Scope of Virtual Reality (VR) Based Disaster Preparedness Training for the Less Literate and Illiterate People

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Abstract

Virtual reality (VR) has evolved over the past decade, and as this evolution continues, scope and significance of using VR in various educational settings are worth exploring. With the availability of low-cost Google Cardboard VR tool and emergence of affordable smartphones, the possibility of creating a participant-centric virtual reality learning environment even in developing countries is not unthinkable. However, there remains a void in the adaptation of the VR based tools in the developing countries. As of today, no initiatives are taken to create a learning setting which would allow less literate and illiterate people to overcome some of the evident curses of illiteracy through planned elevated use of other senses such as vision and sound.

To contribute to this identified void, the author conducted two iterations of small-scale fieldwork where VR based technology was used alongside the author's existing 'Training in a Tab' project. In this project, a tablet device based disaster preparedness training was provided to the technologically disadvantaged, predominantly less literate and illiterate group of people. In 2016, a pilot study was conducted at Uthali Village located in the Manikganj district, Dhaka division, Bangladesh followed by a post-pilot scaling study in 2017, conducted in the Teknaf Subdistrict, Chittagong division, Bangladesh.

Findings from the fieldwork suggest VR based system can be compatible with the existing practices and it is possible to use the VR based system to enhance the learning process in a social setting. From a pioneering initiative to integrate VR within a less literate population, this paper contains a brief record of the use of VR in disaster preparedness settings, sets out the rationale for using this in the developing countries, provides an introduction to possible methods that can be used in the fieldwork. The early findings of both studies affirm VR based system's possibility in stimulating 'disruptive learning' among the targeted less literate population which can lead towards long-term change in the participants' perspectives on disaster awareness and can make them further interested in learning more about disaster preparedness. Despite the concerns with localised content creation, the findings will be able to guide future researchers who might want to create VR based training for a similar population.

Keywords

Virtual Reality (VR), Disaster preparedness, Disruptive Learning, Training In A Tab, Rapid ethnography.

Introduction

Technological artefacts are entangled with our everyday life and have enhanced our lives to many folds. Effective use of technology can empower even the poorer communities. We have seen how mobile phone has managed to defy the class gaps and reach to the technologically deprived communities and created a more extensive, better and quicker communication network (Aker & Mbiti, 2010, Kaplan, 2006, Donner, 2008). Many of those communities are also prone to various natural disasters. Flood, cyclone, drought and earthquake been the most common ones. It is a common practice of the NGOs and governments of developing countries to engage in building up a pool of volunteers who will assist during any natural disasters. However, there are growing concerns that due to lack of recognition of the early

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warnings, communities remain vulnerable and susceptive to loses of lives and resources due to natural disasters (Yap, Heek & Ospina, 2011). It is a growing concern that in the developing countries there is a persistent shortage of resources which limits the scope of disaster preparedness education (Chen, Liu & Chan, 2006; Mishra, Fuloria & Bisht, 2012; Tarek, 2014a). Research initiated by Tarek (2014b) found that tablet-based devices can be used to prepare technologically disadvantaged communities with low literacy better to face natural disasters. This paper looks into a fresh perspective of using VR technology in mass-oriented disaster preparedness training to save lives in the developing countries.

Challenges with the traditional approaches

Common problems that are faced to provide disaster preparedness training in developing countries are resource limitation in the form of lack of experienced trainers, lack of localised contents and supportive systems (Pearce, 2003; Firoz, 2010; Kulatunga, Wedawatta, Amaratunga & Haigh, 2014). In general, rural people mostly remains at dark as designing a training programme for less literate or illiterate people is challenging considering the language of modern technology artefacts is ‘English’ and the translations of the English content to the native language is still in its infancy. The expertise that is required to create localised content and design learning settings where the challenges can be minimised or eliminated remains scarce.

