Integrating Augmented Reality in Higher Education: A Multidisciplinary Study of Student Perceptions

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Augmented reality (AR) is an emerging technology that blends physical objects with virtual reality. Through the integration of digital and print media, a gap between the "on and offline" worlds are merged, radically shifting student-computer interaction in the classroom. This research examined the results of a multi-case study on the use of the AR platform Aurasma in the higher education classroom with 145 students from three disciplines (Education, Human Resource Development, and Marketing) who participated in the study. Research methods included data collection of pre-experience and post-experience student surveys regarding students' experiences using the platform Aurasma for enhancing learning. Findings included primarily positive student attitudes regarding the usability of AR in the classroom setting and insights into how the Aurasma platform facilitated inquiry and understanding of course concepts. Recommendations for future classroom use are given.

Many of our students are born into a digital age surrounded by multimedia images, sound, and video. In this era of information, students have ubiquitous access to more technological tools than any time in history. In a recent study, it was found that 67% of higher education students are now utilizing mobile devices in classrooms (Chen & Denoyelles, 2013) and they desire an environment that closely aligns with how they use digital tools

outside of school (O'Bannon, Britt, & Beard, 2014).). However, a recent survey of undergraduate students underscored the reality that instructors do not fully utilize digital tools that can create "more varied, inspiring, and beyond-the-classroom learning experiences" (Dahlstrom, Eden, de Boor, Grunwald, & Vockley, 2011, p. 6).

The world has shifted so significantly over the last 15 years that most students are not relating to standard teaching practices (Jukes, McCain, & Crockett, 2010). When a task is seen as dull, boring, routine, or irrelevant to a student's life, there is a lack of motivation towards academic activities (Ford & Roby, 2013). The 2011 Horizon Report challenged educators to revisit their "roles as educators in sense-making, coaching, and credentialing" (Johnson, Smith, Willis, Levine, & Haywood, 2011, p. 2). As a result, instructors need to find innovative ways to improve the student learning experience.

New multimedia technologies are offering opportunities for engaging learning experiences. One such immersive technology, rich with potential for enhancing the classroom, is augmented reality (AR); "the use of augmented reality (AR) in formal education could prove a key component in future learning environments that are rich populated with a blend of hardware and software applications" (Kerawalla, Luckin, Seljeflot, & Woolard, 2006, p. 1).

The purpose of this research is to explore the attitudes of students in their use of the platform Aurasma (Aurasma.com) in order to gain insight and understanding of how AR can be incorporated into teaching to improve classroom learning. In the following sections, we provide a review of pertinent literature, collection of data including a multi-case study across three disciplines (education, human resource development, and marketing), findings, cross-case discussion, limitations, and conclusion and implications.

REVIEW OF THE LITERATURE

Augmented Reality (AR) is an emerging technology that merges the physical world with virtual images, graphics, and sound (Yuan, Ong, & Nee, 2008) that allows digital images to be displayed in the physical world. The New Media Consortium reported that "the powerful significance of the concept of blending information and the real world in an increasingly experiential environment has pushed AR to the forefront in the realms of business, technology, entertainment, branding, and education" (Johnson, et. al., 2011, p. 16).

According to McWhorter (2014), AR shows promise for building the learning capacity and work processes of individuals, groups, and organizations. For example, augmented applications create opportunities for students to utilize simulated practice examinations and allow physicians to view anatomical structures prior to surgeries (Zhu, Hadadgar, Masiello, & Zary, 2014).

Ong and Nee (2004) noted that manufacturing is one of the most promising fields where AR can be used to improve the current techniques and provide solutions in the future. It has been suggested that the technicians who train with an AR platform made less errors and improved performance times when compared to their peers. Also, new wearable technologies such as Google Glass are being used to deliver AR experiences that could be a game changer for manufacturing (Edstrom, 2013). By 2018, Juniper Research estimates that nearly 200 million visitors will utilize AR applications through smartphones, tablets, and smart glasses (Wiggins, 2013).

AUGMENTED CONSUMER PRODUCTS

According to Layar (2010), AR has the potential to become the next mass medium intertwining the brands people love with their everyday life. In fact, "many of the latest and most potentially transformative developments in virtuality – social media, augmented reality devices, geolocative services – have nothing to do with creating alternate worlds and everything to do with adding another layer of (virtual) reality to everyday (real) life" (Dholakia & Reyes, 2013, p. 1589). Cutting-edge AR applications are being utilized in marketing campaigns of several well-known businesses in the retail industry such as Ray-Ban that that utilizes a virtual mirror application allowing users to try on their latest styles of glasses (Luxottica group, 2014), and embedded on food packaging from companies such as Starbucks (Lowensohn, 2012). AR technology supports businesses by enhancing the five essential phases of commerce: "Design, Discovery, Details, Desire and Delivery" (Young, 2013, para.2).

