February 2018

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Virtual Enhancement to Physical Spaces: A QR Code Based Orientation Game
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ABSTRACT
University orientations are typically passive events for students, with activities that include sitting and listening to speakers and perhaps talking to others seated nearby. In this project, the authors sought to provide a more active and collaborative component to a university orientation via a team-based game that incorporated content included in a typical orientation and modeled appropriate instructional technology use. This mobile orientation game used QR codes and videos to augment the physical environment of an academic building. This paper describes the design and development process for this game, and presents the results of an evaluation conducted at the end. The game, which lasted an hour, both helped players learn more about the people and key locations within the new program they were joining and, most importantly, helped participants meet and interact with their new peers prior to the beginning of classes.

Keywords: mobile learning, QR code, mobile game, user experience, university orientation

INTRODUCTION
University orientations play an important role in the student acclimation and learning process. Although they typically offer neither grades nor credit hours, student orientation programs are found to be related to student retention (Cambridge-Williams, Winsler, Kitsantas, & Bernard, 2013-2014; Williford, Cross Chapman, & Kahrig, 2001). Orientations may address both basic student needs, such as practical information (e.g., course registration), as well as higher order ones, such as learning how to socialize in the new environment (Taub & Komives, 1998). When graduate students are involved, one might also expect advisors to play a key role in acclimation to the department and local culture (Curtin, Stewart, & Ostrove, 2013), although this practice occurs over time and enhances rather than replaces the role that an orientation program might play.

Two types of integration are important during orientations, academic and personal-social (Robinson, Burns, & Gaw, 1996). Regarding the latter type of integration, students develop relationships and learn about the local culture, both of which can help them as they move forward in their coursework (Pittaway & Moss, 2013). Essentially, orientations lay the foundation for student comfort in the academic environment and later academic success.

Typical orientation activities include presentations about people, facilities, curricula, and other local activities while sitting in a classroom or similar location. Students play a passive role during the presentations, and peer interactions may be limited to people sitting nearby or breaks. Campus tours may also be included in orientation programs. These tours are typically guided events through which the leader imparts not only information about the institution, but also institutional norms (Magolda, 2000). Although tours are more active than classroom-based presentations, they still use a follow-the-leader approach. Further, tours tend to be focused at the macro-campus level. Tours at a more local level—such as within a department or program—are less formally designed and orchestrated, perhaps because navigating a hallway, floor, or suite of a building is not considered as great of an issue as finding a building on campus.

In our graduate program in Instructional Systems & Learning Technologies (ISLT), a traditional information dissemination approach to orientation has long been used to acclimate new students prior to the beginning of the new school year. New students sit through a morning of department-level presentations. In the afternoon, students are placed into smaller groups to meet with faculty and current students at the program level. This approach has been used in our department for more than a decade, and the department-level group orientation continues. However, the authors wondered if it might be possible to follow the lead of others who have used
mobile augmented reality and mobile games as one component of student orientation (e.g., Chou & ChanLin, 2012; Fitz-Walter, Tjondronegoro, & Wyeth, 2011), and to create a collaborative, mobile augmented reality game to help students learn about the program, experience a new technology, and forge initial social connections with their new peers.

We developed, implemented, and evaluated a collaborative QR code-based game (Instructional Systems Orientation Game; ISOG) to replace an hour of regular, presentation-focused orientation activities. This paper presents the game framework, development and implementation process, and post-activity evaluation along with our next steps in extending the game via augmented reality.

BACKGROUND

QR codes are a two-dimensional form of augmented reality (AR) that direct users to specific content or interactions (Schmalstieg, Langlotz, & Billinghurst, 2008). Most people recognize QR codes from a marketing context. These square bar codes have appeared with increasing frequency in advertisements, on signs, and on products. Their presence in an educational context has been less prominent, but they have nonetheless found their applications. For example, QR codes can be embedded in printed textbooks and other learning materials to facilitate access to relevant multimedia-based materials (Bonifácio, 2012; Ozcelik & Acarturk, 2011; Uluyol & Agea, 2012). As Robertson and Green (2012, p. 12) indicated, in this way QR codes help “bridge the gap between paper and Web.”

