Disaster awareness simulation for children with autism spectrum disorder using android virtual reality

Conference Paper · September 2017

2 authors:

Arlene Caballero
Lyceum of the Philippines University
8 PUBLICATIONS   **11** CITATIONS

SEE PROFILE

Francis Balahadia
Laguna State Polytechnic University- Siniloan, Laguna
31 PUBLICATIONS   **124** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Lyceum of the Philippines University View project

Teacher's performance evaluation tool using opinion mining with sentiment analysis View project

Disaster Awareness Simulation for Children with Autism Spectrum Disorder Using Android Virtual Reality

Razor Fino[1], Mark Jessel Lin[1], Arlene Caballero[1], Francis Fernandez Balahadia[1,2]
[1]College of Technology, Lyceum of the Philippines University, Manila, Philippines.
[2]Laguna State Polytechnic University, Laguna, Philippines.
balahadiafrancis@gmail.com

Abstract—The study serves as a technological advancement for learning, utilizing Virtual Reality (VR) and a new experience for children, adolescents, and adults especially with autism disorder. Safety and preparedness are major concerns regarding disasters and calamities. In 2014, 324 natural disasters were registered and 140.8 million people became victims worldwide. The study also wants to catch the attention of the children with autism using VR, immersing them inside the VR world teaching them to be prepared and ready against calamities and disasters. The intention of the study is to create an immersive simulation of different events about disasters to raise awareness of these children towards disaster and calamity. It consists of series of decision making, giving them a choice of what is right and what is wrong. The proponents created simulation in a portable way, utilizing ICT as learning material to expand the social and cognitive development of the children with ASD in emergencies and disaster situation. The system was tested and evaluated by the different professionals and experts related to the study that obtained overall evaluation of 4.39 which was highly acceptable to the respondents. Furthermore, it is well recommended to deploy the system to the school of special children to experience a good tool to educate the children with ASD. Lastly, it should be used and tested as training material for fast responses to any disaster, calamity and emergency situation.

Index Terms—Virtual Reality; Disaster Awareness; Android Platform; Autism Spectrum Disorder; Interactive Technologies.

I. INTRODUCTION

Unfortunate events, unexpected catastrophe or a huge loss of resources or even life, are the common effects of disaster. A serious disruption of the functioning community or society involving widespread human, material, economic or losses and impacts, which exceeds the ability of the affected community or society to cope with its own resources [1]. Because of these, people are trying to develop a way to fight or to reduce the effect of disaster like as disaster awareness training, advocacy, or seminars. There is also an early warning devices that predicts the incoming disaster or calamity in the community or society. But the most important of them all is the preparedness of an individual towards this natural or manmade catastrophe but, not every person has the capability to prepare or to be aware of these calamities especially those children with Autism Spectrum Syndrome (ASD). Children with ASD has difficulty on focusing what in front of them. ASD is a brain-based condition where the brain has not developed in a typical way

[2]. ASD patients are having trouble on making social contact with others, they usually take longer than other children to learn language and often find it hard to make sense of language, so understanding simple instructions and social norms can be difficult.

In the study of C. P. Cotanda [3], they evaluated the effectiveness of a disaster preparedness training programs. The training program improved the knowledge of their target about disaster plan, but it did not improve responses in practical situations. This is due to lack of practical sessions of the training program. This is one of the problems in application of training and preparedness, without a practical training, responses and reactions of the person will not be improved when a disaster occurred. It is supported by D. Passig [4] through technology use Virtual Reality to improve the child's cognitive learning dynamically and with 3D immersive environment was significantly shown greater improvement in the analogical thinking of the children.

With the use of immersive Virtual Reality, everyone can demonstrate a powerful learning material that will especially help these children with their education, preparing them with unexpected real life scenarios that may cost their lives for them to be prepared on different scenario of disaster and calamity. It would also be easy to access as the proponents created the application on AndroidOS platform which is popular on many people around the world. This was based on Smart Phone OS Market Share, year 2016 by IDC [5]. This data is supported by statistics from Statista [6] which shows the number of smartphone users in the Philippines from 2013 to 2020. For 2016, the current number of smart phone users in the Philippines is estimated to reach 27.5 million.

Here in the Philippines, different societies demonstrate advocacy towards autism. Creating opportunity for people with ASD to train them, educate them or help them with their cases. Also, the Philippine government created different laws to protect this people against bullying or abuse and to help them develop their status of well-being. Educating these children about preparedness and awareness towards calamity and disaster is one way to contribute with these societies.

