Immersive Pedagogy: Developing a Decolonial and Collaborative Framework for Teaching and Learning in 3D/VR/AR

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ABSTRACT:

In June 2019, a cohort of CLIR postdoctoral fellows convened Immersive Pedagogy: A Symposium on Teaching and Learning with 3D, Augmented and Virtual Reality *at Carnegie Mellon University. The symposium sought to bring together a multidisciplinary group of collaborators to think through pedagogical issues related to using 3D/VR/AR technologies, as well as to produce and disseminate materials for teaching and learning. This essay presents the Immersive Pedagogy symposium as a model for interrogating and developing pedagogical practices and standards for 3D/VR/AR; we offer a decolonial, anti-ableist, and feminist pedagogical framework for collaboratively developing and curating humanities content for this emerging technology by summarizing the symposium's keynotes, workshops, as well as its goals and outcomes. Workshops, keynotes, and participant conversations engaged with decolonial and feminist methodologies, practiced accessible design for universal learning, offered templates for humanistic teaching, and illustrated the possibilities of using 3D/VR/AR to extend critical thinking. While 3D/VR/AR technologies demonstrate real possibilities for collaborative, multidisciplinary learning, they are also fraught with broader concerns prevalent today about digital technologies, as well as complex issues specific to 3D/VR/AR. There is a clear need to assemble academic practitioners on a regular basis in order to facilitate an ongoing discussion about 3D/VR/AR technology and its responsible, meaningful use in teaching and learning.*

Introduction

As access to three dimensional (3D) technologies has become increasingly available in academic venues, the desire to teach with these emerging technologies, particularly augmented reality (AR) and virtual reality (VR), has outpaced digital humanists' abilities to provide meaningful support for immersive projects. There is a growing and ongoing need to produce shared and open pedagogical materials adaptable to the needs of teachers in various professions and disciplines and are accessible to students without significant coding experience. This need is partially driven by the contingencies of relatively new and rapidly updating technologies, as well as the fact that support for commercially-available immersive tools are tailored for industry purposes. Game-driven tutorials, for example, do not always take into consideration the needs of humanities practitioners seeking to integrate critical thinking with technical mastery. Problematically, contemporary contexts for emerging technologies can structure our interactions with 3D/VR/AR. Though not always visible to users, these can have the effect of naturalizing problematic historical and political narratives through selective access to resources and functionality.

Nonetheless, game engines that offer free educational licenses have been repurposed for academic inquiry and teaching over the past decade. For example, Unity Technologies' Unity 3D game engine is utilized by over 4.5 million users and has been at the forefront of historical and archaeological 3D visualizations in scholarly research. First available in 2005, the Unity 3D game engine has been used to make approximately 60% of all AR/VR applications and is used by 90% of AR/VR companies ("Public Relations" 2019, np). Educational licenses are available for students and educators seeking to use the engine for scholarly or creative use. Its main competitor, the Unreal Engine, while initially inaccessible beyond professional and academic moneyed institutions with licenses, dropped its paywall for educational use in September 2014. VR headsets, once a hypothetical fantasy or niche short-lived technology, are now commercially viable and relatively inexpensive for institutions to purchase, if not students. In a few years, the financial barrier for individuals may diminish, while Google Cardboards and other less expensive stereoscopic viewers with fewer interactive features currently provide alternatives for undergraduate students with access to smartphones. However, students are also increasingly able to make use of 3D/VR/AR technology within dedicated spaces in academic libraries, maker spaces, media studios, and community outreach centers. Yet we would be remiss not to point out that access is still mediated by other social hierarchies; the technology is still not accessible in much of the Global South, and in marginalized communities across the world. These aforementioned developments still privilege students at institutions who have dedicated staff or faculty to maintain and encourage use of 3D/VR/AR technologies and facilities.

This is all to say that in our current 3D/VR/AR moment, digital humanists have a lot to navigate. Current 3D/VR/AR pedagogy and projects can pose problems related to accessibility and long-term preservation of projects and assets, and often run afoul of minimal computing recommendations. Yet the technology offers rich possibilities for multidisciplinary research and collaboration; many virtual reality projects combine art production, computing, archival research, network theory, and data visualization, among other practices. Given its potential for scholarship and teaching, understanding how to use the technology responsibly seems to necessitate engaging with current or learning practitioners to get a sense of what is now possible and what still needs to be done to facilitate productive use of 3D/VR/AR. As many key problems are likely to persist through subsequent permutations of the technology and its use in educational settings, this conversation needs to be ongoing and open. What humanists within and beyond the academy have to say about 3D/VR/AR will probably not be unique to humanistic inquiry. This dialogue will provide crucial critical approaches to the emerging technologies' advantages and limitations that will be of use to industry professionals as well as the casual, creative user. A vocal contingent of humanists seeking to think and learn with 3D/VR/AR may, in fact, fill a wider sociocultural need.

