Art History and Augmented Reality: Designing Virtual Art Exhibitions in the Classroom

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XR (Extended Reality) technologies are developing into an important tool for the study of art history and this article details the innovative teaching strategies and learning outcomes associated with a course taught at the University of Miami in Spring 2020 entitled “Art History and Augmented Reality.” The students participating in the course were all part of the da Vinci Scholars program that brings together talented undergraduates who have an interest in the intersection of science, technology, and the arts. The students were given the task of creating a virtual art exhibition that could be experienced using the Magic Leap Augmented Reality headsets. The starting point of each exhibition was an ancient artwork from the Antiquities Gallery of the Lowe Art Museum at the University of Miami but the students were given free rein to determine the theme and content of the exhibition. The innovation in this project lies in the definition of students in art history as makers; in this activated learning environment, they devised the content and designed the application itself. The interdisciplinarity of the faculty was also innovative, as specialists in art history, user interface design, project management, computer vision, and software engineering all collaborated and shared instructional duties throughout the course. Through this process, the students were empowered to take the skills they acquired and apply them to similarly complex problems and projects at the university and beyond in their professional careers.

The Use of Augmented Reality in Educational and Cultural Contexts: The State of the Field

The role of XR technologies in cultural heritage and art historical studies is currently in a state of definition as adoption of the technologies becomes more widespread. AR (Augmented Reality) apps have been deployed with some success in museum environments, where they create an interactive experience with artworks mostly through the use of smart devices (Garzón and Acevedo; Marques and Costello; Neuberger and Egger). VR (Virtual Reality) has also been used in the recreation of lost or endangered sites or artworks, as seen in the VR experience created by the Louvre (Mona Lisa: Beyond the Glass) to solve problems of overcrowding around the Mona Lisa (Mayers; Casu et al.; Mona Lisa). Virtual Reality, however, is an experience that is deep and immersive but lacks any interface with the physical space surrounding the user. ARSGs (Augmented Reality Smart Glasses), including the Magic Leap and HoloLens headsets, have also been used as a visualization tool for cultural artifacts (Russo; Magic Leap; Muñoz and Martí; Kalantari and Rauschnabel) (Figure 1). It is their unique ability to provide a hybrid experience containing elements of both AR and VR that gives these types of headsets such great potential. Their dual functionality enables different experiences for the user in distinct types of spaces.
The use of XR technologies in education is still limited, with little scholarly research analyzing the learning outcomes for XR experiences. Publications that do exist on this topic generally assess positively the ability of these initiatives to enhance student learning and engagement (Daniela; Garzón and Acevedo 256-57; Casu et al. 82-83). Projects that employ XR experiences in the study of art history include reconstructions of ancient monuments (Flyover Zone; ClassVR; Lind), virtual visits to historic sites using Google Cardboard and Street View (Cappello; Wilson and Antonowicz), projection of frescoes onto classroom walls (Newman), and the creation of virtual art galleries (Oxford College at Emory University). All these projects aim to engage students and activate their learning by providing traditional content in an innovative manner, making the study of 2D and 3D objects more compelling through rich contextual material that recreates original settings and physical spaces. The project addressed here furthers the approaches and outcomes outlined above but also adds the component of using AR as a visualization tool for research, allowing students to present art historical material in an interactive and engaging manner for a variety of audiences—scholars, students, and the general public.

Creating an AR Virtual Art Exhibition: Project Background

The student-centered project presented here was the offshoot of another technology-driven course offered at the University of Miami, funded by the Andrew W. Mellon Foundation. Entitled Animating Antiquity, this project aimed to reanimate ancient objects in the Lowe Art Museum at the University of Miami by staging encounters between the museum-going public, ancient objects, and their printed 3D models. Students generated all the content for the project, producing art historical dossiers and 3D digital and printed models.
while devising interactive strategies that encouraged viewers to engage with these ancient objects in the gallery. A subsequent installation of the 3D printed models in the Lowe gave visitors the opportunity to touch and manipulate the models of the sculptures while learning about the processes used for their creation (Figure 2).

The models in the gallery were to serve as the starting point for the Augmented Reality apps created by students in the course offered in Spring 2020 but COVID necessitated the closing of the museum to visitors. Nevertheless, these ancient sculptures served as the starting point and inspiration for a course that tasked students with the creation of an AR virtual art exhibition.

