Designing Digitally Enhanced Print for International Conferences and Tourism

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Abstract
In an examination of the affordances that augmented reality (AR) offers informal learning at larger scale events and conferences, this study looks at the design and implementation of a set of AR based activities at an international event known as TEDxKyoto. Some of the merits of using AR at events include adding incentive to explore the venue and visit vendors and speakers, connecting digital materials to conference print media, and creating a bridge between physical attendees and virtual ones. The results of the experiment shed light on the merits and challenges to using AR to enhance informal learning at international events. One challenge is the cognitive barriers for first time users and limits of AR technology, the study also suggests some design strategies to offset these challenges and well as maximize the affordances of using AR.

Keywords: Augmented Reality, Informal Learning, Events and Conferences, TED, International Exchange

The Challenge Presented

Consider the following question. If you could change how people see the physical world, how would you use that power to bring people together to share ideas? This is the question from which this paper draws from to start to form pedagogical and psychological reasons to employ augmented reality (AR) and mobile technology for informal learning and international exchange. This paper attempts to tackle this question with an experiment in the use of augmented reality a for large scale international event. The experiment revolves around a set of activities using augmented reality and mobile technology that were designed and implemented at a large international conference. Topics discussed are the affordances of AR, usage goals, design approaches, creation tools, implementation strategies, usage analytics, observations, and ends with a discussion of challenges for future use of these technologies.

The Venue

This year at TEDxKyoto, a new interactive team was assembled and geared to get participants more engaged with speakers, vendors, and volunteers. We wanted to encourage more interaction between all stakeholders both in-person and virtually on-line. Looking to approach the idea on several fronts and link them all together we put together a series of activities that have never been seen at TEDx events ever before. The result was an interesting mix that got great reaction from participants.

The TEDx Program is designed to help communities, organizations and individuals to spark conversation and connection through local TED-like experiences. The focus is on curating an interesting program of speakers and performers to engage audiences. Another goal was creating activities for participants that encouraged interaction. The main of these activities revolved around the use of augmented reality and mobile technology. We created a smartphone application that allowed participants to explore the venue in a way that adds learning value and contributes to the event goals. This app displayed digital information over physical objects all over the event such as signs, artwork, volunteer T-shirts and the distributed speaker program.

AR, VR, and Everything In-between

To understand what affordances augmented reality can give learners and event participants let's first come to define what AR is, how it has evolved, and what different types of AR are. AR is sometimes called mixed reality, and sometimes even confused with virtual reality. While augmented reality is widely considered in the spectrum of mixed reality there is a fundamental difference between augmented and virtual reality. Virtual reality is a completely simulated environment. While the places and things in a virtual environment can be made to act and look like what we see in reality, there are no meaningful connections between the simulation and what it is made to represent. AR has to incorporate something from the physical world. That something could be as simple as a physical object around you, or just your physical location represented by GPS coordinates. Just as the name suggests, reality is being augmented instead of virtually created. What part of the physical world is augmented, how it is used, and even the balance between the real and simulated can vary greatly. This is where the idea of mixed reality is applied and it represents the entire spectrum between the real world and a completely simulated one. Augmented reality is just one aspect from that continuum (Milgram & Kashino, 1994).