This is the context in which a small cohort of 2017-2019 Council on Library and Information Resources (CLIR) Postdoctoral Fellows organized *Immersive Pedagogy: A Symposium on Teaching and Learning with 3D, Augmented and Virtual Reality* at Carnegie Mellon University on June 26 and 27, 2019. The CLIR cohort included Lorena Gauthereau (University of Houston), Jessica Linker (Bryn Mawr College), Eric Kaltman (Carnegie Mellon University), Emma Slayton (Carnegie Mellon University), Neil Weijer (Johns Hopkins University), Alex Wermer-Colan (Temple University), and Chris Young (University of Toronto). The goal of this

symposium was to assemble a wide range of stakeholders to develop teaching materials and strategies that considered problems inherent and specific to immersive technologies, as well as to address problems that affect but are not unique to 3D/VR/AR. It is for this reason the symposium was so attentive to decolonial and feminist methodologies in thinking about appropriate pedagogical applications. Building on the previous work of scholars such as María Cotera, Elizabeth Losh, Tara McPherson, Angel Nieves, Roopika Risam, and Jacqueline Wernimont, we have advocated for an intersectional digital humanities that interrogates a wide range of technologies through the critical methods developed by the fields of ethnic and feminist studies. Such methods, we argue, can highlight the ways that technologies often leave out marginalized people by replicating colonial hierarchical structures including race, ethnicity, class, gender, and disability.

The *Immersive Pedagogy* symposium offered an early, if not first-of-its-kind opportunity to have productive conversations about what critical approaches to 3D/VR/AR could look like from a multidisciplinary and multi-professional perspective. Additionally, the symposium sought to seed collaborations within and beyond academic institutions and stand as a model for future conversations on these topics. In recounting our experiences with different applications of 3D/VR/AR technology in pedagogical spaces, the group tackled a number of thorny issues, while acknowledging that we would need to continue the dialogue by reconvening in person and in digital venues. We sought to develop teaching materials collaboratively with the long-term plan of sharing these resources through a variety of means, including open-access publications by organizations like the Digital Library Federation. In the remainder of this essay, the *Immersive Pedagogy* organizers describe the symposium's theoretical foundation and methodological approaches as a model for structuring communities around 3D/VR/AR, summarize some of our group's findings, and invite digital humanities practitioners to help us to continue this work.

## Structuring a Symposium on Decolonial Models of Immersive Pedagogy

Because the initiative was organized by CLIR postdoctoral fellows, the symposium emphasized diverse ways that libraries participate in creating, curating, and preserving 3D/VR/AR pedagogical materials. We considered faculty, staff, and students as equal partners in 3D/VR/AR projects, and aimed to include early career researchers at the table. Overarching goals for the symposium included teaching faculty and librarians how to support and enable learning for students using 3D technologies, but also to help students to disseminate skills within their own communities. By bringing together scholars from a wide range of disciplines and professions, we addressed problems while identifying new ones. Participants had the opportunity to share links and descriptions to their projects (current and in progress) with each other prior to the symposium, via a Slack channel and Google Docs. They also shared information on their work during a lightning talk round as examples of the kinds of humanistic projects 3D/VR/AR could cultivate. The symposium began and ended with keynotes from experienced practitioners whose work modeled creative and responsible uses of the technologies.

Our opening keynote speaker, Angel Nieves (Associate Professor of History and Digital Humanities at San Diego State University), presented "Developing a Social Justice Framework

for Immersive Technologies in Digital Humanities." Nieves's talk outlined strategies for achieving social justice through digital-supported inquiry, highlighting his own work on *Mapping Soweto*, a 3D reconstruction of apartheid South Africa. Nieves emphasized the need to ground digital work in women of color theory and argued that fields such as ethnic studies have developed a foundational structure that would benefit the field of digital humanities as a whole:

> If we brought the sorts of methodological and practice-based questions about power, privilege, and access from ethnic studies to our work in immersive technologies, we might begin to see new ways of harnessing these tools–that originated as part of the military industrial complex–to serve our social justice needs. (Nieves 2019)

Mapping Soweto draws from Belinda Robtnett's (1997) work on social movement theory, revealing the often messy, multilayered narratives of social movements by visualizing a map of spatial liberation. This 3D representation shows what Nieves terms an "intersectional cartography," or a network of social activists–especially networks of women and young girls– across townships "and how those activist networks were embedded into the physical geography and vernacular architecture of individual houses, streets, and neighborhoods" (Nieves 2019). Attention to intersectionality further reveals the ways multiple identities–township, gender, sexual orientation, class, and race–came together to form a cohesive activist movement, whose complexities are often lost in the official retelling of history. In particular, Nieves identified immersive technologies as one way to "re-establish coalition-building potential" (2019) with local communities and reminded us that the important work of recovering marginalized histories for social justice is often messy.