In cases where the local volunteers are trained, the content is mostly delivered in a traditional classroom setting. This approach often becomes monotonous after a while, but also it limits the participant's ability to take an active part in real life problem-solving scenarios. At volunteer level, some of these training occasionally include tabletop exercises where a simulated emergency situation is discussed and some short real-life drills. Despite those efforts, one critical element remains missing which is ‘realism'. Drills and exercises can somewhat bridge the gap, but these activities are prone to inconsistency as in a real-life event there are many elements which are beyond human control. Virtual reality is such an advanced, cost-effective technology that may be used to further reduce this gap (Farra, Miller & Hodgson, 2015).

Technical background of VR

VR typically refers to computer technologies that use software to generate the realistic images, sounds and other sensations that replicate a real environment (or create an imaginary setting), and simulate a user's physical presence in this environment (Helsel, 1992; Lacrama & Fera, 2009). VR can be defined as an immersive, realistic simulation of a 3D environment created by a combination of hardware and interactive software which is controlled or experienced by bodily movements (Psotka, 1995; Brooks, 1999).

A person using virtual reality equipment is typically able to "look around" the artificial world, move about in it and interact with features or items that are depicted on a screen or in goggles (Rheingold, 1991; Pimentel & Teixeira 1993; Biocca & Levy, 2013). Guo (2017) noted that most 2016-era virtual realities are displayed either on a computer monitor, a projector screen, or with a virtual reality headset (also called head-mounted display or HMD) (Smolentsev, Cornick & Blascovich, 2017). HMDs typically take the form of head-mounted goggles with a screen in front of the eyes. This screen in the majority of the cases is mobile

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devices. In such systems. VR programs may include audio and sound generated by the speakers or headphones of the connected device.

Existing initiative of VR use in disaster preparedness training

Hsu et al. (2013) reviewed several VR-based simulation disaster training projects in the United States, on the governmental, academic, and private sectors. Among government agencies, New York City Office of Emergency Management (OEM) uses VR-based training where trainees can communicate emergency response needs through a facilitator who guides them through decision points and objectives. Los Angeles Police Department (LAPD) uses the commercially available Hydra simulation system to foster disaster-based training for its incident command officers. Hydra features immersive simulation training with video feeds that monitor decision-making processes. DHS Federal Emergency Management Agency (FEMA) is developing several DHS projects that aim to align with modelling and simulation priorities at the FEMA National Exercise Simulation Center (NESC) to create tools that may support future National Level Exercises. Based on his comprehensive review Hsu et al. (2013, section 9) concluded that

> …the emergence of virtual reality platform-based technologies applied to disaster preparedness and response training offers significant potential advantages over other traditional forms of training and is gaining increasing acceptance.

Two studies conducted with a short time gap, first one by Kizakevich et al. (2007) and Heinrichs, Youngblood, Harter, and Dev (2008) evaluated participant VR experiences in disaster training using short response questionnaires. The authors found that a majority felt immersed and reported an increase in confidence following participation in the simulation. Both studies were located within clinical settings. Physicians and nurses in a VR, caring for disaster victims in an emergency department, felt VR was useful for learning teamwork and clinical skills (Heinrichs et al., 2010).

Considerations for a VR based research in the developing countries

There are three basic requirements for a VR system: 1) VR headset, 2) A mobile device capable of providing VR functionalities and 3) Content for the VR system. Google Cardboard is an excellent low-cost VR viewer. At present, there are many basic Android smartphones which cost just a bit more than the best range feature phone, and they are supported by many Google VR apps which are available for free. Unfortunately, there is VR content scarcity. However, as this technology has started to get mainstream attention, soon the higher costs associated with VR content development can be further minimised.

Research problem

Whether VR content (e.g. 360-degree videos) can be comprehended by less literate and illiterate participants in the developing countries were not practically tested in the past. Similarly, to what extent VR based systems can be used within an existing disaster preparedness training programme for the same group of participants were not explored yet. The main focus of both iterations remained to contribute to both of these issues.

