do about the risk and the damage. It can increase engagement and numbers of participants and users, but does not lead to the same result."* They do however recognise that with youth gamification of serious topics may be more appropriate.

Immersed 2.0

FEMA is working on a new VR experience, *IMMERSED* 2.0. It is currently in production and should be complete by the end of 2019. It will be built as a smartphone VR app for Samsung Gear because the durability and cost effectiveness, recommended by Brightline Interactive. The second version builds off the first virtual environment and story and will be produced with the same agency Brightline. FEMA plan to build *Immersed* 2.0 into the same Immersed app

rather than designing a new one.

Immersed 2.0 will no longer target community officials, but the general public and will be five - seven minutes in length. The aim is to challenge homeowners to make decisions for themselves in a flood and see the impacts their decisions and consequences of inaction have across the whole neighbourhood. For example, how to ensure you can still commute in a flood or pick the kids up from school. *Immersed* 2.0 is centered around a family in a home and uses techniques to increase emotional connection with the storyline, such as seeing the personal impact of a flood through images of family photos floating in the water, or the water rising above your childrens' height marks on the wall.

FEMA discussed customising *Immersed* 2.0 to different areas of the US or different types of homes, however this was ultimately not possible given the elevated cost of this level of customisation. It is designed to be representative but not fully customised though FEMA recognises that the experience would be more impactful if this customisation was possible. FEMA built a diverse family into the experience, for example with mixed-race family members and an adopted child. Immersed 2.0 will be available in English and may be translated into Spanish and French. It will contain a high level voiceover and audio effects, for example the sound of rain.

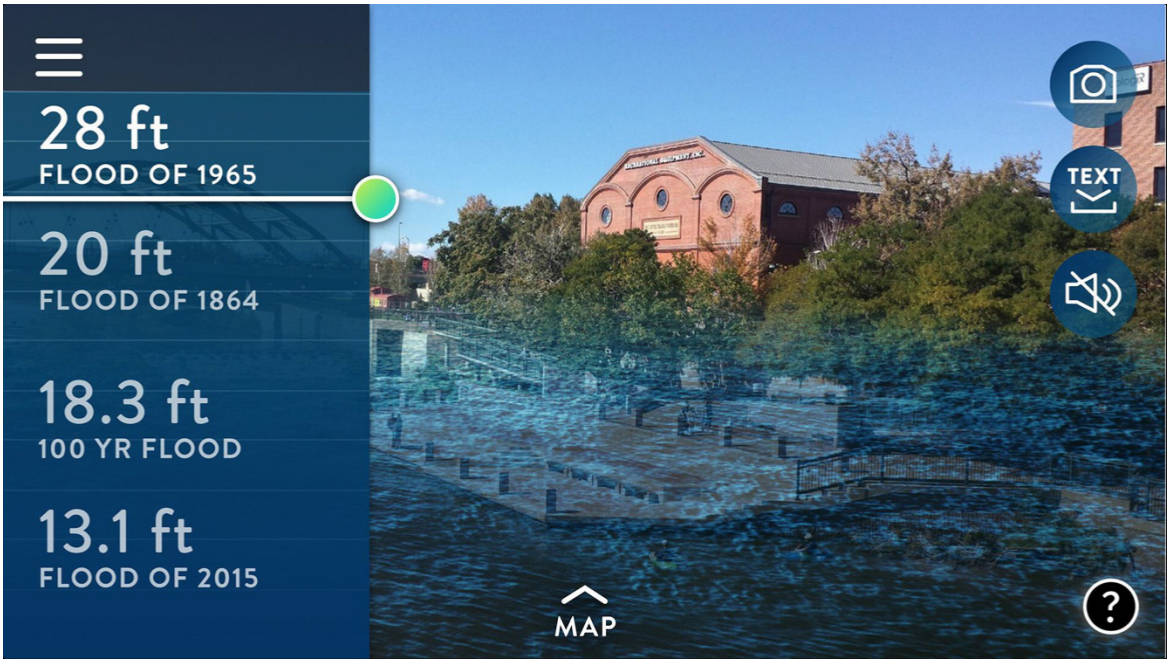
Floodwalk AR

In collaboration with agency Bajibo[4] based in New York, FEMA have also recently produced an augmented reality experience called *Floodwalk*. The *FloodWalk* App is produced specifically for Denver, Colorado in the US and uses augmented reality to educate and engage users about flood risk and hazard reduction. It allows the user to visualize historic floods, learn about how to reduce risk, and see what has already been done to make Denver safer and more resilient to natural hazards.