Teaching these children with preparedness towards these calamities using natural way of teaching might not be effective. Improving their knowledge and response towards disaster and calamity especially to the children with ASD is really difficult so with the creation of Disaster Awareness Simulation using VR to catch these children's attention and

raise their awareness towards disaster and calamity that might save them in the future in case of unexpected event happened.

II. LITERATURE REVIEW

The effectiveness of disaster trainings is seen in knowledge and response of people who partook with the training programs. Virtual Reality (VR) might be a good platform for this training because with computer generated or programmed events the proponents can create more complex scenario where one can develop his/her quick judgement which is critical in emergency situation like disaster and calamity. It appears to be a promising and motivating platform to safely practice and rehearse skills for children with Autism Spectrum Disorders [7]. Based on World Health Organization [8], One out of four people suffer from mental disorders like autism and thus, could not comprehend and follow information like a normal-functioning individual. This presents a real challenge to these people regarding disaster responses.

A study about improving social cognition of people with ASD using role-playing VR was conducted [9]. The study measured the changes in neural system of the target and showed a remarkable result as the patients shows improvements with their social behavior, also supported the use of VR for training, educating purposes. Virtual reality appears to be a promising and motivating platform to safely practice and rehearse social skills for children with Autism Spectrum Disorders [7]. It is indeed a good platform for safety practices like disaster and calamity. The VR simulation may provide a realistic scene that may be hard to procure in real life. Another study in which VR was implemented children with ASD [10] was used to improve the social skills of children with mild-autism. The study created a simulation of daily conversation or events commonly seen in everyday life. The results of the study showed an improvement with the child's verbal and non-verbal recognition, conversational skills and social performance. Based on the result of systematic review in terms of use of VR in psychological treatment for mental health problems [11], VR was effective for individuals with range of severe mental health problems compared to normal conventional treatment. The study covered twenty-four (24) controlled trials published in between 2012 to 2015. Also, the study stated that VR is potential to enhance the mental health research and development.

These studies supported the proponents' proposed study in which VR is used to deliver a more effective learning method for children with ASD. Using an immersive 3D environment to improve the analogical thinking of the children [4] was a good idea which was used in the proponent's proposed study to create a Disaster Awareness Simulation. The study wanted to create a tool as training material of learning with the aid of technology to improve social and cognitive learning responses in practical situation like calamities and disaster that might be experienced by the children and person with ASD.

III. RESEARCH METHODOLOGIES

The researchers conducted series of procedures to develop the system and follow some model shown in Figure 1 to capture all necessary information regarding the study.
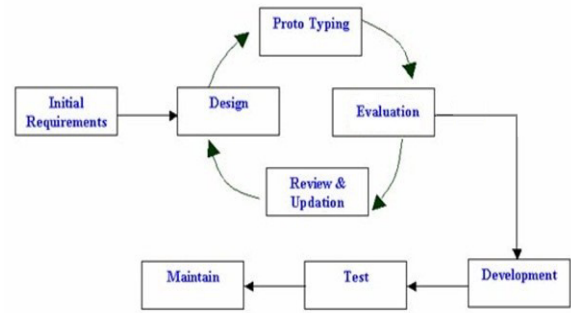

Figure 1: Research Framework

As for the initial requirements, all information and data needed for the study were gathered from different kinds of studies and literatures of game development, ASD, Disaster, Calamity and Virtual Reality. The information and data were reviewed, analyzed and evaluated to come up with the developing and designing of the system. The proponents also took pieces of advice from a consultant of psychological field. This consultant was provided a range of scopes where the proponents were used to adjust the system's scopes and limitation.

The system used Prototyping method in which a prototype was built and tested, and then reworked as necessary until an acceptable prototype was finally achieved from which the complete system can now be developed and tested by different IT evaluator and professional experts related in the study. To easily maintain the system prototype, it applies Unity as based development software, Visual Studio C++ for scripting, Blender and Adobe Photoshop for modeling and texture, Android SDK compiling and google VR SDK for head tracking integration on mobile phones.