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Conducting the VR-based empirical research

The author had followed interpretivist philosophy in the research design as the nature of the research was explorative, and the participants were believed to have their way of constructing reality. The research strategy was rapid ethnography which has its roots in the works of Pink (2001) and Pink and Morgan (2013) and was further developed by Tarek (2017a, 2017b). In a rapid ethnographic setting, various data collection points are used for later analysis which compensates for the shorter direct involvement in the field. In this variant, captured videos and observation logs enable the researcher to conduct data analysis out of the field.

Observation and interview were used as the main methods of data collection. The incorporated research strategy was suitable as that approach could emphasise the participant's subjective experiences which can reveal meanings that people place on the events, processes, and structures of their lives and their perceptions, presuppositions and assumptions.

Locations

The pilot study was located in the Uthali Village located in the Manikganj district, Dhaka division, Bangladesh. The location is close to the River Brahmaputra. The pilot study took place in October 2016. The post-pilot scaling study was located in the Teknaf Upazila located in the Cox's Bazar district, Chittagong division, Bangladesh. The location is close to the Bay of Bengal. The scaling study took place in January 2017.

Sampling technique

As the research was experimental, it required enthusiast participants. To ensure wider coverage, the author used purposive sampling in both cases. In this research, a literate person was defined as someone who could confidently communicate with the community using a range of techniques including reading and writing. A Semi-literate person was someone who lacks fluency in reading and writing. An illiterate person was the one who was unable to comprehend the written form of the native language. Participants who could use feature mobile phone were treated as mature and others as entry-level technology literate.

TABLE 1: SAMPLE FOR BOTH ITERATIONS

			Pilot: Uthali (Total 5)		Scaling Phase: Teknaf (Total 12)	
Age	**Technology Literacy**	**Literacy**	**Male**	**Female**	**Male**	**Female**
18+-35	Elementary	Literate			1	
		Semi-literate	1		2	
		Illiterate				2
	Mature	Semi-literate		1	1	
35+	Elementary	Literate				2
		Semi-literate				1
		Illiterate		1	1	
	Mature	Literate	1	1		1
		Semi-literate			1	

Upon recruitment, initial guidance was provided to the participants so that they would understand the basic handling techniques. This was an add-on activity alongside the standard disaster preparedness training as detailed in Tarek (2014b, 2016). This activity was placed after the participants learnt recommended actions during a major earthquake. Through this,

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the author intended to find out their level of understanding of actions required during a sudden onset of an earthquake. Before starting the clip, it was ensured that the devices were fully charged and was used where there was optimal network connectivity. This took time as availability of the mobile network was not consistent across the village. Once connected to the network, the targeted VR clip was access through the software previously installed on the Android phones. The short VR clip was around 10 min long and depicted the Nepal 2015, earthquake scene. This was shot in the real time, and it was judged by the author to be the most suitable video clip present at that time on earthquake which comprised the ‘realism' effect.

Figure 1: Snapshot of the video shown to the participants

This clip was publicly available and was not further modified. The participants were required follow the clip as per the prior briefing. The participants were asked a set of semi-structured questions including the following questions related to the VR content:
1) What have they felt (physically and emotionally) while they were watching the video?
2) Did the VR content bring any change in the way they previously perceived earthquake?

Early findings from the field study

Data sources for this study were 17 interview transcripts and two observation logs. Interview transcripts and observation logs were coded to generate specific themes related to the use of VR. Through the interviews, one of the key identified issue was the feeling of fear that they might drop the device. The ability to hold the mobile separately was somewhat uncomfortable for 11 of the participants. From the observation log, it was found that the participants understood the initial instructions. While the clip played, the participants were engaged within the screen, and they did bodily movements as if they were within the clip. Four of the participants were a bit stiff, six were a bit too animated, and seven were controlled. Overall, a sense of connectivity could be observed.