Unity Model of Winnie and Nelson Mandela House, Soweto
(model from September 2018)
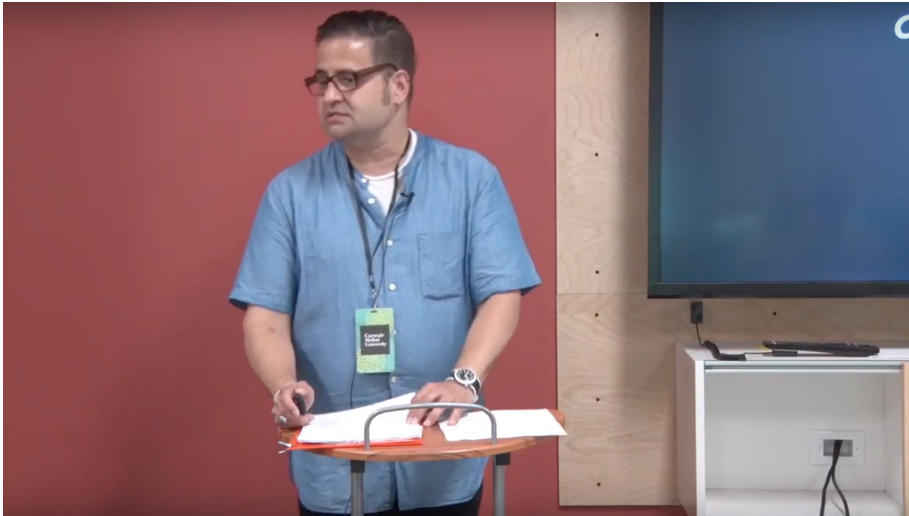
Angel Nieves presents "Developing a Social Justice Framework for Immersive Technologies in Digital Humanities" at the *Immersive Pedagogy* symposium.
https://www.youtube.com/watch?v=zsJQg69nB90&list=PLbkhiRA2P3qIPV5hrdVmIwWN3lcEiKzy8

Our closing keynote speaker, Juliette Levy (Associate Professor of History at the University of California, Riverside), presented "How Not to be a Replicant: Working Towards a Useful VR." Working with a team of women programmers, Levy has developed VR simulations for teaching abstract concepts related to historical thinking, interpretation, and writing. Levy's keynote presentation focused on the question of gaming and interactivity; and she traced the origin of her experimentations in VR from teaching large lecture classes numbering in the hundreds in hybrid and online courses. Rather than approach VR in the mode of cultural heritage projects, reproducing a historical location, to deal with pedagogical problems commonly experienced in online learning, Levy's team built *Digital Zombies,*[1] an abstract simulation meant to introduce students through game-based learning to the hierarchy of library information and assessment of primary and secondary resources. Levy envisioned a VR environment for her historical research methods class that not only encouraged students to follow a written outline of research steps, but to extend their library experience in a more immersive, playful way by completing a series of game-like missions related to research that students would be more likely to remember. Levy argued that the cognitive effect of a VR experience has a lasting impact on users: "What matters about doing something in VR isn't about what happens in VR, but what happens outside of VR, after the VR experience" (Levy 2019). Yet, despite the advantages of VR, Levy warned that a lack of critical conversation and pedagogy around digital literacy can have dire consequences, as increasingly ubiquitous immersive technologies become exploited to misrepresent historical

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events. The stakes for fomenting critical conversations between technology creators, consumers, and scholars, therefore, are quite high, as they could have lasting effects on how people choose to build and interpret virtual representations of historical events and people.

 Juliette Levy presents "How Not to be a Replicant: Working Towards a Useful VR" at the *Immersive Pedagogy* symposium.