The course “Art History and Augmented Reality” was the inaugural capstone for a group of students in the Da Vinci Scholars Program. Students in the class were not required to have any background in either art history or Augmented Reality, so the course presented the opportunity to test the effectiveness of experiential learning. In
a combination of lecture and practicum components, students learned about Greco-Roman antiquity and its material culture while developing skills in the use of Unity. Each class session in the first half of the semester followed a split format as the students developed competence in both the content and form of the virtual exhibition application they were creating (Figure 3).
The University of Miami has had a collaborative partnership with Magic Leap over the past three years in which the company donated a number of headsets to the university to encourage experimentation. As a result of this partnership, the students were able to use Magic Leap headsets to develop their content. The original conception of the project was more augmented in nature, where the students would have the antiquities in the museum interact with virtual objects and content. When that scenario was no longer feasible—given the closure of the museum—the apps took on a more “virtual” aspect, highlighting the versatility of AR that makes it such an extraordinary visual tool.

**AR Application Content and Exhibition Design**

Each student was assigned one work of ancient sculpture around which they were to create a virtual exhibition. There needed to be a theme or concept that united the objects included in the exhibition and defined the delineation of the path or paths users would take through the experience. In the end, the premise and movement through each of the final apps were quite distinctive and differed markedly from one another. One app focused on a bust of Theseus and Ariadne and explored their symbiotic relationship through the concept of heroes in antiquity. In the assistance she provided Theseus and the bravery she displayed in the face of challenges and obstacles, Ariadne was as much a hero as her male counterpart Theseus (Figure 4).
The second app had a funerary urn as its starting point and the student traced the central role women played in care for the dead in ancient Greece. The experience led the user through the funerary rites that ushered the deceased into the underworld ensuring a good afterlife through a good death. Beginning with a portrait of a Roman man, a third student project attempted to reconstruct his identity. No greater shame could befall an important man in ancient Rome than to be forgotten, and without any inscription (or body for that matter) this sculpture was rendered completely anonymous. The app devised multiple scenarios to recontextualize this Roman male and understand why such portrait sculptures were so popular in ancient Rome (Figure 5).
The last app focused on a female portrait head from the Roman period but instead of contextualizing it in antiquity the experience explored connections with contemporary portraiture of African American women. A series of visual comparisons addressed issues of womanhood, identity, and agency as well as the relationships of power between the artist and the person represented in the portrait.

**Approaches to App Creation and Learning Outcomes**

If the first half of the course was about knowledge acquisition related to both content and technology, then the second half activated that knowledge. By the midterm break, students had devised a storyboard that delineated the content and format of the app and then the building process began. Students organized their tasks through a Trello board where they could also store assets, share ideas, and brainstorm (Figure 6).
The app was built using Unity and hands-on guidance from faculty was complemented by web-based tutorials. Weekly scrums provided the opportunity to present ongoing work, discuss problems and solutions, and solicit input from faculty and students, while demonstrating progress towards a goal. Even with the challenge of meeting virtually throughout the second half of the semester, all the students successfully completed their projects by the final class session. There the experiences were streamed through Twitch so that the participants in the class could see the app as experienced through the headset. Final steps included the posting of all assets, the final app, and video recording in order to have a complete digital archive of the project.

This course innovated in its conception of art historians as makers. As a humanistic discipline, art historical study is often characterized by passive learning through traditional delivery methods like class lectures. All art history students at the University of Miami are required to take studio art classes where they engage in hands-on work—painting, sculpting, printmaking, photography. It is assumed that the art historical content will inform the artwork the art students make in the studio and vice versa. So why not integrate these two types of learning by incorporating a hands-on technological component into the art history classroom? In this approach, students gain knowledge about new digital visualization techniques and platforms that can be of great use in future careers in the art world. They see art historical knowledge applied in a tangible way, making abstract ideas and concepts concrete. They can also see the inherent potential of technology to revolutionize the field of art history. XR technologies are only now being used with some frequency to present art historical content.