QR codes also have been used within educational games. For example, middle school students were engaged in a forensic science mystery in which QR codes were positioned around the school, providing students with information to help solve the mystery (Bressler & Bodzin, 2013). Part of the QR code’s appeal in a game context is its ability to conceal content until a user requests it. Another advantage, when compared to other location-based technologies, is the ease with which QR codes can be created by people with average technology skills, such as teachers (Kwon, Kim, & Woo, in press).

In the context of orientations, libraries have begun using QR codes to create technology-enhanced scavenger hunts. Scavenger hunts have long been used to help orient new users to library facilities (Czarnecki, 2012) and they can help lessen the anxiety experienced by new students (Collins & Dodsworth, 2011). Additionally, one university tested a mobile game as a follow-up to a traditional orientation. This game included QR codes along with other features such as check-ins and friends lists to encourage students to become actively engaged (Fitz-Walter et al., 2011). Another university created a narrative-based orientation game, also integrating QR codes as a key tool for game play (Schroyen, Hartwick, & Tay, 2011). Collectively, orientation activities and games such as these served as the inspiration for this project.

PROJECT RATIONALE

Our rationale for designing this game was threefold, and anchored around a set of six learning objectives. Table 1 presents the objectives and indicates how the game activities helped achieve each objective.

<table>
<thead>
<tr>
<th>Objective</th>
<th>How addressed or achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students will be able to identify the ISLT faculty and staff by name and sight.</td>
<td>Watching faculty/staff videos</td>
</tr>
<tr>
<td>2. Students will be able to locate ISLT faculty and staff offices.</td>
<td>Watching faculty/staff videos while standing outside corresponding office</td>
</tr>
<tr>
<td>3. Students will be able to locate important locations with in the Stone Building.</td>
<td>Walking to each location</td>
</tr>
<tr>
<td>4. Students will be able to identify the functions of important locations in the Stone Building</td>
<td>Watching location videos</td>
</tr>
<tr>
<td>5. Students will be able to use QR codes and mobile devices to access information.</td>
<td>Using devices to access QR codes on each game path</td>
</tr>
<tr>
<td>6. Students will be able to identify multiple peers by sight and name on the first day of classes.</td>
<td>Working in small groups during the activity</td>
</tr>
</tbody>
</table>

Table 1. Game learning objectives

First, we wanted to create an interactive and informative orientation game that would motivate students to learn about the faculty, program, and facilities (learning objectives 1-4). We chose a game format knowing that gamified activities have been found to motivate students in non-game contexts (Fitz-Walter, Tjondronegoro, Koh, & Zrobok, 2012; Fitz-Walter et al., 2011). The game format provided a reason for students to access all of the QR codes, and the technology allowed us to not only orient new students to the building, but also to link the physical space to...
information about how and by whom the spaces are used. Students who played Schwabe & Göth’s (2005) location-based mobile game most enjoyed the mixed reality elements of the game, suggesting to us that virtual and physical worlds could work together well within an orientation event. Additionally, location-based games have been found to support learner self-efficacy (Schmitz, Schuffelen, Kreijns, Klemke, & Specht, 2015). In some ways this format was similar to the QR code game created by Gressick, Spitzer, and Sagarsee (2014) in which learners scanned codes in a new building while answering questions about course-related content, except in our game the building orientation and other learning content were highly interrelated and we were focused on providing content rather than assessing knowledge.

Second, given that our academic program focuses on learning technologies, we felt that orientation was a great opportunity for modeling technology use for new students and giving them the opportunity to have a successful experience learning a simple technology (learning objective 5). Although we agree that augmented reality is more productively integrated into educational settings when focused on as a concept rather than as a physical technology (Wu, Lee, Chang, & Liang, 2013), we also felt that encouraging students to use this potentially unfamiliar technology before classes began would promote awareness of the technology-based culture in which the program operates.

Third, we saw the game as a means of helping new students become socially integrated with each other and with current student leaders via their game collaborations and interactions (learning objective 6).

GAME CONCEPT AND DESIGN

The game concept is simple. A scavenger hunt format is used to move participants through physical locations and previously has been used during orientation functions to familiarize participants with locations and services (Marcus & Beck, 2003). Although orientation scavenger hunts have been criticized in settings such as libraries for being superficial and without clear purpose (McCain, 2007), these activities suffer from poor alignment between objectives (e.g., learning to conduct library research) and activity (e.g., locate a random research article). In our game, we felt that the learning objectives and activities were effectively aligned since both were focused on identifying people and locations, with no higher order skills involved.