The symposium included five workshops that centered theory, methods, and practices significant to and capable of incubating pedagogy related to US Latinx, Latin American, and Caribbean studies, which we prioritized when considering applicants. The workshop topics were: 1) Decolonial Methodology and Theory, 2) Accessible Immersive Pedagogy, 3) Integrating Immersive Technology in the Classroom, 4) Critical Writing for Immersive Tech, and 5) Collaboratively Designing 3D/VR Experiences. The *Immersive Pedagogy* organizers, joined by Jasmine Clark (Temple University) and Juliette Levy, led the participants through these interactive workshops ("Program" 2019). Pedagogical content crafted by participants before, during, and after the symposium included a bibliography of 3D/VR/AR-related readings, an archive of workshop slides, video recordings of keynote presentations, adaptable templates for pedagogical activities, and working models of 3D/VR/AR pedagogical applications. For example, Kat Hayes and Samantha Porter submitted a video walkthrough of their IOS app *Virtual MISLS* that explores historic buildings at Fort Snelling,while Meaghan Moody and Carol

Salmon submitted a description of their work with students using a virtual map of historic Paris to better understand life under German occupation during World War II.

Carnegie Mellon University (CMU) Libraries hosts the symposium's materials on its institutional repository, KiltHub. KiltHub provides stable, long-term global open access storage for 3D/VR/AR assets, and functional applications, as well as pedagogical and technical documentation. Materials in this repository are held for a minimum of ten years, ensuring that what is submitted will remain available past typical terms of software updates. The teaching materials produced during and following the symposium will also be published in the Digital Library Federation's Pedagogy Working Groups open-access series, the DLF Teach Toolkit. The materials will be revised and tested, including during a pre-conference workshop at DLF's Annual Forum 2020.

Immersive Pedagogy Symposium participants in discussion.

The following essay sections explore the key components of the symposium, which outlined the theoretical foundations to decolonizing development and curation of 3D/VR/AR tech, before guiding participants through workshops on decolonial critique and accessible design, on integrating immersive technology into the classroom and beyond, and on collaboratively designing 3D/VR projects.

Decolonial Foundations: Critical Approaches to the Development and Curation of 3D/VR/AR Technologies

To practically introduce the decolonial methodologies and theories crucial to our workshops on developing and curating 3D/VR/AR materials, the *Immersive Pedagogy Symposium* opened with

a workshop, led by Gauthereau and Youngon, the "walkthrough method" (Light, et. al. 2018, 881-900), a critical analysis of technology using the Unity Asset Store as an example. This exercise was contextualized through a theory of decolonial pedagogy and a discussion on the critical analysis of the game platforms that curate content for 3D modeling and representation.

The application of decolonial theory and methods to digital pedagogy allows students to interrogate and resist colonial, hierarchical epistemologies, especially the privileging of Western European and Anglocentric knowledge structures. Such an approach is increasingly necessary as 3D/VR/AR technologies become integral to Western education systems and overwhelmingly applied to cultural heritage projects by and for Western consumers. While colonialism refers to the "political and economic relation in which the sovereignty of a nation or people rests on the power of another nation," making that nation an "empire," coloniality "refers to long-standing patterns of power that emerged as a result of colonialism, but that define culture, labor, intersubjective relations, and knowledge production well beyond the strict limits of colonial administration" (Maldonado-Torres 2007, 243). Thus, coloniality denotes the ways in which colonial hierarchies of power continue to structure our everyday lives (i.e. racialized class hierarchies, labor hierarchies, gender hierarchies, the gender binary, racism, etc.). Decolonialism urges us to actively de-link from colonial epistemologies and ontologies in order to avoid re-creating colonial worldviews and hierarchies.

Considering the ways that 3D/VR/AR technologies allow users to create immersive worlds and environments, the symposium sought to stress the need to avoid replicating the colonial gaze. Representing marginalized people through this gaze continues to enforce racialized and gendered hierarchies of power. Colonial epistemologies continue to control knowledge production, not only through institutional archives, but also through academic research, digital projects, and 3D/VR/AR environments. Jacqui Alexander and Chandra Talpede Mohanty argue that decoloniality has a "pedagogical dimension" as it obligates us "to understand, to reflect on, and to transform relations of objectification and dehumanization, and to pass this knowledge along to future generations" (1997, xxviii-xxix). For this reason, the symposium's first workshop exercise involved guiding participants through a decolonial walkthrough of the Unity Assets Store. The walkthrough method requires researchers to directly engage with "an app's interface to examine its technological mechanisms and embedded cultural references to understand how it guides users and shapes their experiences" (Light, et. al. 2018, 882). We asked participants to browse and search the Unity Assets Store for 2D, 3D, audio, and animation assets and interrogate them using a decolonial approach, as well as to document their walkthrough by taking notes, taking screenshots, and recording audio-visual content.