Figure 2: Participants in the training

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The participants expressed that they were very much interested to experience the system. Regarding physical feelings, some of the participants reported mild nausea because of the rapid movement. Primarily, they needed time to absorb the screen content and the phenomenon that their body needed to respond to the video to some extent. As they were holding the device for some time, some of the participants told their hands felt a bit exhausted. It would have been useful if they used the strap to tie it with their head, but they felt shy to do that. Regarding the content, though they have found it interesting they expressed that they wished the language was in Bangla as they could not understand the spoken Nepali language. There were certain similar words and familiar tones which were picked up by the participants. Regarding changing perspective, the participants hold the view that seeing the devastation from an earthquake from the onset made them relive the nature's wrath. The experience unanimously was intense. The participants stressed this sort of video experience could make people more interested in learning about disaster preparedness.

Discussion on the possible learning process and beyond

Hedberg & Alexander (1994) considered the potential of virtual reality (VR) as the latest white knight in the arsenal of educational technologies. The use of VR, in general, indicates an individualistic learning setting. However, this study suggests VR can be used in a social learning setting. Hsu et al. (2013) suggested that VR systems can be combined or adapted to other traditional instructional formats to capture the distinctive advantages of each format. Considering the scarcity of VR content in non-English language at present placement of the VR content should be within a larger training setting.

Hsu et al. (2013) claimed, the immersive and participatory nature of VR training offers a unique, realistic quality to training that is not present in classroom-based or web-based modalities, yet retains considerable cost advantages over large-scale real-life exercises. This indeed is a case, and this ‘realistic' nature of the immersion can be further integrated into existing learning settings. FEMA (2015) suggested that volunteers can be immersed in a virtual environment that allows them to get advanced tactical training. These volunteers can perform the planned operations multiple times within the virtual reality environment and achieve mastery in dealing with problematic or trying situations during a disaster event. As in a virtual environment, the chaos can be realistically presented; thus the expectation is those who are interacting with the environment will reproduce their actions in a real-life scene by defying the human nature of getting rattled when faced with a real threat (Bliss, Tidwell, & Guest, 1997).

Most interestingly, findings of this research indicate that literacy wasn’t a barrier in using the VR Cardboard set and as VR video clips do not, in general, require writing and reading skills, this opens up enormous possibilities in designing content for the VR systems to be used among less literate and illiterate people. VR Cardboard sets can eventually be a very suitable training medium for the less literate and illiterate people which can indeed initiate ‘disruptive learning’ (Tarek, 2017a; Tarek, 2017b) which occurs when a newer or unfamiliar technology is used within a learning setting that hasn’t been prior experienced by the participants leading to increased engagement and motivation in the learning process.

To imagine the future of VR content within the target participants, it can be suggested that, it is possible to create strategic training sessions requiring the ability to think under pressure

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(time) and come up with the most sensible solutions by choosing among a series of outcomes. This can be further enhanced by narrative immersion where individuals will be presented with a story set in a world that mirrors their locality. This experience will be similar to watching a (localised) movie but with a greater level of engagement. The cinematic experience can potentially be intensified by putting the viewer (participant) inside the story and if the future technology permits, possibly allow them to virtually change its course.

Growing implementation of VR-based training for disaster preparedness and response, conducted either independently or combined with other training formats, to realise these distinct benefits, is a keenly anticipated development (Seymour et al., 2002; Hsu et al.,2013). The empirical findings contribute to the void of the absence of VR based research on less literate and illiterate users. In the current stage of growth, if VR content creators consider participants across the literacy spectrum it will be able to contribute largely towards disaster preparedness training, especially in teaching various aspects of decision making under immense pressure. Alongside this, the findings also reinstate the 'disruptive' nature of the learning it can bring to a networked learning environment. The future direction of this research work will be further exploration of the disruptive nature of the learning and VR based system's potential to be a standalone 'Disaster Preparedness' learning medium for the less literate and illiterate people.

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