AUGMENTED REALITY IN EDUCATION

Augmented reality has the potential to revolutionize education. Klopfer and Sheldon (2010) emphasized that the potential of AR for learning is its capacity "to enable students to see the world around them in new ways and

engage with realistic issues in a context with which the students are already connected" (p. 86). There are numerous examples of how schools are implementing AR into classrooms. For example, in higher education, The Georgia Institute of Technology and The Massachusetts Institute of Technology are working to enhance student learning through AR gaming simulations (GeorgiaTech, 2014). Further, AR has been utilized to make complex concepts in mechanical engineering more easily understood by students (Liarokapis & Anderson, 2010).

AR is expected to play a more significant role in teaching and learning over the next few years. According to Liarokapis and Anderson (2010) although current teaching models may be successful, new visualization technologies are poised to improve the learning experience and increase student understanding.

THEORY OF LEARNING WITH AR

In line with the constructivist theory of learning, an augmented environment moves from a teacher-centered environment to a learner-centered one where students construct new information based upon their previous knowledge. Students use their interactions with new environments to create meaning. Dunleavy and Dede (2013) pointed out that as a cognitive tool and instructional approach, AR is

> primarily aligned with situated and constructivist learning theory, as it positions the learner within a real-world physical and social context while guiding, scaffolding and facilitating participatory and metacognitive learning processes such as authentic inquiry, active observation, peer coaching, reciprocal teaching and legitimate peripheral participation with multiple modes of representation (p. 1).

One of the most important purposes of an educational environment is to promote social interaction among students (Cobb, Heaney, Corcoran, & Henderson-Begg, 2010). And, Kaufmann (2003) reported that AR technology facilitates learning through collaboration as students and instructors in different physical locations can share a common virtual learning environment (VLE) through the use of virtual objects. These collaborative opportunities are fundamental to the formation of a constructive classroom environment.

While the potential for using AR across disciplines is far-reaching, little is known about how AR enables students to construct new understanding (Sumadio & Rambli, 2010). Also, few studies have been undertaken in busi-

ness and industrial studies. Additional research will help educators make informed decisions in the use of AR for learning across disciplines.

METHODOLOGY

Project Description

Across the U.S., the augmented reality platform Aurasma is being implemented in classrooms to enrich lessons through the use of teacher and student-made activities. Created by the software company Autonomy in 2011, Aurasma (www.aurasma.com) is the world's first visual browser to merge the real-world with rich interactive content such as videos and animations called "Auras". Aurasma is a free application that is available for iOS and high-powered Android devices that allow the user to create 3D overlays that will trigger (play) based on an image.

According to Aurasma's creator Matt Mills, the platform uses advanced image and pattern recognition much like the human brain (Haymarket Media Group Ltd., 2012). Currently, 100,000 partners have delivered various promotions using Aurasma across 100 countries, "to create meaningful, engaging and powerful mobile AR campaigns that drive revenue and demonstrate innovation" (Aurasma, 2015, para. 3).

Across three disciplines (education, human resource development, and marketing), students were asked to create a content specific AR image using the free version of Aurasma Studio (https://studio.aurasma.com/register). Specifically, students were required to register for an account, upload a trigger and overlay image, create a channel name, and augmented image. Students had to submit their auras to their instructor using a project template provided on the course website.

RESEARCH DESIGN AND DATA COLLECTION

The researchers used an exploratory, mixed-methods approach to address the goals of this multi-case study. Creswell (1998) contends that in order to build conceptual models for the future, a case study should provide a thorough description of the context, the processes observed, a discussion of the main findings, and the lessons to be learned.

To accomplish the purpose of this study, the following research questions will be addressed:

1. What were student's perceptions regarding the usability of the
    Aurasma tool for learning?
2. How did augmented reality enhance student learning?

INSTRUMENTATION

Data was gathered in the form of pre- and post-experience surveys in
order to examine the perceptions of students using the platform Aurasma.
The pre-experience survey contained 11 multiple choice questions which
were examined: student demographics (age, race, level of education), stu-
dent access to technology (Internet, computers), and current technology use
(social media, video streaming).

The post-experience survey contained five multiple choice questions
and three open ended questions designed to discover usability and student
attitudes after the use of Aurasma as a pedagogical tool for learning in the
higher education classroom. Institutional Review Board (IRB) approval was
obtained prior to the study. See Table 1 for a cross-case comparison of the
context of the study and the study participants. Following the comparison,
the three case studies will be presented.

CASE ONE: EDUCATION

Setting and Participants

This exploratory case study was conducted in an undergraduate science
methods course in the College of Education, at one regional four-year uni-
versity during the fall of 2013 and spring of 2014 semesters. For their as-
signment, students (see Table 1) were asked to use the Aurasma platform to
create an aura centered upon elementary scientific content. Then, each stu-
dent integrated the aura into an inquiry-based lesson plan and taught the les-
son in their field-based classroom.