To guide the decolonial inquiry, we asked participants to consider a set of questions adapted from Roopika Risam's discussion of the stakes of postcolonial and decolonial digital humanities (2019, 35-46):

- What are compulsory activities within the Unity Asset Store?
- What are the social hierarchies within the menu system?
- To whom and which types of users is this knowledge accessible?
- What is considered a "legitimate" asset within the Asset Store?

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- Whose epistemologies, such as histories, languages and memories, are considered important enough to archive in the Asset Store?
- What knowledge or assets are privileged within the Asset Store?
- Does the asset avoid the exoticization or fetishization of a people/cultures?

This inquiry resulted in participants recognizing the disproportionate representation of a Eurocentric worldview. For example, they noticed that the search term "Viking" yielded twice as many results as "Native American," whereas the term "Indigenous," yielded zero. Among results for the search term "Mexican," participants discovered a Mexican Restaurant Pack that reflected generalized stereotypes of Mexican aesthetics and cuisine, reduced to bottled hot sauce, chips and salsa, and a decorative green parrot. Assets also reduced the multiple and varied cultures, nations, flora, and fauna of the entire African continent to the miopic colonial imaginary of only the Serengeti, populated by wild animals. During group break-out sessions exploring the asset store, participants discovered a potential intervention through editing crowdsourced user tags. Like during Wikipedia Edit-a-Thons, users could challenge the authenticity of colonial representations of people, cultures, and nations by tagging or reviewing assets as not authentic, representing stereotypes, reproducing colonial views, etc. Since the symposium, unfortunately, unity has removed the user tagging option and currently reserves metadata creation to the creator.

This workshop stressed that engaging in decolonial work requires a constant questioning of how knowledge (3D/VR/AR environments, research, stories, syllabi, etc.) is being produced, who is producing it, whose stories are being told, and how these stories are being told. Not only should we consider what histories are told in the digital world, but we must also attend to the ways in which they are produced. As a result, the participants learned that generating and interacting with 3D/VR/AR environments they must use decolonial methods to acknowledge their role as world-creators and reflect on the ways that these technologies often replicate colonialism.

In the following workshop, Clark foregrounded the ableism endemic to technological innovation in the West, introducing participants to accessible user design for virtual reality. This involved a tutorial on developing alternate access plans for disabled students in classrooms. Clark's work with Temple Libraries' colleague's developer Jordan Hample and Wermer-Colan has prioritized research into and creation of accessible features for VR during their development of the *Virtual Blockson: A Primary Source Teaching Tool for Secondary Education* (Clark 2018, np). Clark's workshop overviewed the standards of the World Wide Web Consortium's Web Content Accessibility Guidelines in order to showcase the problems with applying standards created for web-based screens to virtual reality environments and experiences. She related an overview of key advancements that can be made to enable universal design for this emerging technology ranging from innovations in haptic feedback to caption legibility. Clark's talk focused on guiding participants through strategies for accessing resources for disabled students at their universities. She led participants through an exercise with a template she created for developing "alternate access plans" that enable teachers to offer comparable options for students who cannot use available VR and/or AR hardware and software. This approach to accommodating students with different learning styles, provides a realistic way for teachers to work with emerging technologies in academic institutions, most of which still lack sufficient resources to support disabled students in the use of analog technologies.

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Virtual Lessons: Integrating Immersive Technology in the Traditional Classroom and Beyond

After the symposium's opening workshops on decoloniality and anti-ableism in immersive pedagogy, Levy's workshop put to practice the principles she laid out in her closing keynote address on the idiosyncratic game mechanics for simulating virtually interactive dialogue and exam questions involving classification. VR offers, Levy argued, a unique pedagogical opportunity, functioning as a distraction-free zone where her students were able to recollect experiences at a much higher rate compared to other learning activities. During the workshop, Levy asked symposium participants to select several library books from various library collections and work in groups to think about how to put the texts in conversation with each other based on titles, subject headings, table of contents listing, and a quick skim of their contents. Levy demonstrated how and why she constructed a VR environment that simulated this activity, as her students had to physically place boxes with various titles onto empty shelves in an order that reflected connections. The application of VR to this type of historiographical exercise, Levy maintained, left a lasting impression on the students that they were able to put into practice for essay assignments. Levy's emphasis throughout her workshop on the pedagogical significance of "what happens before and after" the virtual experience, furthermore, offered a valuable foundation for the subsequent workshop on integrating writing exercises to guide student learning during virtual and augmented reality experiences.