The game consists of seven paths. Each path consists of two locations, two QR codes, two videos, and two clues. The first clue on each path provides a riddle or asks a question; when solved, the answer indicates the second location on the path. The second set of clues consists of letters. When all seven paths have been followed and all seven letters are collected, the letters can be anagrammed to form the name of the event where the prize could be picked up. This game structure is similar to one used in an Italian museum (Ceipidor, Medaglia, Perrone, Marsico, & Romano, 2009).

Seven game paths were created because the program has six faculty members and one main staff member. The first physical location on each game path is a person’s office. The corresponding videos for these locations are introductions in which the faculty member briefly welcomes the student, sharing information about their classes taught and research topics. The staff member’s video is similar, only it focuses on her role in helping students rather than class and research topics. At the end of each video is a location clue.

The location clues lead to another space in the building that is of interest to incoming students. For example, one clue reads, “If Dilbert or Dwight Schrute were students in ISLT, this is where they would be all day long.” This clue leads to the ISLT “cube farm,” where graduate student carrels are located. Other clues lead to the main department office, Cyberlounge, Morgan Multimedia Studio, Technology Sandbox, Learning Resource Center, and Dean’s office. These locations were chosen because they represent places in the building that are frequently referenced and that students may need to visit during their first weeks at the university.

In each of these locations another QR code is posted. These QR codes are linked to videos that introduce both new people (either affiliated with the location or the program) and the purpose or function of the location. At the end of these videos is a letter clue.

The letter clues, when assembled in the right order, spell out the word SEMINAR. Seminar is the ISLT program’s regular speaker that occurs throughout the school year. Students are heavily encouraged to attend seminar because the speakers provide a strong augment to the regular course curriculum. When played during orientation, all students who participated in the game and then attended the first seminar were eligible to receive a prize, which was an aluminum water bottle with program name and a QR code for the program Web site printed on it.

Prensky (2001, p. 119) suggests six critical elements of a game structure: rules; goals and objectives;
outcomes and feedback; conflict, competition, or challenge; interaction; and representation or story. These elements are evident in most games, but some activities considered games may not include all of them. Although ISOG is a simple game, it does include each of these elements to varying degrees, as outlined in Table 2.

<table>
<thead>
<tr>
<th>Game Element</th>
<th>Manifestation in ISOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rules</td>
<td>There is a specific order or plan for game play</td>
</tr>
<tr>
<td>Goals and Objectives</td>
<td>The goal is to get the prize at the end by following the clues and anagramming the word. The embedded learning objective is to familiarize new students with the faculty, staff and facilities. The objective along the way</td>
</tr>
<tr>
<td>Outcomes and Feedback</td>
<td>Feedback comes via successfully finding the next QR code.</td>
</tr>
<tr>
<td>Conflict, Competition or Challenge</td>
<td>Although everyone who finishes wins a prize, there is a time challenge (finish in the allotted hour) as well as natural competition among teams to finish first.</td>
</tr>
<tr>
<td>Interaction</td>
<td>Teammates interact with each other as well as the technology as they locate the QR codes, watch the videos, and solve the clues.</td>
</tr>
<tr>
<td>Representation or Story</td>
<td>The game is about how our program functions.</td>
</tr>
</tbody>
</table>

Table 2. Game Elements in ISOG

GAME PLAY

Game play begins by forming small teams of 3-4 players. The game can be played individually, but we chose to use a collaborative team format for three reasons. First, a team format would require students to work together and get to know each other. Second, teams were less likely to get stuck on a clue than a group. Third, within any group we felt confident that there would be at least one person who felt comfortable or adventurous enough to work the technology.

Each team needs at least one mobile device with a QR code reader installed. After the rules are explained to the teams, they are given one hour to complete their task. The fourteen videos have a combined running time of less than twenty minutes, leaving forty minutes to solve clues and navigate the building.