In order to meet the demands of a 21st century workforce, we must edu-
cate our students with a greater content knowledge in STEM (science, tech-
nology, engineering, math) subjects (PCAST, 2010). Teachers will need to
employ an inquiry-based pedagogy enabling students to actively construct
meaningful knowledge through hands-on activities. Furthermore, in order to
learn science, the Next Generation Science Standards (NGSS) stressed the
need for students to visually connect scientific concepts through the use of
models and explanations (NRC, 2012).

Table 1
Characteristics of the Participants and Courses According to Each Case

	Case One	Case Two	Case Three
Discipline	Education	Human Resource Development	Marketing
Course Level	Undergraduate	Undergraduate	Graduate
Number of Participants	n=43 (40 female / 3 male)	n=63 (47 female/16 male)	n=39 (22 female, 17 male)
Millennials (1982-1995)	n=36 84% of participants	n=51 82% of participants	n=25 64% of participants
Generation X (1965-1981)	n=4 9% of participants	n=8 12% of participants	n=11 28% of participants
Baby Boomers (1946-1964)	n=3 7% of participants	n=4 6% of participants	n=3 8% of participants
Ethnicity of Participants	77% Caucasian 12% Hispanic 7% Asian 4% Black	80% Caucasian 14% Black 3% Asian 3% Hispanic	51% Caucasian 23% Hispanic 18% Black 5% Asian 3% Hawaiian/Pacific
Course Type and Context	Science Methods Course in College of Education, Fall 2013, Spring 2014	Training and Development Course, College of Business, Spring 2014	Advanced Marketing Course, College of Business, Spring 2014
Purpose of the Course	Provide prospective teachers with the opportunity to acquire scientific knowledge and methods of teaching science to early childhood (EC) - 6th grade students.	Provide an overview of the planning, design, implementation and evaluation of training and development in a variety of business and non-profit settings	Provide an overview of marketing principles, strategy, and consulting. AR was utilized as a promotional tool for business-to-business and business-to-consumer marketing.
Course Delivery	HyFlex course which combined both online and on campus meetings	Blended delivery (2 on campus meetings, 4 real-time group meetings, remainder online)	Online delivery of all course materials
Purpose of the AR Assignment	Use Aurasma to create an aura centered upon elementary scientific content and integrating the aura into an inquiry-based lesson plan and teach the lesson in their field-based classroom.	Utilize the Aurasma platform to create an aura for training a newly hired employee within the context of a fictitious business to enhance onboarding efforts in the company.	Use Aurasma to create an AR promotional initiative for a business or non-profit that would improve marketing efforts such as enhanced business cards and in-store displays.

Schools often lack teachers with the pedagogical knowledge to teach STEM subjects in motivating and engaging ways. According to Delello

(2014), by providing a technology-enhanced learning experience through the use of AR, student engagement, motivation, and scientific interest increases. Research has also shown that AR applications improved student knowledge while reducing common misconceptions (Tian, Endo, Urata, Mouri, & Yasuda, 2013).   In this case, pre-service teachers were provided training and support as they incorporated AR lessons into elementary school classrooms. The objective was to help pre-service teachers learn science content while improving their technology skills. Additionally, elementary students would be provided with a more inquiry-based approach to learning.

RESULTS

Pre-Experience Survey

The pre-experience survey revealed that 93% of the students participating in this study had high speed Internet at home. Eighty-one percent of those students had Smart phones, 95% of them reported to also own a laptop or tablet, and just over 50% indicated they also owned an iPad. The majority of students (88%) indicated that when using a computer, they most frequently spent time using social networks such as Facebook and Twitter. In fact, 95% of the participants had a Facebook page and 81% had a Twitter account. Participants also noted that they commonly spent time surfing the Internet (84%), working on class assignments (81%), emailing (63%), and posting links to the social site Pinterest (63%). Eighty-one percent of the participants also noted taking pictures at least once per week; yet, only 12% of the students created or uploaded personal videos.

When students were asked *How often have you used QR Codes, Aurasma, or other augmented reality*, 95% of the respondents reported never having used an augmented platform at all (70%) or rarely (25%). Also, 74% of the participants noted never having used an online simulation or game to learn science.

Post-Experience Survey

When asked on a Likert scale to rate their overall experience with the Aurasma platform, with zero being negative and five being extremely positive, 77% of the participants rated their experience positive (19%) or extremely positive (58%). Over 94% of all of the participants planned to use

Aurasma after graduation and when asked *how often they would use Aurasma in the future*, the majority (94%) of students noted they would use the platform 2-3 times per month. By the end of the course, 77% of the students had shared their project and 82% of participants felt that the Aurasma platform enhanced their course learning experience.