Wermer-Colan's workshop modeled how to guide undergraduate students across the disciplines through a structured composition exercise for reflection, in particular, by guiding the participants through a reflection on what they hoped to learn and do in the coming school year as they sought to develop their immersive pedagogy projects. To provide a context and model for students before their writing reflections, Wermer-Colan summarized his current projects employing 3D technologies for Temple University Libraries' Digital Scholarship Center (now the Loretta C. Duckworth Scholars Studio). Temple Libraries has experimented with transforming the purposes of library collections, development, and reference work to enhance its learning and technology outreach, including through its Makerspace Grants for Teaching and its newly constructed VR Lab in the new Charles Library. Wermer-Colan's past experiences working in Writing Centers in the City University of New York (CUNY) System helped him to think about ways the Digital Scholarship Center can use 3D/AR/VR technology to enhance learning across the disciplines.

As an example of Temple Libraries' supporting the use of immersive technologies in class-room projects, Wermer-Colan detailed a collaborative project with Ajima Olaghere, Assistant Professor Criminology working with her ethnography students to do "systematic social observation" of Philadelphia neighborhoods. This project used 360 cameras to record neighborhoods affected by Temple's gentrification of North Philadelphia. The recordings were later viewed in affordable smartphone headsets that allowed students to remotely examine environments to understand what contributes to disorder and crime, while the instructor facilitated ways to maintain a critical understanding of what they were viewing. The accompanying writing exercises guided students to reflect on their mediated experiences of urban space and call into question the "broken windows theory," common assumptions that visible signs of public disorder exacerbate criminal behaviors. The use of phone-based headsets

also invited an opportunity for students to consider the physical processes that enable virtual technology. Instructors were faced with the problem of scaling pedagogical uses of VR; as this project opted for using inexpensive headsets, students also considered how to create immersive experiences that were of similar quality to those offered by state-of-the-art VR headsets like the HTC VIVE or the Oculus Rift.

To illustrate the role libraries and digital scholarship centers can play in the curation of 3D content for teaching and learning, Wermer-Colan overviewed a complementary use of immersive technologies. His collaboration on the Virtual Blockson project with Digital Scholarship Librarian Jasmine Clark, Academic Technician and Developer, Jordan Hample, and Blockson Archivist Leslie Willis-Lowry aims to recreate Temple's Charles L. Blockson Afro-American Collection as a virtual reality game for innovating the teaching of primary source literacy in high schools across Philadelphia. The project at its heart allows a small, fixed collection and its reading room to be available to students remotely, lowering the intimidation factor and physical limitations of these spaces, while enabling interactive explorations of historical artefacts. The Virtual Blockson offered an opportunity to discuss how libraries can help curate interactive gaming environments for remediating archival collections and cultural heritage sites to foreground previously marginalized histories.In these contexts, virtual reality offers affordances for lowering the barrier for students to use archival sources and spaces, facilitating access and accessibility, and offering students a novel medium through which to conceptualize analog and digital literacies necessary to navigate the changing new media world today.
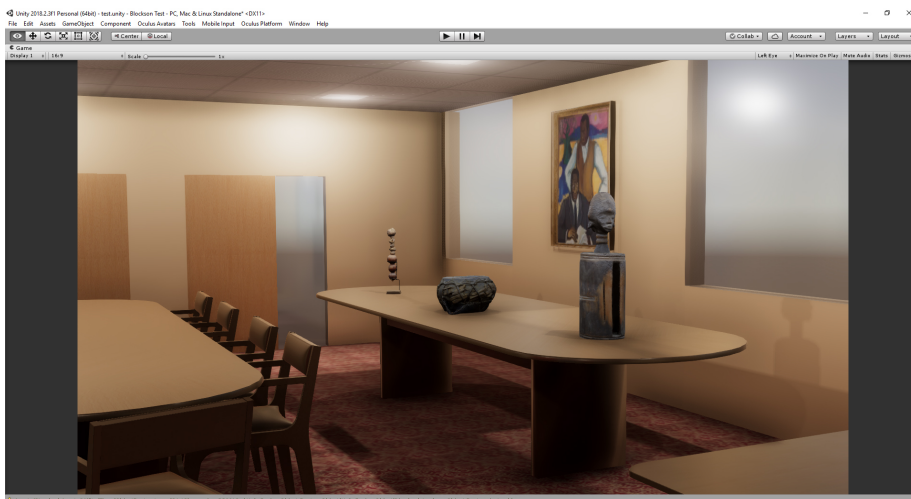
Screenshot of the Virtual Blockson designed by Jordan Hample using Unity 3D. For more, see Jasmine Clark's "Progressing Towards an Accessible VR Experience": https://sites.temple.edu/tudsc/2018/11/07/progressing-towards-an-accessible-vr-experience/.