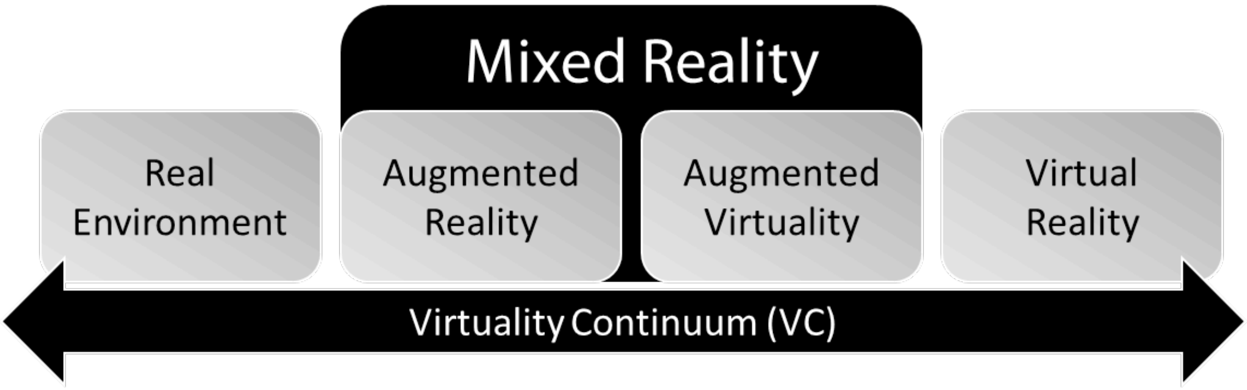

Figure 1. Milgram's reality-virtuality continuum.

Augmented reality has more of the real world represented than virtual, the opposite is true for augmented virtuality which is mostly a simulated environment. An example of AR in this context would be a heads-up-display in the cockpit of a commercial airliner. The view out the front of the aircraft is augmented with information from the various flight instruments. An example would of augmented virtuality might be a digital map of an area that is enhanced with pictures and video from respective locations in an area. Using Milgram's continuum educators can now start to think about where how much the learning can benefit from simulation vs. real-world interaction. Some affordances of AR over VR is the connection to the real world and the inclusion of face-to-face interactions. Situated learning theory states that learning is taken from physical and cultural settings (Brown et al. 1989). That suggests that augmented reality environments have learning merit if it can enhance face-to-face interactions. On the other hand, completely simulated environments have their advantages also. Having the ability to explore expensive to reach or dangerous areas and situations for example.

To capitalize on the value of new face-to-face interactions at events like TED, this experiment uses as much of the physical world as possible and use the technology to augment and enhance participants' interactions with the venue and each other. So in this instance augmented reality in the strictest sense of it definition was used as it is the form of mixed reality that is closer to a complete reality.

Categorizing AR

There are several other ways to differentiate types of mixed reality besides looking at the balance of the real and simulated. Some of those ways has to do with the type of hardware used. The hardware and software capability is a main driver of how AR can be used as seen between the iterations of the last 10 years. An early popular example in 2000 was MagicBook (Billinghurst et al., 2001). It used a desktop PC and a webcam to track and augment simple pre-programmed images and is well contrasted to the much more powerful mobile applications of more recent years is directly related to graphical processing capability that is needed to analyze visual data in real time. But visual data is in most cases only one of the sources of data utilized. On a typical smartphone there are a variety of sensors that can be utilized, a GPS locator, motion sensors, directional gyros, and radios that can pull information from the internet.

Figure 2. AR hardware technology matrix

For the experiment, the augmented reality smartphone application uses a marker based camera tracking system. This system requires pre-programmed images to be included in the application so that they can be augmented when the camera detects and image.

Affordances of AR for Events and Conferences

Because this technology would be new to most people attending the event and therefore have some motivation through novelty but also reluctance by intimidation of complexity. To maximize the benefits to learning and design and also to successfully pitch the use of AR to event planners, it is important to be able to point out the merits and challenges of implementing this technology.

AR can connect supplemental digital resources to the physical world. This can help turn any physical object or location into a digital learning opportunity. Mobile and desktop applications have been made to display interactive digital content when used with textbooks and other printed materials (Billinghurst et al. 2001; Rambli et al. 2013). This allows AR to be a bridge for e-learning content to be applied to any printed materials commonly found at large events including posters, pamphlets, tote bags, business cards, and banners.

AR can encourage exploration and to try new things. The melding of virtual on to the real world offers a high level of immersion into the content. The digital content is connected to the physical object and therefore instills sense of exploring unknown territory. These effects have been reported when AR was used in educational and game based tourism (Zurzuela et al. 2013; Guttentag, 2010). For the case of conferences and events this affordance can be pointed at encouraging participants to visit vendor booths or interview special guests.

AR is suited for alignment with constructivist based learning. As AR activities can incorporate exploration of objects and environments, thus is well suited for problem-based, project-based, and other constructivist related learning activities. Applications that have these type have been tested on mobile devices to have a high level of usability (Santos et al. 2014). For events and conferences these concepts could be employed to create some type of game or problem based activity that relates to the overall event theme.