Features include:

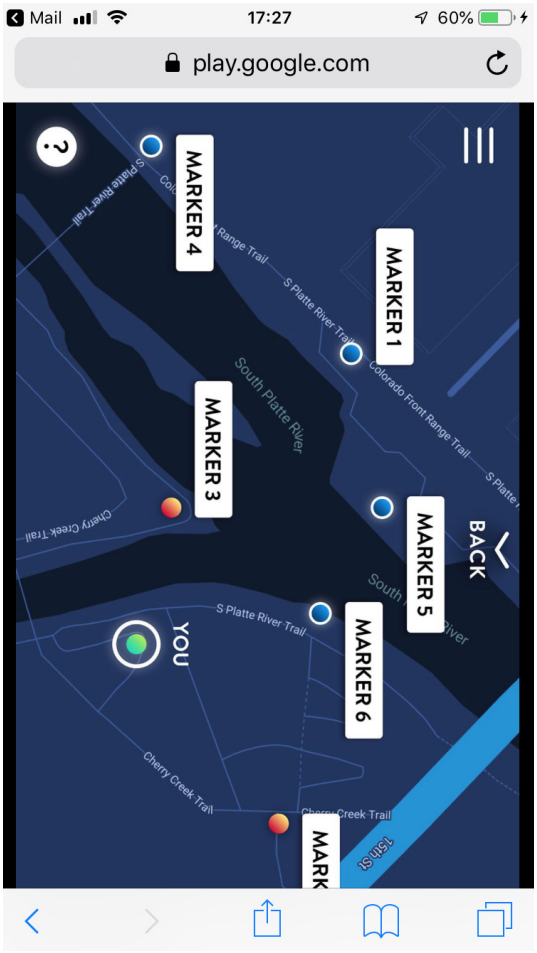
- On-screen text and audio voiceover narration
- Historic photos and research that overlay damage from actual events
- 6 totems show areas of historic flood risk and mitigation actions [see image]

4 https://www.bajibot.com/



- A slider allows the user to see different levels of flooding
- Video to show the value that mitigation brings, to some of the public areas that people might not realise are designed to reduce their risk
- Shows what areas look like before mitigation and what they look like now
- Users can enjoy each experience from within the predefined locations or from home
- There is an option to take and share photos
- Connect through linked resources to learn more about what can be done at home to further reduce risk

In the future FEMA will be able to add in different locations to the same app if other communities are interested in developing a similar tool.



Floodwalk was released on June 13 2019 on the Apple Store[5] (for iPhones 6s and newer) and Google Play (for Androids) stores in English and Spanish. It has an age rating of 4+. A total of nine consumer ratings to date give the experience five out of five on both app stores.

Floodwalk is a collaboration between: Resilience Action Partners[6], The City and County of Denver, Urban Drainage and Flood Control District (UDFCD), The Greenway Foundation, and the Chatfield Reservoir Mitigation Company.

Other future plans

In the future, FEMA would like to use augmented reality to show property-specific flood risk information in a visually compelling manner. The technology is already available for this feature, as is the ability to predict increased risk in the future like sea level rise, but the FEMA predict it will take several years before this is possible. They would also consider using real time data from, for example, FEMA Flood Risk Data and the US Geological Survey, to represent real time flood risk. FEMA predicts that the challenge will be how to build this functionality in a way that is acceptable on the legal and IT sides for data privacy. *"This [AR and real time data] is the solution of how to educate people on risk in their community but we have a lot of groundwork to lay internally before we can even have that conversation."*

5 Requires iOS 11.0 or later. Compatible with iPhone, iPad, and iPod touch
6 Resilience Action Partners JV is comprised of Michael Baker International and Ogilvy Public Relations and is funded by FEMA

Key learnings

FEMA state that they have had *"lots of eye opening learnings from the process…."* of creating *Immersed*. These have been gathered and reflected on informally as there has been no formal evaluation of *Immersed*.

Learning points include:

- *Focus on the outcome and not the cool factor:* It can be easy to lose the outcome in some of the cool factor. It is important to identify what outcome you are striving for and continue to evaluate it throughout development.
- *Immersion works:* The immersive part resonates very well. People actually start to understand their flood risk and it spurs the right conversation afterwards.
- *Balance realistic vs overwhelming*: Getting the balance of the realism of the content to motivate community officials to take action, and not being overwhelmed by the intimidating nature of the content was a process that took some time. This was even more relevant to the development of Immersed 2.0 that targets the general population and possibly younger audiences. FEMA's advice is,

"Don't be too afraid of using less realistic graphics, it will help with some of the separation. You're not trying to scare people, you want an emotional connection but don't go Hollywood-esque."

- *The importance of user testing and evaluation*: FEMA highly recommend user testing throughout development and evaluating the experience through the lens of the desired outcome.
- *Showing the value of mitigation is not enough - you need to empower action:* Feedback from community officials on Immersed highlighted that *Immersed* sparks the right conversations among community officials and that they learnt the value of mitigation actions but questioned how to do something about them afterwards. Therefore FEMA realised they needed to offer a way to empower people to connect and take action. *Immersed* is not designed to solve risk, but to kick start the conversation and get community officials to demand action and change. FEMA need to be able to empower community officials to have a better conversation with the people who can make those changes.
- *Need to make the experience more personal and emotive:* The community official experience works for that specific target audience but not for the general public who do not see community-wide risk as their responsibility. Therefore when FEMA decided to create a virtual reality experience targeted at the general public (*Immersed* 2.0) they knew they needed to make the new experience more personal and emotive. Therefore *Immersed* 2.0 is centered around a family in a home that shows flood damage with everyday items that create a sense of connection around them. This emotional connection can change behaviours, particularly when combined with the analytical side of the brain.