Open-ended Responses

When students were asked about their first impressions of the platform Aurasma, forty responded. The analysis of the open-ended responses exposed five major themes: *Apprehension, Practice, Affirmation, Lack of Technology,* and *Connection.*

The first theme that emerged from the data was *Apprehension.* Initially, many (48%) of the students were intimidated by the technology as highlighted in the following statement, "I thought that it was going to be very hard and I was very intimidated. It turned out to be a lot easier than it looked". Another student communicated, "I was horrified of Aurasma... it looked way too high tech and advanced." And although there was apprehension among many of the participants, 45% of participants commented that *practice* made the Aurasma platform easier to use. For example, one student remarked, "It was somewhat difficult to figure out at first but after I played around with it for a little while it was easier to work with." Another student stated, "I thought that it was going to be difficult to work, but once I played around with it for a few minutes, I learned that it was actually very easy."

The third most common theme was *affirmation*. Students' first impressions of the platform were mostly positive. Students reported that Aurasma looked fun (3/8%), cool (4/10%), interesting (6/15%) and impressive (1/3%). Many also reported they "liked it" (5/13%), loved it" (3/8%) and found it easy to use (7/18%). For example, one student commented, "I thought it was really cool! I never even knew that type of technology existed." Another noted, "It was user friendly and very technologically advanced."

The fourth theme was based upon a *lack of technology*. A few students (n=3) reported the lack of a personal "smart" device as the initial reason for not having access to the platform. For instance, one student commented, "I found it difficult if you did not have an up to date smart phone, iPhone, or iPad." Another student commented, "It's kind of easy to make if you have an iPhone or iPad… I had trouble getting everything to load and I don't own an iPhone or iPad. I finally had to use my friends phone to make it." A third

student shared a related comment: "I had no device to check it, and the person I called to have them check it with their phone could not see the picture but everything worked out well and I really do like it."

Finally, ten (25%) of the students reported a *connection* between using AR to their future classrooms. For example, one student remarked, "I think students would really enjoy using this type of technology in the classroom. It makes pictures and images come to life for them." Another student commented, "I see the BENEFIT of integrating this app in activities for students." A third remarked, "My future students will love it!"

When students were asked *did you find creating auras with Aurasma to be difficult*, the 40 responses to this question were divided between the themes of *no* (n=9), *yes* (n=9) and *mixed* (n=22). The students who had no difficulties reported the platform easy to use. For example, one student stated, "No, it was very simple. The instructions are very easy to follow as well." Another student commented, "I found it clear! I have made 15 so far!!! They are genius!" However, for others, the platform was perceived as somewhat difficult. Most of the difficulties stemmed from a lack of appropriate technology. For example, six of the students remarked that their mobile devices would not read the aura. One student stated, "I guess my smart phone isn't smart enough, I eventually had to use my friend's phone." Students also commented that technical issues, including problems creating channels (5%) and embedding video overlays (15%) made the platform difficult. For example, one student noted, "They were only difficult because I could not figure out how to use YouTube videos for my auras because they were too long." However, even though there were difficulties revealed, the majority (55%) of the students who initially had complications noted that with practice, the aura was simple to create. For instance, one student commented, "I was confused at first when trying to upload trigger images and videos, but after catching on I think it is pretty easy to create an Aurasma." Other students remarked that they wanted better instructions and more support from the platform. For example, one student stated, "[I] needed more instruction on how to create an aura. Once I knew what to do it was very simple." An additional student indicated, "The hardest thing was searching for a video that went along with my lesson. I wish the app itself had more educational videos that teachers could use."

When students were asked for their *suggestions on using Aurasma in the future*, a variety of recommendations emerged. For example, many of the students (31%) reported they wanted more in-class instructional time to learn the program as noted in the following comment: "[Create] one in class on the technology day, so that everyone is comfortable with at least the ba-

sics before leaving the classroom." Other students recommended "starting earlier" as described in the following comment, "I would advise students to start early so you can be as creative as you want." One student even suggested, "Maybe using a different program other than Aurasma would be better." Yet, another student recommended the instructor, "Keep promoting its use among future teachers" and commented, "I personally think that it is a great tool to enhance students' learning."