AR can allow you to see the world through a different lens. These applications can use the location and incorporate information and media of another time, or at the same time but in different places. This can allow the user to be transported in time and space and in a sense be put in someone else's shoes. For example in tourism, an augmented reality application was created for visitors to the devastated areas from an earthquake and tsunami in Fukushima, Japan. The application allowed visitors to the area see images taken in the same location taken before the disaster and hear stories from survivors. These empathetic inducing concepts could be used for events which are looking to fight a cause or raise awareness.

Challenges to Overcome

First time users to AR can be prone to cognitive overload. The mix of virtual and real can take some time for the senses to get used to. Also some practice is sometimes needs to correctly position devices in relation to the content to be scanned. Add the fact that you are also to be charged with a new task that requires the use of AR and first time users can struggle (Dunleavy, 2014). To help alleviate these effects for first time users some simple tasks to first learn to use the technology are suggested for the design.

AR use is highly reliant on newer technology and internet connections. AR applications are constantly scanning and analyzing visual data and therefore require a high amount of computational power. This means AR applications are not prone to be compatible with even slightly older technology. For images to be recognized by AR apps they need to be pre-programmed into devices, that can be a problem for devices with limited storage capacity. The large amount of data need to be downloaded for AR applications might cause bandwidth issues at venues with limited wireless internet capabilities.

Design Principles

One particular interesting aspect to this project was observing a wide variety of backgrounds and levels of technological skill interact and/or resist to this type of activity. One of Hofstede's (1983) four cultural dimensions is uncertainty avoidance and it measures a culture's acceptance of ambiguity. This behavior closely linked to how different cultures accept and use new technologies. Uncertainty avoidance levels are represented differently in Japan than many western cultures and has been observed to have an effect of how new technologies are adopted and used (Straub, Keil, & Brenner, 2007). These ideas were observed in several ways, one being the use of flip and smartphones by participants. Although the application created was available on android and iOS devices, we found some interested participants unable to use the application because they used older phones without a standard operating system. It is why that activities were created that didn't require the use of smartphones.

Ideas for better informal learning and to help spread information from participants to each other and the world over social media were borrowed from the tourism and hospitality industry. User generated data or electronic word-of-mouth (eWOM) has become very important to the travel industry and in particular tourism marketing. Word-of-mouth consumer to consumer communication has proven to be more trusted and effective than normal advertising mediums (Katz & Lararfeld, 1955). Because of the multi-national presence of the event we used Hawkinson's (2012) research model for finding cross-cultural eWOM to choose which social media outlets to integrate into the activities to promote communication virtually during and after the event.

Event Activities Implementation

A smartphone application was adapted for iOS and Android devices. The application was preprogrammed with 35 images that could be found around the venue, inside the event program booklet, and on the T-shirts of volunteers. A simple logo was created and attached to most of these images so users of the application could know that the image could be enhanced. But some of the images that could be scanned were not identified, this was done to strengthen the exploration and constructivist affordances. Information about the application and how to download and use it was placed in the event gift bag and distributed at volunteer stations. The instructions simply pointed participants to application download links via a website or a QR code. To demo and explain the applications use and to give details about the activities a website was created. A short presentation was also given to all participants just before the opening ceremonies. When loaded on a smartphone the application would run a constant visual scan using the device's camera. When a pre-programed image is recognized by the application, various digital media would display over the image on the device's display. In many cases the digital media had some amount of interactive like links to external websites, social media feeds, and other simple interactive elements. The pre-programmed images that could be scanned by the application would be posters of event partners and speakers, also event logos and sponsor pamphlets. The application would display links to speaker social profiles, videos of past speakers, and links to twitter feeds and message boards for participant interaction.

Figure 3. Augmented reality application viewing printed event information.

The smartphone application was considered the main activity because it had took the most hours of preparation and could be used by any and all participants with compatible devices. A few other activities were implemented to both draw interest to the use of the application and to scaffold the use of it to reduce cognitive load. One of these activities was an augmented reality booth that had PCs loaded with AR software connected to high-definition webcams and large displays. This made it possible for passers-by to experience a simple version of the same type of augmented reality used in the application. Volunteers asked participants to present their program booklets to the camera and event logos displayed in real time. This allowed participants to see what AR can do and also allow them to practice with the spacing and positioning needed to use the software properly. In an added merit to the event goals, screenshots of participants with the digital AR content were taken and curated onto social media feeds so they can be seen and distributed freely.

