Sustaining a Citizen Science Initiative Using an Augmented Reality-Related Technology Application

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This session presents reflections on the systematic process by which an Augmented Reality-related technology application coined as the Augmented Reality Rain Gauge (ARRG) was designed. After the design stage, ARRG was tested and deployed to support a citizen science initiative involving drought monitoring outreaches across Oklahoma public libraries. The goal of this initiative is to create awareness about drought and its related environmental conditions to educate volunteers on STEM library programs.

Introduction

Augmented reality (AR) enables users to superimpose virtual objects on a physical target in the real environment using a computer-assisted contextual layer of information (Azuma, 1997; Di Serio et al., 2013). The contextual layer of information employed by AR technology is usually made up of graphical texts and multimedia contents that are strategically situated around the physical object using digital platforms such as a mobile phone display, wearable glass, or goggles. The main reason for augmentation is to provide concise information situated around a physical object's attributes. However, additional characteristics of AR include its real-time interactivity and capacity to promote learning skills (Di Serio, et al., 2013). One of the advantages of the interactiveness of AR is that it enhances the "sense of place described as being comprised of two main elements: place attachment - the bond between people and places; and place meaning - the meanings that people ascribe to place" (Toomey, et al., 2020, p. 2). Creating a sense of place around a community's points of interest using AR encourages social collaboration within the community, which may ultimately motivate people to come back for more of such experience.

AR technology is also readily affordable as it improves learning performance through its effectiveness in improving user learning gains and motivation (Chen et al., 2017). Research has shown that AR helps increase student's academic achievement (Turan, et al., 2018; Yoon & Wand, 2014), increase student motivation (Di Serio, et al, 2013; Tobar-Munoz, et al., 2017; Yang, et al., 2018), and reduce the cognitive load (Turan, et al, 2018). The augmented reality rain gauge (ARRG) consists of a physical rain gauge embossed with an AR code that we designed for stickers that serve as an integral part of the gauge. Adding the AR code sticker to the rain gauge allows users to experience virtual interaction with the rain gauge through their mobile devices. One of the main attractive features of ARRG is the 'Make It Rain' application (MIRA), which runs on a smartphone or any mobile device connected to the Internet. The other main key design features of the ARRG applications are:

- Access to rain gauge installation guide for librarians.
- 3 CoCoRaHS videos on weather conditions monitoring.
- Access to CoCoRaHS weather station signup web page.
- Access to the spottyrain.org website resources, including factsheets on drought monitoring.
- Installation as a static display for library observation space.

Literature Review

Virtual and Augmented Realities in Learning

The concepts of virtual and augmented realities are relatively new in literature. The history dates back to Sutherland's work on head-mounted devices in the 1960s to the present situation, where there has been a tremendous advance in virtual and augmented reality through research work in the field of 2D image-based virtual reality and 3D graphics (Azuma et al., 2001; Di Serio et al., 2013; Liou et al., 2016;). An example of this development is visible in computer simulations, which are required to render augmented reality scenarios fully (Azuma et al., 2001; Vasilevski & Birt, 2020). According to Liou et al. (2016), learning scenarios embedded in augmented reality systems help student learning because students become more motivated in task repeatability and completion. Similar to Liou et al. (2016) findings, as part of the mixed method study carried out by Di Serio et al. (2013) on students' motivation using augmented reality, Di Serio et al. (2013) discovered that many students achieve "higher levels of engagement in learning activities with less cognitive effort" (p. 595). Augmented reality has been used in the lab for science learning and corporate offices for workplace learning (Pejoska et al., 2016; Cheng & Tsai, 2012).

The social aspect of learning using augmented reality was explored by Pejoska et al. (2016) as a mobile learning discourse in the workplace. The researchers finding show that workplaces can be referred to as "microsites" where the focus is on personal learning experiences from available physical and social resources made possible by "augmenting synchronous communication in response to emerging contexts" (Pejoska et al., 2016, p. 476). In the same vein, Yang et al.'s (2016) observation of pre-service teachers indicates that social interaction increases with the use of mobile augmented reality applications in a chemistry lab. This interaction observed through a series of semi-structured interviews is relevant to my study because I can see how a clear collaborative effort emerges from participants in an augmented reality scenario, making them more motivated to work together efficiently. Considering the surmise that citizen science plays a major role as a prime mover of social learning and responsibility, Masters et al. (2016) claim that participation in citizen science projects has the potential to lead to increased scientific literacy. Another exciting part of this is that including augmented reality in education makes learning fun. It can increase motivation, which is also a significant factor in citizen science projects' volunteer recruitment (Saez-Lopez et al., 2020; Masters et al., 2016; Liou et al., 2017).

Purpose

The purpose of this study is to understand the experiences of Oklahoma library patrons, of small and rural libraries, who use the augmented reality application for community science projects. The study aims to find ways to increase the participation of rural Oklahoma library patrons in their use of the augmented reality application for community science projects such as drought monitoring. At this stage in the research, community Science is defined as the "scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions" (OED, 2014). On the other hand, augmented reality applications will be generally defined as visualized user interface tools that display multimedia content with physical objects on smart mobile devices. This study will find answers to the following research questions:

1. What are the experiences of Oklahoma library patrons, of small and rural libraries, who use the augmented reality application for community science projects?
2. What are ways to increase the participation of rural Oklahoma library patrons in their use of the augmented reality application for community science projects?
3. What are the attitudes of library patrons?

Method

The initial installment of the augmented reality rain gauge was done in coalition with the Southeast Oklahoma Library System (SEOLS), with 15 public libraries now having the rain gauges as static displays. To engage with the ARRG, the user downloads the Zappar app, which scans a code (like a QR code). Once scanned, the app provides both animation and audio effects that simulate heavy rain with thunderstorms. Participants engaged with the augmented reality rain gauge in the following steps:

The first point of engagement occurs when users see the Zapcode on the rain gauge, and they recognize that they must use an AR app to interact with the rain gauge. They can only interact with the app by installing the Zappar App on their smart devices. The second point of engagement occurs when users open the Zappar app on their devices and attempt to capture the Zapcode on the rain gauge using the back-facing camera of their device after a successful scan of the app a user-friendly interface is displayed on their device. The real engagement starts with the ARRG when users interact with menu items on the interface by tapping and selecting buttons such as 'Make It Rain' from where they can 'Play' or 'Stop' the rain effects, Home button is for the project's website homepage, while the Twitter button and Facebook button takes users to the project's Twitter page and Facebook page respectively.

If users do not have the Zappar App installed on their mobile devices, they will be directed to download it from either the Apple App Store or Google Play. The Zappar App is available for iPhone, iPad, iPod Touch, and most Android phones and tablets.

Findings and Discussion

The augmented reality rain gauge has been leading program changes because users find the application generally easy to use and interact with based on the affordability of the app and the physical rain gauge. The learning outcomes from our current iteration of ARRG arose from the installation of the gauge in library spaces to provide means by which librarians and library patrons can learn simple tasks and facts about drought monitoring and management. These learning outcomes include library patrons and librarians knowing where and how to access online resources containing information about weather conditions within their communities, library patrons learning how to set up their weather stations using the CoCoRaHS network webpage tool for signing up as precipitation observers and reporters, and library patrons knowing how to install their rain gauges with the help of the installation guide included with ARRG.

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