CASE TWO: HUMAN RESOURCE DEVELOPMENT

Setting and Participants

This exploratory case study was conducted in an undergraduate human resource development course (63 total undergraduate students; 47 female and 16 male) within a College of Business at one regional four-year university during the spring of 2014 semester. For their augmented reality (AR) assignment, students were asked to utilize AR as part of a business training plan (See Table 1). Working in virtual workgroups of about three students each, they created a fictitious business including name, original logo, and description and then were asked to design a business training plan for onboarding new employees into their fictitious business. Each workgroup produced a short (1-2 minute) video that could be utilized as one of several training activities for onboarding new employees. Through Aurasma, the video was embedded with a trigger image (company logo) that would play the video when activated within the Aurasma "App" (application) installed on a smart phone or digital tablet. Figure 1 illustrates a training channel created by one of the workgroups for their fictitious business, Destination Travel. Note that a template was provided for each workgroup that were instructed to place their trigger image inside the box on the template and add a description for their embedded training video.
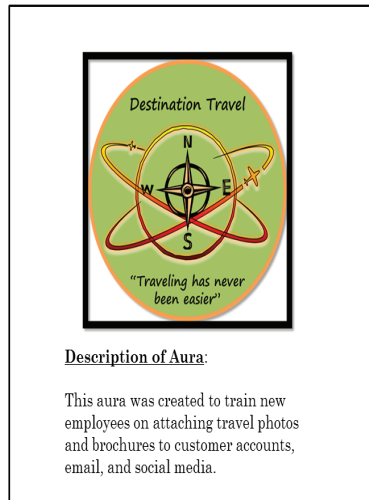
Figure 1. Trigger Image Created in a HRD Undergraduate Course

Employee development is one of the primary responsibilities of HRD professionals to increase learning and performance in an organization. Because training can be a highly effective process for developing expertise, HRD professionals often seek cost-effective methods such as using technology to enhance the training environment (Cascio, 2014). According to Shein (2014), one of the real advantages for using AR for training is that the employee can see the actual environment where they will be expected to perform a task or repeat an action in the future, before they expected to do so. In the current study of undergraduate business students, the training videos were created by virtual workgroups and embedded into a visual object were useful because they demonstrated a skill and could be viewed repeatedly by a trainee on a relatively inexpensive and portable mobile device for the purpose of mastering a specific task to gain the needed expertise.

RESULTS

Pre-Experience Survey

According to the Pre-Experience Survey given at the onset of the HRD course, 92% of the students participating in this study had high speed In-

ternet at home. Also, ninety percent of those students had Smart phones, 97% of them reported to also own a laptop or tablet, while 38% indicated they also owned an iPad. Further, the majority of students (87%) indicated that when using a computer, they most frequently spent time using social networks such as Facebook and Twitter. Also, 75% of the participants had a Facebook page and 37% had a Twitter account at the beginning of the course. Participants also reported that they commonly spent time surfing the Internet (83%), working on class assignments (75%), emailing (65%), and posting links on the social site Pinterest (38%). Seventy-one percent of the participants reported taking pictures at least once per week; yet, only 17% of the students created or uploaded personal videos.

When students were asked *How often have you used QR Codes, Aurasma, or other augmented reality*, ninety-five percent of the respondents reported that they had not used an augmented platform at all (75%) or rarely (16%). However, 87% of the participants noted they routinely utilized You-Tube.

Post-Experience Survey

Over 94% of all of the participants planned to use Aurasma after graduation and when asked *how often they would use Aurasma in the future*, the majority (63%) of students noted they would use the platform about once every one or two months.

By the end of the course, 30% of the students had shared their project with others denoting they saw value in the project. Also, the majority (90%) of participants felt that the Aurasma platform enhanced their course learning experience.

Open-ended Responses

Three open-ended responses on the student survey are relevant in this study. Responses by participants to each of the questions were coded and themed and are presented next.

When asked about their first impressions of the platform Aurasma, students reported their initial impressions of the platform Aurasma in three general themes. The first theme represents the most comments (n=37), *Intimidating at First, but Easier than Expected* as illuminated by this student comment, "Being a Baby Boomer who refused to learn new technology, I

was scared to death, but with the help and patience of some of my young classmates I lost the fear". Another student commented that Aurasma was "Intimidating at first but after watching videos it was easier to understand, impressive and I can see this cutting edge technology being the next training platform". The second most common theme (n=23) that emerged from the data was titled *Pleasantly Surprised* and represented by this participant comment, "I was surprised and impressed by the technology and really intrigued by it". Another student commented, "I thought it would be a fun application to work with and something that I might be able to use in my office". Two students remarked that their initial impression about Aurasma upon logging in was that it was an *Out-of-Date Platform.* One student said, "My first impressions were that the software was very behind. Aurasma seemed out-of-date and somewhat difficult to use" while the second student commented, "The program seemed to have an old windows feel despite being new technology".

Participants were asked to convey their perceptions about creating auras with Aurasma through the question, "Did you find creating auras with Aurasma to be difficult?" Responses were fairly evenly divided with "No" at 52% (n=32) and "Yes" at 48% (n=30). The following extracts from participants' comments represent the responses to these two themes. One student answered "No, I went through all the tutorials you provided us so it wasn't that difficult" and "No it was very simple and self-explanatory using the Aurasma platform." Another student remarked, "No, it was much easier than I originally anticipated." In contrast, one student answered "Yes, because this was my first time actually using this type of technology" and another participant further described: "At first yes. Felt more comfortable as the semester went on"; and finally, one participant reported: "At first yes. Felt more comfortable as the semester went on."