There are myriad possibilities for the deployment of such technology in the visual arts and cultural heritage and students with knowledge of these new approaches and tools can be at the vanguard of the field.
The model employed for the teaching of the class was also innovative in its collaborative and interdisciplinary nature. Four faculty members worked together to deliver content and assist students in the design and implementation of their AR apps. Experts in the field of art history and software engineering, with emphasis on user interface design, app development in Unity, project management, and AR platforms like Magic Leap, all shared their extensive knowledge to guide students through the process of app creation. Though interdisciplinary teaching is not new, the team put together here was quite diverse, bringing together disciplines that do not necessarily interact with one another and breaking down barriers and academic silos. This pedagogical approach can benefit students, as it exposes them to professionals who promote excellence through their contribution to their respective fields. A blended classroom allows students to experience a number of disciplines simultaneously but also explore how they can work together to create something greater than what might be achieved in a single field. It also allows students to devise answers to complex problems from a variety of perspectives. Such a one to one teacher to student ratio was ideal in that it allowed for extended interaction in and outside the classroom. But even a team-taught approach that included just two faculty with expertise in art history and software engineering could produce positive results for art history-based student XR projects. Hopefully, university-level instruction will continue to employ a collaborative and interdisciplinary model so that it is not the exception but the rule.

In the realm of the digital humanities, this course employed two different methodologies to the study of art history. The one empowered the students to serve as their own technologists. The students in the class had never worked in Unity before nor had they used Magic Leap headsets, yet in the course of a semester they accumulated sufficient expertise to create an AR application using these tools. Through experiential learning, they gained digital skills and collaborated in troubleshooting and problem solving. The course’s instruction, however, was based on a divide and conquer mentality, where faculty with different areas of expertise shared their knowledge in a collaborative approach that was synthesized in the work of the students. The future of a technology-driven art historical practice will certainly encompass both approaches. Students should be exposed to as much knowledge as possible and then they can select the path or paths they wish to take. Access to technology could encourage a student to learn more about it or team up with others who have complementary skills and interests; an approach where students serve as domain experts is one that has been implemented with great success at the University of Miami. Either way the discipline of art history benefits from more activated content and new, compelling ways to view and interact with objects and artworks in the classroom and cultural institutions.

**Leveraging the Flexibility of AR to Create Novel Contexts**

One of the greatest benefits of AR is the grounding of users firmly in their context. The experience enriches one’s own environment rather than obscuring or eliminating it (Muñoz and Martí 86; Haynes 81). The augmentation of the real world with additional content encourages the creation of new juxtapositions between here and there, then and now. These virtual exhibitions created new relationships between ancient objects and
contemporary viewers as the headset users experienced enhanced and dynamic content beyond what one would see in the museum. The small number of studies that assess the effect of XR technologies on learning have shown that the use of these types of applications enhances educational outcomes, activates viewers, creates novel, curated experiences, and increases the retention of the content provided in the app.

Like all digital technologies, AR experiences are inherently portable. Users can access content virtually anywhere there is a space suitable for the specific experience. Additionally, AR technologies offer the potential of customizing (or localizing) experiences based on the space that the user currently occupies, possibly presenting additional content relevant to that space (keyed to a known feature of that environment, for example). The difficulties of visiting physically distant sites are mitigated by detaching an artwork from its immediate context and transporting it to the viewer. The users of the goggles receive a rich, visually compelling cultural experience, deployed wherever they might be. Students in a remote class setting could view, manipulate, and discuss the features and characteristics of these virtual exhibitions from completely different venues but still enjoy a shared experience. That type of connected communal viewing would also be available to other audiences even more geographically distant. Bringing art and architecture to people instead of vice-versa also results in the democratization of culture; if you have access to a pair of headsets you can experience rich, cultural content. There is great promise, then, for the use of these technologies in underserved communities (Art Processors; Haynes 81, 87).

**The Future Potential of AR Experiences in Educational and Cultural Institutions**

Though it is still an emerging field, there are myriad possibilities for the incorporation of art historical content into museum, educational, and cultural heritage institutions, and spaces with AR (Russo; Rauschnabel). The use of ARSGs presents a number of advantages over smart devices in deploying AR content. The headsets have the benefit of being hands-free, unencumbering the user by wearing rather than holding the device (Kalantari and Rauschnabel 230, 236; Haynes 84; Rauschnabel 213). In contrast, the hand-held phone or tablet creates an element of distraction, requiring viewers of the app to look down at the device and divide their attention between virtual and real-world content (Muñoz and Martí 88, 91; Marques and Costello 2-4). ARSGs provide an improved and more expansive field of vision that optimizes the presentation of virtual content. With the headset on, the user can look at both types of content simultaneously, enhancing the force of the virtual content as it interfaces with the real world.