The different levels of technology acceptance demanded not just some low tech scaffolding, but no tech activities that could be used. That is why a simple pen and paper reflection activity was created next to an AR booth where participants wrote simple messages and they could be scanned into the computer to be augmented with the application. There were volunteers at this station to explain how it connected to the other AR activities and invited participants to try it.

With these three activities all levels of technical skill and acceptance could have a path to full mastery of the application given a short amount of time and cut down on confusion and cognitive overload. See Table 1 for a see a reference on how the activities were used to scaffold into participants' AR mastery to use the smartphone application.

Table 1: Scaffolding to AR mastery

Technical Skill Level	Activity	Scaffolding to AR mastery
Low	Message from the past (pen and paper)	Demonstration by a volunteer (hear about AR)
Medium	AR photo booth (no download required)	Practice using AR without the use of a mobile device (Experience AR)
High	AR application (download required)	Exploration of venue with AR mobile application (Participate with AR)

Instrumentation

Data was collected from each activity to analyze participant turnout. This allowed the comparison of each activity and how the participants progressed from one to another. Volunteers were at every activity and they recounted observations of participant interest. Each activity had a different way to collect data on its usage. See Table 2 for a breakdown of the main instrumentation of each activity.

Table 2: Activity Instrumentation

Activity	Participant count method	Supplemental Data
Message from the past (pen and paper)	Physical card count	Observations, volunteer notes
AR photo booth (no download required)	Screenshot count	Social media data, observations, volunteer notes
AR application (download required)	Google Analytics Unique device count	AR trigger information, Usage time, Timestamps, Social media data

Observations and Results

Overall the participants and volunteers enjoyed all of the activities. There were many surprised and smiling faces observed from first time users of the AR photo booth and the AR application. For each level of technical skill there was a decline in participation. There were 312 messages from the past cards written, 107 screenshots taken and curated, and 45 unique devices accessed at least one of the AR enhanced media.

Conclusions

AR has multiple affordances for increased engagement at conferences and events (Zurzuela et al. 2013; Guttentag, 2010). There are also several challenges to face in successfully implementing AR and creating a design that properly aligns to the event goals. One of those challenges known to using AR for first time users is cognitive overload (Dunleavy, 2014) and introducing some simple ways to show how to use AR before using in a task helps that problem (Mayer & Moreno, 2003).

The activities designed in the experiment anecdotally helped participants and reduce cognitive overload for first time users of AR. But the user data showed a negative correlation between the needed technological skill and the number of participants in that activity. This suggests that there is a barrier of first time use of AR but the results don't suggest a reason why.

How AR can be used and implemented is heavily reliant on the available technology and the prior experience (Dunleavy, 2014). So when considering a design approach for implementing AR based activities for events and conferences, the two main considerations should be learning goals and available technology. The third main consideration is audience technology skill and acceptance level, but a deficiency in this area can be helped at least in part with proper design of the activity and a multi-level introductory approach.

The Next Iteration

The next iteration of these activities or this experiment could benefit from improvements in design and advancements in mobile technology. One major hurdle to use the AR application was the need to download a lot of data. Storage on mobile devices and bandwidth at the event where at a premium. Perhaps a step between medium and high technological skill could be implemented by preloading the application on tablet devices that could be used in the close vicinity of the AR booth to test using it with having to download the application on participants' personal devices.

These AR activities would be enhanced with the use of heads-up-displays (HUDs) instead of smartphones and tablets. The always on passive scanning of the particular AR application that was used in this experiment would be well suited to the use of HUDs like Google Glass. Participants would not have to hold up their mobile devices for long periods of time in sometimes awkward positions. However a test was run with this application on Google Glass and it was found that it lacks the processing power to give any acceptable amount of responsiveness.

Future Research

A comparison of similar studies could help determine how AR technology usage is progressing into the mainstream. If the same AR application could be tested with the same group over several sessions, the results might help determine how helpful the initial learning about AR before given a task is correlated to cognitive overload.

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