Wermer-Colan foregrounded in both these projects the use of writing exercises to help students reflect on their virtual experiences in meaningful ways. The 360 SSO writing exercise encouraged humanistic thinking about the technology by asking students to compare their field

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work exercises with the virtual experience, as well as writing reflections that asked the students to identify various ways the 360/VR technology mediated said experience. Similarly, humanistic writing exercises were designed to guide students before and after their experience of the Virtual Blockson's introduction to archival spaces, etiquette, and practices through game-based, interactive experiences. Drawing upon the Society of American Archivists' Standards for Primary Source Literacy and the Common Core Standards for historical understanding, digital literacy, and critical thinking, these critical writing questions ensure students reflect upon the virtual experience of library collections of historical artifacts from the African diaspora. After offering these models to the *Immersive Pedagogy* participants Wermer-Colan guided the group through a critical writing exercise to reflect on their own plans to implement the 3D/VR/AR technology for various pedagogical purposes. Wermer-Colan encouraged participants to think of resources at their local institutions, pedagogical standards in their disciplines, and affordances in the spatialized medium of VR for enhancing their approaches to teaching. Furthermore, the writing exercise at once simulated the kind of exercise participants could implement in their own classes and pedagogical spaces and in the future, offering an opportunity for participants to reflect on what they had learned during the symposium.

Feminist Reconstructions: Collaboratively Designing 3D/VR Experiences

The concluding workshop, run by Linker and Young, offered a sustainable model for including students as partners in the creation of 3D/VR pedagogical materials, through an overview of Linker's time creating the Bryn Mawr Women in Science project with her various undergraduate partners: Elia Anagnostou, Courtney Dalton, Jocelyn Dunkley, Tanjuma Haque, Arianna Li, and Linda Zhu. From 2017 to 2019, Linker taught undergraduate students how to integrate historical inquiry with 3D technology in order to think about women's invisible scientific labor, the spaces they occupied, the tools they used, and their everyday lived experiences. The project considers Margaret Rossiter's "The ~~Matthew~~ Matilda Effect in Science," which articulates a systematic disparity in affording women scientists credit for sophisticated and important discoveries, which in turn necessitates that historians find ways to tell stories in order to make their labor visible. It likewise adapts aspects of Pamela Smith's *Making and Knowing Project* by taking seriously the need to consider scientific processes. However, rather than engaging in physical reenactment, students offered up women's processes in a modern, digital format, contextualized by a recreation of spaces that were no longer intact or available for historical analysis.

Screencap of the 3D-rendered Advanced Biology Lab c. 1900, from *Bryn Mawr Women in Science*.

Linker and her students recreated two laboratory spaces that had once existed at Bryn Mawr College in the late nineteenth and early twentieth centuries, the Major Chemistry Lab and the Advanced Biology Lab.[ii] Students learned a variety of 3D skills, including 3D modeling, photogrammetry, various mechanics of the Unity 3D game engine, and the Oculus Rift. Interactive WebGL versions of the project are available online, and a VR demo of Bryn Mawr's Advanced Biology Lab was available at the conference. The Advanced Biology Lab was the site of early genetic research and a place once utilized by Nettie M. Stevens, the subject of Stephen Brush's *Nettie M. Stevens and the Discovery of Sex Determination by Chromosomes*. Years before Margaret Rossiter coined the phrase "the Matilda Effect," Brush identified that Stevens' discoveries had been overshadowed by male collaborators or individuals working concurrently on the same subject. Her contributions had likely been diminished because she was a woman. Students researched each space by spending time in Bryn Mawr's Special Collections. Through building each laboratory, the students became aware of how to put historical materials in conversation, as no resource could tell them everything they needed to know to build and contextualize the 3D models. Pedagogically, the two-year process of building was designed to seed humanistic deployment of 3D technologies by undergraduate collaborators. Afterward these students participated in professional presentations of the digital and historical work, and served as ambassadors to various communities in order to disseminate the skills the project cultivated to a wider audience.

Linker enabled her students to accomplish a lot in a short period of time; no student was an expert in the technology or in historical research prior to their tenure on the project. This was intentional on her part, as she sought to teach rather than to employ experts. Students represented a diverse range of interests and majors, and all students participated in each phase of production (rather than assigning humanities majors to research and STEM majors to coding) so that afterwards, they could create projects similar to this on their own. Part of what facilitated their success is that she treated them as equal partners in the project, making decisions with them throughout the two years they worked together.