Play begins in the main office suite, where all seven faculty and staff offices are located. From there, clues lead players to secondary locations elsewhere in the building. At these secondary locations, teams watch the video, collect the letter clue, and then return to the main office suite to follow another path. Figure 1 demonstrates the activity cycle for the game. Game play is over when the final anagram is solved or the hour is up.

![Figure 1. Game activity cycle](image)

DEVELOPMENT PROCESS

The development process for this game was simple and required few resources. The most challenging part was creating clues that would lead to locations. All live action videos were recorded using an iPad, with text-based screen shots showing clues edited onto the end. The videos were hosted on YouTube. A unique QR code was generated for each video, and those QR codes were printed on plain paper. The game was usability tested the day before implementation to ensure all QR codes functioned as intended.

IMPLEMENTATION

Prior to the orientation, we sent an email to all incoming students, informing them that there would be a technology-based game using smartphones and tablets. We recommended downloading a QR code reader in advance and bringing their personal devices, if possible. We also reassured students who might not own devices or who might be daunted by the technology that extra devices would be available and that the activity would be team-based.
On the day before orientation, QR codes were taped to the doors at each location and additional mobile devices were secured in case they were needed. The authors served as facilitators and current ISLT students came to interact with the game players and provide assistance as needed with the technology, solving clues, and finding locations.

Teams were quickly formed in a classroom with assistance from the facilitators. Each team needed to have at least one member who had a mobile device with a QR code reader. The game rules were explained and players were given a brief demonstration of how to scan a QR code. Then teams were led to the main office suite where the stage one codes were located. Each team was told to start at a different door to avoid congestion. Volunteers were positioned around the suite to assist teams as necessary.

**EVALUATION**

**Method**

We planned in advance to evaluate the orientation game to determine if students liked it and if it was an appropriate activity to continue during future years. We were also interested in whether the game achieved any of our learning objectives, although we were hesitant to actually test participant knowledge in this context. With approval of our university’s Institutional Review Board (HSC No. 2012.8780), we both observed the teams as they played the game and asked players to complete a brief survey about their experience at the end of game play, touching on what parts of the game students enjoyed, their perceived outcomes, and their future actions. The anonymous survey was completed electronically, either by using a personal mobile device and loading the survey by scanning a QR code, or via one of the iPads that we supplied for this purpose.

**Findings**

Twenty students played the game, and all but four showed up with their own device. All teams completed the activity within 30-45 minutes. Two groups did not choose to follow the activity path as prescribed above in Figure 1. Instead, they watched all of the first set of videos, collecting the location clues, and then they visited the other locations in the building to collect the letters.

Game play was not always smooth, but its challenges encouraged social interaction. For example, one group comprised entirely of international students did not understand the North American cultural references embedded within some of the clues and needed assistance. Students reported talking to people around the building to get assistance, and at the end of the game players informally shared their experiences solving certain clues, laughing and chatting with each other. In this sense, the game seemed to help the players get to know each other better both within and across groups, and game players started to develop a comfortable rapport with other students, accomplishing learning objective 6.

Sixteen students completed the survey. Ten were Masters students and six were PhD students. Six were male and ten were female. Half of them had prior experience with QR codes, and half did not. The four students who did not bring a device indicated that they owned neither smartphone nor tablet. Nine students (57%) labeled themselves as early adopters, and four (25%) indicated a preference to wait until a technology is mainstream before using it. Three students (19%) indicated they feel no need for new technologies, mainstream or otherwise. This demographic information confirmed that learning objective 5, which focused on introducing technology, was a worthwhile one for half of the participants.

Participants indicated that during the game their groups took one of two approaches to using the technology. Either all team members gathered around a shared mobile device controlled by one group member, or they all used their own mobile devices and did not share. In the latter case, observations suggested that this approach could cause some difficulty because multiple students could have the same video playing at once, creating out-of-sync audio.

Students were asked to indicate what aspects of the game they enjoyed most. Working with a team and the game format were the top two aspects, with the informational parts receiving the fewest affirmative responses (see Table 3). Nine students (60%) indicated that they enjoyed all parts of the game.