When students were asked for their suggestions on using Aurasma in the future, they recommended a variety of solutions. These comments were themed around (1) *watching tutorial videos* represented by the comment, "Watch the videos, and research it on YouTube"; (2) *start early on the project* represented by the comment, "Get started earlier in the semester on the project in order to allow your group to be more creative…if you wait too long to get started you end up settling for the simplest thing to get the project completed", (3) *create as much as possible on a desktop computer* illuminated by the comment: "It is easier to use Aurasma Studio on a computer than the App on a tablet or mobile phone", and, (4) *be creative* represented by the comment, "Be creative, Aurasma is a lot of fun and the possibilities are endless."

CASE THREE: MARKETING

Settings and Participants

This exploratory case study was conducted in a graduate marketing course within a College of Business, at one regional four-year university during the spring of 2014 semester. Participants for this study included 40 graduate students (22 female/18 male) who were enrolled in an advanced marketing course with online delivery. The purpose of the course was to provide an overview of marketing principles, strategy, and consulting. Augmented reality was utilized as a promotional tool for business-to-business and business-to-consumer marketing (See Table 1).

Students were asked to create an augmented reality promotional initiative for a business or non-profit organization that would enhance their marketing efforts. Augmented reality promotional initiatives included the creation of trigger images on business cards, in-store displays, or informational brochures. Overlays included photographs, website links, and videos.

Businesses and organizations are continually faced with integrating innovative technologies into their marketing initiatives in order to interest and engage consumers. A primary purpose of this augmented reality project was to challenge students to learn a new technology and to discover the marketing potential of this technology. Augmented reality was introduced to the students with a video that demonstrated what augmented reality was and marketing examples were provided to help them better understand the potential of this application in a promotional context. Next students were required to find an example of augmented reality in use by a business or organization and to share that example via the learning management system discussion board. Students were asked to create an augmented reality promotional initiative for a business or non-profit organization that would enhance their marketing efforts. Augmented reality promotional initiatives included the creation of trigger images on business cards, in-store displays, or informational brochures. Overlays included photographs, website links, and videos. These trigger images were then shared with students in the course as well as with faculty, staff, and students at a university augmented reality showcase. Projects were assessed based upon the ease of use, appropriateness for the business/organization, promotional effectiveness, and marketing application.

RESULTS

Pre-Experience Survey

It was found that 92% of the students participating in this study had high speed Internet access at home. Ninety-seven percent of those students had Smart phones, 90% of them reported to also own a laptop or tablet, and 44% indicated they also owned an iPad. The majority of students (92%) indicated that when using a computer, they most frequently spent time surfing the Internet and searching on Google. Eighty-two percent reported currently using social networks such as Facebook (93%), Twitter (92%), LinkedIn (90%), and Pinterest (33%). Participants also noted that they commonly spent time on the computer sending and receiving email from family and friends (72%), working on class assignments (59%), and video conferencing (44%). Sixty-four percent of the participants reported taking photographs at least once per week; yet only 13% of participants created or uploaded personal videos.

When participants were asked *how often have you used QR Codes, Aurasma, or other augmented reality,* 87% percent of the respondents reported that they had not used an augmented platform at all or rarely (13%).

Post-Experience Survey

Forty three students participated in the post-experience survey. When asked on a Likert scale to rate their overall experience with the Aurasma platform, with zero being negative and five being extremely positive, the mean value of 4.09 represented a positive experience for students.

Over 68% of all of the participants planned to use Aurasma after graduation yet when asked *how often they would use Aurasma in the future,* the projected frequency of usage was low (40%) noted less than once a month or never (11%). By the end of the course, 81% of the students had shared their project and 74% of participants felt that the Aurasma platform enhanced their course learning experience.

Open-ended Responses

Three open-ended questions asked participants about their perceptions of Aurasma: *what were your first impressions of the platform, did you find*

creating auras with Aurasma to be difficult, and what suggestions do you have for using Aurasma in the future. Responses by participants to each of the questions were coded and themed and are presented next.

When students were asked about their first impressions of the platform Aurasma, the analysis exposed three major themes: *Intimidation, Interesting, and Innovative.* The first theme of *Intimidation* represents the most comments (42%). Students expressed initial intimidation, "It seemed it would be difficult to navigate", and "I was overwhelmed with the new technology." However, many students expressed that the initial intimidation diminished with practice "I found it a little difficult to understand, but I soon got the hang of it and found it rather fun." The second major theme that emerged from the data was *Interesting* as represented by this participant comment, "Aurasma is pretty incredible. I thought it was fun creating augmented reality." Another student commented, "I was quite impressed with the simple yet fun and interesting features it displays." The final major theme of *Innovative* is best represented with the following comment, "Very cool technology. It can be applied in multiple settings or media and has the potential to really change marketing."