Tech industry analysts have already acknowledged the popularity of wearable technology and predict that the ARSG market will continue to expand. Microsoft has released a new version of the HoloLens, Magic Leap 2 devices are now available, and various other companies already have headsets on the market or have filed patents on designs they plan to produce. The popularity of ARSGs stems from their ease of use, functionality, and ability to provide activated experiences where the user can interact with cultural objects (Russo). Through
the use of the headsets, users can create deeper connections to artworks and personalize their experiences with the augmented content, catalyzing a shift from passive to active viewership.

These clear benefits are offset by some challenges. As new technologies continually emerge, adopters of this technology face the dilemma of determining which headset to select. Is the one they choose the best ARSG on the market? Does it have a high learning curve or are there questions about the producer’s financial stability and longevity? More complex user interfaces can present obstacles to users, requiring training before being able to navigate the device and enjoy the content presented on it (Marques and Costello 4). Perhaps the most serious challenge to widespread adoption of ARSGs is the high price point for most if not all headsets (Muñoz and Martí 97). This situation will likely improve as the technology becomes more widespread and additional companies enter the market. Meanwhile, however, the cost of each individual headset remains high, constituting a serious investment to outfit a class of twenty students, for example. Their high cost would also require heightened security measures in public venues to deter theft or misuse. Financial considerations make the ideal of a democratized user base difficult to achieve in the short term, a goal that is central to the broad dissemination of virtual content. At this point it is safe to say that ARSGs have moved beyond the realm of gimmickry, but there is a long road ahead to achieve widespread adoption. The producers of headsets need to be incentivized to create lower cost models or a range of products for different audiences and users.

Collaborations between headset producers and partners from educational and cultural institutions could be a fruitful way to address some of these challenges. Creative individuals whose research and professional activities focus on cultural objects could provide ideas for the development of innovative content as well as a ready and willing audience for the testing of hardware and software prototypes. Such partnerships could facilitate the distribution of quality AR content and familiarize a broad array of users with the potential that ARSGs possess.

**Conclusion**

Art history stands at the threshold of new opportunities to transform the practice of the discipline. Though still facing some obstacles to widespread adoption, AR holds out the promise of expanding the field to new venues and audiences while deepening the understanding of art and architecture by providing a rich, immersive, and interactive experience of art. This technology can create a compelling sense of virtual presence for artworks and forge a unique synthesis of viewer, artwork, and context. AR applications bring art to the viewers themselves and give it meaning in their space, making interaction with cultural objects personalized and site-specific. The melding of the real and the virtual in an AR experience can engage, educate, and inspire audiences, and will hopefully encourage continued experimentation with the implementation of XR technologies in art historical research and pedagogy.

The use of AR in a classroom setting is still a relatively new phenomenon but it offers great promise in activating learning, engaging students with technology, and presenting art historical content in an interactive and compelling manner. Students learn more effectively and retain information better in an experiential
environment where they can see the results of their work in real time. In an interdisciplinary setting they can learn and implement a creative and multifaceted approach to problem solving from a variety of methodological perspectives. Exploring the interface of art history and XR technologies in university coursework can acquaint students with the great potential that these technologies hold, encouraging them to revolutionize the field of art history in both academic and museum environments.

**Works Cited and Consulted**

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Footnotes

1. The author would like to acknowledge the College of Arts and Sciences at the University of Miami and the Da Vinci Scholars Program in the college for the opportunity to teach this class. The Lowe Art Museum has been a steadfast and enthusiastic partner in the projects addressed here and support from the Andrew W. Mellon Foundation CREATE Grants Program funded the initial creation of the *Animating Antiquity* display in the Antiquities Gallery of the Lowe. Finally, the instructors and students in ARH 347 were essential to the success of this project; thanks to instructors Nick Alberti, Chris Mader, Nick Tsinoremas, Joel Zysman, and students Nhadya Lawes, Olivia Orris, Alexis Paul, Stefanie Suarez.

2. For full video walkthroughs of each of the student-generated applications, see miami.box.com/s/6wgkazjimi6i8xfyc04a1eu9i0j34putx. Videos are provided courtesy of Nhadya Lawes, Alexis Paul, and Stefanie Suarez.

3. In the *Animating Antiquity* project, art history students collaborated with students from the Interactive Media Department of the School of Communication at the University of Miami to create smart device-based AR apps that enhanced visitor experiences of objects in the Antiquities Gallery.