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of Students</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working with a team</td>
<td>13</td>
<td>87%</td>
</tr>
<tr>
<td>The game format</td>
<td>12</td>
<td>80%</td>
</tr>
<tr>
<td>Use of technology</td>
<td>11</td>
<td>73%</td>
</tr>
<tr>
<td>Faculty welcome videos</td>
<td>10</td>
<td>67%</td>
</tr>
<tr>
<td>Building/facility information</td>
<td>9</td>
<td>60%</td>
</tr>
</tbody>
</table>

Table 3. Most enjoyed parts of game
Students also were asked to indicate which outcomes they experienced due to game play. All students indicated at least one outcome, with interpersonal outcomes being the most common ones (see Table 4). Considering the findings reported in Tables 3 and 4, it is worth noting that a few of the participants were new Ph.D. students who had previously been enrolled in the program as Masters students. They may account for the lower ratings on items related to program information because they were already familiar with the faculty and the facilities.

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of Students</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feel more socially integrated in the program</td>
<td>15</td>
<td>94%</td>
</tr>
<tr>
<td>Make potential new friends</td>
<td>14</td>
<td>88%</td>
</tr>
<tr>
<td>Get excited about using new technologies</td>
<td>13</td>
<td>81%</td>
</tr>
<tr>
<td>Get motivated for the start of classes</td>
<td>13</td>
<td>81%</td>
</tr>
<tr>
<td>Learn new information about the program</td>
<td>13</td>
<td>81%</td>
</tr>
</tbody>
</table>

Table 4. Game outcomes

In terms of game play, nine students (57%) reported a sense of competition, wanting to finish before other teams. Ten (63%) said that they would definitely attend seminar to retrieve their prize, with only one student reporting that they definitely would not retrieve it. Finally, fourteen students (88%) indicated that they would like to participate in similar learning experiences in the future.

DISCUSSION

Based on the observations and survey findings, we feel that the game was a success. All players successfully completed the game during the allotted time and appeared in good spirits. Further, students’ perceptions of game outcomes suggest that many of them achieved the learning objectives, particularly objectives 5 and 6, which focused on technology and social interaction, respectively. Although the content from the videos (learning objectives 1 – 4) was rated lower than technology and social interaction in terms of both enjoyability and perceived outcomes, and participants were not assessed to determine how much of it they remembered at the end.

An interesting unanticipated outcome was that the QR codes continued to serve as both a conversation piece and an information source throughout the school year. Faculty did not take them down, and people who scanned them. It was not unusual to be sitting in a faculty office and suddenly hear one of the game videos being played on a mobile device in the suite.

Limitations

The evaluation component of this project has several limitations. First, the data are based on one implementation of the game with a small number of players. Second, the learning objectives were not directly assessed at the end of game play. Third, the participants might have been inclined to provide only positive feedback, knowing that a faculty member and students within the program developed the game.

Game Extensions

One of the students who played the game, the fourth author, opted to take the game one step further and embed it in a virtual model of the College of Education building. This model displays the game space on a digital map, as some other QR code and orientations games have done (Fitz-Walter et al., 2011; Schwabe & Göth, 2005). Virtual Stone, as it is called, was built using Google SketchUp, and it provides a three-dimensional walkthrough of the building, accurate down to the placement of desks and photos on the walls (see Figure 2).

At critical locations of Virtual Stone, information augments are available to users. These augments mirror the locations where QR codes were placed in the physical environment, and both text and video augments are available (see Figure 3). Through this model of the building an alternate version of this game now can be offered to our online students, providing them with a stronger sense of connection to the university, the program, and key faculty and staff. Additionally, students on campus may use the virtual model to help navigate the physical building.

Figure 2. Instructional Systems Suite in Virtual Stone
CONCLUSION

In closing, we believe that game-based activities such as this one can be useful both for orienting individuals to a new institution or organization and as an icebreaker, giving new people a chance to interact with each other while solving a challenge and learning new information. An additional benefit for some participants may be an introduction to a new form of technology.

Most of the effort required to create this type of game-based activity occurs during the design phase. The most difficult tasks are identifying the learning content and determining how to best connect both concepts to physical locations and chunks of content to each other. The development time and equipment needed to create a basic QR Code scavenger hunt game can be minimal, although virtual model development, if desired, is more time intensive. The use of virtual models is not necessary, but is helpful when including participants who are located at a distance is desired.

REFERENCES


Virtual Enhancement to Physical Spaces by Dennen, Hao, Lee, & Lim