Participants were also asked their opinion regarding the usefulness of augmented reality for businesses. All but one of the participants responded that augmented reality would be useful for businesses with comments such as "It seems to be a very inexpensive way to engage customers. AR is going to change the way advertising and selling is done!" Another student commented how augmented reality can be used for specific target marketing with, "It is even useful to help businesses connect with younger demographics". The one student who did not believe augmented reality would be useful for businesses commented on the time necessary to learn the new technology, "Honestly, I cannot see people using it often for business. In business, would people be willing to take the time to create an interesting video of the information they are trying to get across?"

Participants were asked whether or not they found creating auras with Aurasma to be difficult. Responses were fairly divided with "Yes" at 57% (n=20) and "No" at 43% (n=15). For those students who responded "Yes", the following extracts represent the comments, "At first, yes it was difficult. I don't consider myself technologically illiterate or an expert, so I was a little surprised at how confusing it seemed at first" and "At first I found creating auras very difficult. I have very little experience with technology, so trying to load anything into a program was challenging, to say the least." For those students who answered "No", comments included "No, it was fairly easy" and "Once I understood the process it was very easy." Another student

stated, "No, I found it easy and created mine in less than an hour, once I decided what to do."

When students were asked what suggestions they have for using Aurasma in the future, the three most common responses were: (1) *Provide a video tutorial* represented by the comments, "Create and post a walk-through type of YouTube video to explain in graphic detail (for all of us newbies) the exact procedures on how to create and share auras from start to finish" and "A video tutorial rather than a list of instructions will enhance the experience; (2) *Technical issues with the app* such as creating accounts, "I would suggest that students create an account first, the app account should be created later" and using mobile devices, "Some bugs need to be worked out as far as navigating the creation stages on a mobile device. The pages hang up, certain sections get covered by other windows and are then impossible to get back to, etc." and "Using it on a larger tablet versus phone"; and (3) *Stronger integration with the semester project* were represented by the following comments, "Having students incorporate Aurasma with their client project" and "Maybe incorporating it into the final project that is assigned."

DATA ANALYSIS

We analyzed the acquired data using basic descriptive statistics, which enabled us to portray and discover patterns emerging from these data. We analyzed the three open-ended survey questions using an inductive and comparative approach (Merriam, 2009). In multiple cases, data are analyzed within the case and across cases to categorize the similarities and differences in each. As Creswell (1998) stated, when multiple cases are chosen, the research team should "first provide a detailed description of each case and themes within the case, called a *within-case analysis*, followed by a thematic analysis across the cases, called a *cross-case analysis*, as well as assertions or an interpretation of the meaning of the case" (p. 63).

CROSS-CASE FINDINGS AND DISCUSSION

Descriptive Commonalities

Regardless of discipline or educational level, the majority of students in this study were Millennials who spend a considerable portion of their time online and are socially connected. For example, over 90% of all students re-

ported owning a Smart phone and a laptop or tablet. Additionally, over 92% of the students in each case were connected to the Internet at home. These findings are consistent with research which reported that 96% of today's Millennial generation are connected to a cell phone and use them to access the Web (Pew Research Center, 2010).

In this study, the ethnicity of the Education and HRD was more represented by Caucasian (77%) and (80%) compared to Marketing (51%) which had the highest percentage of Hispanic (23%) and Black (18%) participants.

RESEARCH QUESTIONS

In order to answer the two research questions in this study, it was necessary to look across the data and analyses from the three cases for shared patterns and characteristics. Although these three cases represented both online and hybrid models of instructional delivery, certain themes emerged that can be used to describe the usage of AR as a tool for learning. In regards to research question one *what were student's perceptions regarding the usability of the Aurasma tool for learning?,* four broad themes emerged: *Intimidation, Practice, Technology, and Training*.

In this study, students across all three disciplines followed the same user guidelines while creating an aura specific to their course content. And, regardless of discipline, students were evenly divided in their opinions on the usability of the platform Aurasma.

Augmented reality is somewhat of a novel approach in higher education. For example, in this study, almost 90% of all students had never or rarely used an augmented reality platform. And, undoubtedly, almost half of the students in each case felt overwhelmed or *intimidated* when using first attempting to use AR. Dunleavy and Dede (2013) noted that AR may contribute to student cognitive overload as students experience the complexity of the technology. Also, Moos (2013) noted that cognitive overload is common when students are engaged with assignments utilizing multimedia involving multiple sights and sounds. Yet, in all cases, the participants in the study noted that with *practice*, creating an aura became "simple" or "easier".