A. System Architecture

The system architecture shows the interaction of the users to the system; the use of device and prototype show a vital role in the proposed system shown in Figure 2. It also shows the flowchart diagram in the Figure 3 of the application. The system application is only applicable for smart phones with Android OS of 5.0 LoliPop and above. The recommended smart phone size should be in between 3.5 inches and 6 inches. The size may vary depending on what VR Viewer the user is using. The system also needs a controller or a mouse, wired or wireless to operate the application.
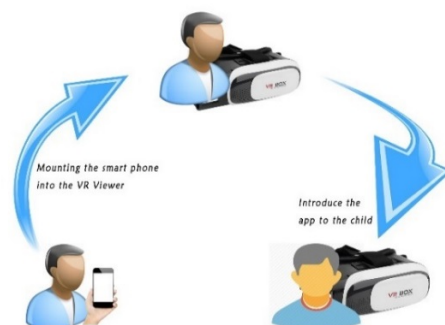

Figure 2: User Interaction

The user needs to place the smart phone inside the cartridge of the VR Viewer, it has straps that support the weight of the phone and the viewer. The user has the liberty to use different VR viewers and smart phones, as long as it

covers the system requirements. The user may also use different controllers or mouse to navigate through the application. The system has its own customized pointer that follows the head rotation of the user. The user may need to look at the menu option before clicking or activating the menu.
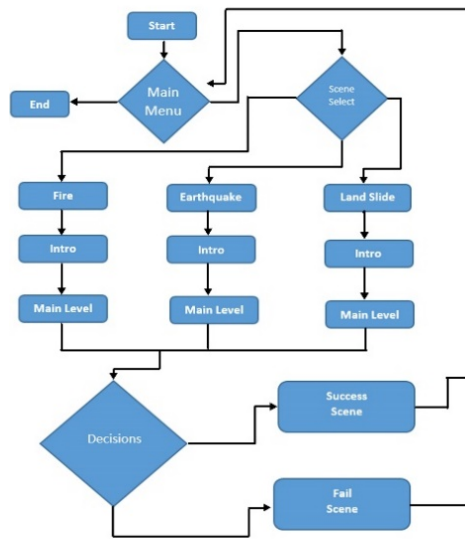

Figure 3: Flowchart

B. System Features

The system is a Virtual Reality Simulation of Disaster and calamity designed for the use of children with ASD that serves as learning material to raise their awareness towards disaster and calamity. The system is designed to catch the children's attention using special effects and immersive experience. The prototype consists of three (3) different scenes, fire, earthquake, and rockslide. The system features 360° degrees' 3D environment, lights, voiced narrations and instructions, and sound effects. The system also has technical features such as Graphical User Interface, Event systems, Virtual Reality modules.

C. 3D Environment and Virtual Reality

Virtual Reality is a realistic and immersive simulation of three-dimensional environment, created using interactive software and hardware. The system provides a virtual reality experience with 3D environment created and designed by the proponents shown in Figure 4. The simulation has real-time animation, sound effects and special effects that will immerse the user with their experience of the application.

Figure 4: Camp Scene

D. Graphic User Interface

The system uses a unique way of deploying GUI. All GUI seen in the application are created using two-dimensional text placed as three-dimensional object inside the simulation. All GUI are classified and behaved as 3D objects in which it can also be programed and animated in the same way as a normal object in the application shown in Figure 5. This is intended so that the proponents customized cursor or pointer will be able to interact with the GUIs.

Figure 5: Different view inside the environment. (Main Menu Scene)

E. Event Systems

Event systems are scripts and compilations of different components used in the application development. The event system handles the animation, timed events, object triggers, lights, camera angle, sound cues and visual cues seen inside the simulation. It also handles the modules like VR module and control module. The control module is responsible with the user inputs since it detects the screen touch on smart phone or the mouse/controller click.

IV. RESULTS AND DISCUSSION

Based on the obtained result of the study given by the different respondents such as the IT and technical experts like IT Professors and Staff, Psychologist and ASD Parent, the system gained overall impact at high level and acceptability. Table 1 represents the general assessment and ranking of the respondents.