#8
Internal Evaluation and Learnings

Process

The design process was resource intensive given the work with high profile external creative and PR agencies. It involved a wide range of stakeholders from both within FEMA to inform the storyline content and ensure accuracy, and externally for both the technical expertise and behavioural science. The specific inclusion of behavioural scientists in the production process was a strength for ensuring *Immersed* would have the greatest impact on community officials. In *Immersed* 2.0 this also balanced requests from the end user, in this case increased gamification, with the techniques that would have the most impact on learning outcomes and behaviour change.

Looking forward, reusing assets from *Immersed* to build *Immersed 2.0* will increase the cost effectiveness of the new virtual reality simulation.

Product, features and content

Immersed is highly customised for the niche audience it serves. Although the graphics no longer appear cutting edge, *Immersed* was ahead of its time and one of the first disaster management virtual reality simulations produced. It is a testament to the quality of the product that it is still effective today to encite behaviour change in community officials. The most out of date components and barriers to scaling up, such as the computer connected headsets and cost, are being replaced by FEMA with the new Samsung Gear app version, therefore ensuring relevance going forward, however performance might be affected, as Samsung Gear VR does not offer high-end VR performance as it is tied to a smartphone's features.

Immersed 2.0 will bring the experience to a new, much larger group of users. A missed opportunity, recognised by FEMA, was not incorporating more decision making and branching scenarios into the experience. It focuses on flood impacts and household mitigation actions and the user is able to see the consequences of these - however the user is not put into the position of having to make decisions themselves.

"Because of funding constraints, one thing we are not doing in the new one enough is to make it more interactive and have people make more decisions. We know people make bad decisions in disasters, but we haven't come away from the story line too much."

There are some safety concerns in the school scenario of *Immersed* when the user has to evacuate a teacher and has to walk across a small board. A number of users have felt so immersed in the experience that they jumped and nearly hit a real wall in the room where trialing the simulation. When this is turned into an app and FEMA is no longer present at the demos, health and safety should be considered.

FEMA has plans to build a monitoring and feedback system into the new app version and this will be important to be able to better evaluate *Immersed* and understand impacts.

Scalability

The ability to distribute *Immersed* more widely above and beyond conferences and events with representatives from FEMA HQ was compromised until the arrival of standalone VR headsets that increase scalability exponentially. FEMA recognised this potential as soon as the technology was available and planned the launch of a smartphone version of the app and a roll out plan of providing headsets to the regional offices to give them more flexibility to scale the reach of Immersed. Samsung Gear headsets retail at approximately 35 USD and can be run with the users own smartphones. Together the phone and headset are significantly cheaper than the gaming computer headset combination and also provide more flexibility to use the headsets at events and meetings without the need for computers, poles and speakers.

The augmented reality app *Floodwalk* was expensive to produce but now offers the ability to integrate other locations at a lower cost if partnership arise in the future. The app itself is highly scalable among users with access to smart phones with iOS 11.0 and up as it is free.

Effectiveness

Despite a lack of thorough evaluations, FEMA has been able to gather anecdotal feedback from users that indicate that the virtual reality experience is achieving the awareness raising aim of being aware what mitigation steps community officials can take. They have also recognised that to achieve their aim of behaviour change, they need to find ways to facilitate next steps and actions.

Key Learnings

Although Immersed is not targeted at teachers or students, there are many key learnings of relevant for SBDRR from this hazard focused virtual reality experience.

- Immersion works to help understand flood risk and other concepts that are

hard to imagine unless they have been previously experienced.

- The combination of emotional connection with analytical tasks like decision making in virtual reality experiences increases behaviour change.[7]
- Augmented reality allows more personalisation or customisation of an experience and virtual reality allows for more control of the narrative.

- Identifying key outcomes from the start and regularly checking they are being achieved in the design is key to not being distracted by the "cool factor" of new technologies. User testing can help with this process.

- Sacrificing on the realistic quality of graphics in virtual reality does not automatically mean a less realistic or immersive experience, and can help to separate the immersive experience from reality. This can be useful for younger audiences.

- While compromising some of the quality of the experience, choosing to build experiences for mainstream platforms, especially those powered by smartphones, enables reaching a wider audience and empowering them to use it by themselves.

- Balancing the requests of users with behavioural science is important to ensure learning outcomes can be achieved.

- When planning an immersive experience to ensure behaviour change is achieved it is necessary to think beyond the end of the delivery of the experience to what happens next. For example to empower action for mitigation tips

7 For examples of analytical decision making, see the case study of Ania Design Lab's Philippines Disaster Preparedness Simulator, and the example of Auckland City hospital earthquake preparedness simulator: https://arxiv.org/abs/1802.09119

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