As with any new technology, challenges will exist. Many of the difficulties stemmed from inadequate technology and an overall lack of experience using the Aurasma platform. For example, even though most of the students reported having a cell phone that was capable of connecting to the Internet, students noted difficulties in both viewing and creating their aug-

mented projects as stated in the following education excerpt "it kept crashing on my devices. It might have been user problems, but I finally got it to work with no problem." Also there was some frustration in uploading trigger images or large videos. In order to alleviate these challenges, students across all three disciplines suggested additional *training* including extra tutorials and video support for increasing AR technology development. Technology development is an important learning process for any student wanting to enter the professional workplace where employees are frequently expected to learn new technology platforms and applications (McWhorter & Lynham, 2014).

In regards to research question 2: *How did augmented reality enhance student learning?, three* broad themes emerged: *Interest, Course Enhancement, and Future Application*.

To begin with, each case demonstrated examples of student *interest* in learning with augmented reality. Students noted that the creation of auras was interesting and fun. Also, in all three areas, the majority of students felt AR *enhanced their course*. However, education and HRD students (94%) were more receptive to using AR after graduation than marketing students (77 %). The marketing students may have been less receptive to using AR after graduation since most students in the MBA program were working professionals with less time to learn and apply new technologies. In fact, education students (who had the most face-to-face course sessions) were the most receptive to the technology and were also the students with the most hands-on face-to-face time with their instructor. In addition, the literature pointed to education as being a field that has embraced emerging technologies including AR and it is these K-12 classrooms where the education students in the course were spending field experience hours. This immersion in K-12 classrooms may have enhanced the motivation to produce creative products as they are seeing students in the schools finding value in the AR activities.

Finally, it should be noted that students recognized the potential for AR outside of the classroom as demonstrated in the following education comment, "I thought it was a very interesting app that could lead to many discoveries especially in science." HRD students were interested in using AR for training and development purposes in their future careers while marketing students overwhelmingly stated the usefulness of AR for businesses as represented by this comment, "I think we have only scratched the surface of the potential usefulness from AR in the business world. I think it will only become more prevalent as more and more people become aware of its potential for use in marketing, training, advertising, etc."

LIMITATIONS

Several limitations were found in this study. One limitation of this study is its generalizability due to the fact that the study was based on just 145 students from one four-year institution. Also, the sampling technique utilized a convenience sample and the data was self-reported. Furthermore, this study examines AR with the Aurasma platform and not all available augmented applications (e.g. Layar, Daqri). Finally, the study did not measure the extent of the content learned in each course.

CONCLUSION AND IMPLICATIONS

This cross-case study represented the perceptions of students in three disciplines towards using AR as a tool for learning. The findings suggest that AR can enhance a student's experience in the classroom. Not only were students impressed with the technology, they also found relevance to their future careers outside of the classroom.

Our students are growing up in a digital world where emerging technologies such as augmented reality will continue to become a pivotal part of their life. And, although today's students are "plugged into" a digital landscape, this study also revealed that for some of the students, equitable access to a high powered device was absent. The implication that follows is unless schools provide the mobile device, it is important to evaluate both the technology and the infrastructure (e.g. network) the students will employ for AR within classrooms. Also, students need more explicit instruction in the form of text and video to create and share their AR products.

It is vital that we consider how AR can move beyond being just another tool for edutainment. It will be important for educators to develop a new approach to the traditional means of instruction—one that looks at the connection between what is learned in the classroom and what will be needed to compete in a global workforce. In this aspect, there will be a need for interdisciplinary collaboration in order to value the contributions of others while seeing the connection beyond academia.

As a result of the findings in this study, instructors in each discipline represented intend to make modifications to their future AR course projects. For instance, in Education, pre-service teacher reflections as well as elementary student perceptions on the use of AR will be collected. Additionally, pre and posttests of specific science-based content will be administered by the prospective teachers before and after each AR enhanced lesson in order to

measure the learning gains of the students. HRD student feedback reflected the need to provide more in-depth training videos through AR that encompass not only onboarding of new employees but also other training needs within organizations which an area for future improvement. Also, the HRD instructor plans to incorporate more detailed learning aids such as step-by-step instructions and also real-time group meetings (RTGMs) vital for online courses where the students are working on a group project at a distance (McWhorter & Delello, 2015). In Marketing, the instructor plans to use an actual client in a service learning environment so the students can apply this technology to solving real business problems. In addition, a video tutorial will be created to give more upfront training for the AR assignment. These future revisions will allow students the capacity to transfer learning from one context to another, blurring the boundaries between formal and informal learning (Johnson, et. al, 2011).

Because technology extends human capabilities, the business and non-profit community from various disciplines may benefit from insights into the use of AR where community leaders provide authentic venues for the AR products developed by the students. Although AR is still in its infancy, the potential for student learning and collaboration is far reaching and presents exciting possibilities for the future.

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