Table 1
Level of Acceptance of the System

Characteristics	Weighted Mean	Interpretation
Functionality	4.47	EXCELLENT
Reliability	4.32	EXCELLENT
Usability	4.71	EXCELLENT
Efficiency	4.33	EXCELLENT
Maintability	4.22	EXCELLENT
Portability	4.32	EXCELLENT
MEAN	4.39	EXCELLENT

The table shows overall evaluation of each criterion of ISO/IEC 9126. The survey was distributed in 30 respondents in different sectors (IT Experts, Government, Healthcare and Education) Usability, with the highest weighted mean of 4.71. This criterion determines how easy the user understands the system. Functionality comes next with 4.47 weighted mean, functionality contains the suitability, accuracy and interoperability of the system to the target users. Efficiency, Reliability and Portability criteria get almost the same results of 4.33 and 4.32 weighted mean. These criteria determine the efficiency, adaptability and fault tolerance of the system. Maintability comes in last place with 4.22. This criterion determines the stability of the system. As the system is still in prototype stage, the stability of the system is not that solid yet. Most of the respondents see this point and recommend some advice.

Based on the results, the system is proven to be effective as a disaster awareness training that will help children with ASD. The system is easy to understand and the system is accurately effective to children with ASD as they will not be able to remove their focus when operating inside the virtual environment.

V. Conclusions and Recommendations

Using VR device simulates disaster scenario for children with ASD as learning material to raise their awareness towards disaster and calamity. The system provides a suitable, reliable, easy to use, effective and portable solution for the children with ASD that commended by the experts. It confirms the use of VR in mental health is effective to develop social and cognitive learning of ASD children. With the device, it can provide a disaster training easily in virtual reality with portability and quickness.

With this developed system, it serves as powerful visual learning material for children with ASD as they have difficulty on focusing since VR solves this problem. The simulation development can be controlled and changed based on the client's preference. The system is easy to understand and is accurately effective to children with ASD as they will no longer remove their focus when operating inside the virtual environment.

Future work may include more beautiful graphical design and more complex audio cues to raise the immersion level of the user to the system. The system may also improve decision event trees, adding more branches on the choices of different scenes. It is well recommended to deploy the system to the school of special children to experience a good tool to educate the children with ASD. Lastly, it should be used and tested as training material for fast responses to any disaster, calamity and emergency situation.

References

[1] UNISDR, "Terminology," [Online]. Available: https://www.unisdr.org/we/inform/terminology.

[2] Raisingchildren.net, "Autism spectrum disorder (ASD)," [Online]. Available: http://raisingchildren.net.au/articles/autism_spectrum_disorder_overview.html/context/.

[3] Cristina Parra Cotanda, Mónica Rebordosa Martínez, Victoria Trenchs Sainz de la Maza, Carles Luaces Cubells, "Impact of a disaster preparedness training programme on health staff," Anales de Pediatría (English Edition), vol. 86, no. 3, pp. 149-154, 2016.

[4] David Passig, David Tzuriel, Ganit Eshel-Kedmi, "Improving Children's Cognitive Modifiability by Dynamic Assessment in 3D Immersive Virtual Reality Environments," Computers & Education, vol. 95, p. 296–308, 2016.

[5] I. D. C. IDC, "Smartphone OS Market Share," 2016. [Online]. Available: from http://www.idc.com/prodserv/smartphone-os-market-share.jsp.

[6] Statista, "Number of smartphone users in the Philippines from 2013 to 2020 (in millions)," 2015. [Online]. Available: https://www.statista.com/statistics/467186/forecast-of-smartphone-users-in-the-philippines/.

[7] Michelle R. Kandalaft, Nyaz Didehbani, Daniel C. Krawczyk, Tandra T. Allen, Sandra B. Chapman, "Virtual Reality Social Cognition Training for Young Adults with High-Functioning Autism," J Autism Dev Disord, pp. 34-44, 2013.

[8] World Health Organization, "Questions and answers about autism spectrum disorders (ASD)," 2016. [Online]. Available: http://www.who.int/features/qa/85/en/.

[9] Daniel Yang, Brent Vander Wyk, James McPartland, Tandra Allen, Sandra Chapman, Kevin Pelphrey, "Neural Mechanism of Behavioral Response to VR-SCT in Young Adults with Autism," Center for Translational Developmental Neuroscience, 2014.

[10] Michelle R. Kandalaft, Nyaz Didehbani, Daniel C. Krawczyk, Tandra T. Allen, Sandra B. Chapman, "Virtual Reality Social Cognition Training for Young Adults with High-Functioning Autism," J Autism Dev Disord, pp. 34-44, 2013.

[11] Lucia R. Valmaggia, Leila Latif, Matthew J. Kempton, Maria Rus-Calafell, "Virtual reality in the psychological treatment for mental health problems: A systematic review of recent evidence," Psychiatry Research, vol. 236, no. 28 February, p. 189–195, 2016.