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To prepare her students to participate as equals, she devised a plan that would serve as an introduction to using 3D technology to address social and pedagogical problems, and would also serve as a diagnostic tool for assessing student strengths and interests. Essentially, students were asked to propose and implement a 35-hour project (which could be run over the course of weeks or a couple of days, depending on individual need) that used an aspect of the Unity 3D game engine's functionality to teach users about something the students cared about. Students drafted plans that identified what they knew, what they needed to learn, and were prompted to think about modularity, such that students could scale the project if they were running out of time. Students who were not familiar with coding at first could use Unity's GUI interfaces to produce fully functional scenes, allowing for students with varying levels of proficiency with computer science to produce something useful by the end of the exercise. By the end of the 35-hour period, students not only had a small project they could put in professional portfolios, but had become proficient in a particular aspect of Unity, thought about the technology as a means to serve others, and in implementing their projects, had a better sense of what they would need to do going forward. It also convinced them that they were capable of using the technology in a way the Unity tutorials did not engender. Linker and Young guided the participants in thinking through how symposium participants might adapt this exercise for their own project teams.

Conclusion

Through the symposium and the workshops described above, participants engaged in conversations around designing socially-conscious pedagogy for 3D/VR/AR. Building a framework for teaching and learning with 3D/VR/AR technologies founded in decolonial theory and practices resonated with our participants. This enabled the group to evaluate how projects and assignments fit into an ethical model for cultural heritage pedagogies. The symposium closed with a productive discussion about what the participants learned, with a focus on planning for future steps.[iii] Several participants suggested the importance of backward design, which would specifically place the learning outcomes as the first step in creating 3D/VR/AR and related assignments.

Conversations among group members brought up multiple questions, such as: how do we anticipate student use? How do we adjust our use of 3D/VR/AR in response to unexpected circumstances? How do we introduce emerging technologies in the classroom while accommodating individuals unable to take advantage of the intended purposes of ready-made hardware and software? How can these technologies enhance hybrid and online learning? Are students (or faculty) distracted by the freedom of immersive environments? Can we create bilingual metadata in a VR environment? If one could, where would you display subtitles or transcriptions in a virtual or augmented environment?

These conversations confirmed that digital humanists would benefit from future cross-institution discussions of 3D/VR/AR, as well as from shared access to teaching materials, which are often siloed within institutions and departments. Students engage differently with course concepts and each other, depending on the application of the technology within that course. Student learning is dependent on the skills and interests of individual instructors; collaboration is necessary for producing robust materials and responsible projects. Perhaps the most challenging task is

creating accessible and sustainable materials applicable to multiple modes of disciplinary learning outcomes at a time of rapid technological and institutional transformation.

In an effort to increase the reach of the conversations that arose out of *Immersive Pedagogy*, the symposium organizers are working to produce an open-access, peer-reviewed publication containing lesson plans and educational material to facilitate disciplinary and interdisciplinary work that engages 3D/VR/AR technologies. This project aims to extend the work of the Digital Library Federation (DLF) Pedagogy Working Group's Teach Toolkit that provides lesson plans for digital library instruction.[iv] To guide educators to adapt immersive technologies to the needs of diverse disciplines, the Immersive Pedagogy teaching materials will introduce a range of 3D hardware and software, including asset or game repositories. The teaching materials will include diverse lesson plans with tailored learning outcomes, introducing a representative sample of available immersive technologies and resources while addressing humanistic pedagogical goals. Because this project was born out of the CLIR postdoctoral fellowship program, it aims to contribute to the growing field of scholarship on the crucial role that academic libraries or research and teaching centers can play in the integration of immersive technologies across the curriculum.

The *Immersive Pedagogy Symposium's* prioritization of decolonialism, feminism, and accessibility speak to a radical and critical perspective that can apply to a range of 3D/VR/AR applications and instruction methods. Indeed, in starting conversations on how to promote making immersive experiences accessible and inclusive there is an opportunity to move beyond operational concerns to lasting pedagogical practices. For decades, contingencies have transformed education and cultural heritage, requiring us to rethink the potential of emerging communication technologies through a critical lens. More evident in the midst of the COVID-19 global pandemic, which has spurred the need for digital ways of teaching and learning, is the critical pedagogical use of virtual surrogates. These include 360 museum spaces and objects, 3D virtual meeting spaces, photogrammetry models, and interactive exhibits. By addressing upfront, rather than through remediation, the issues of social justice, accessibility, and decolonial pedagogies in immersive technology, educators can leverage these tools to respond to a transformative period in the education system.

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[i] Levy, Juliette. "'Digital Zombies'– A Learner-Centered Game: Social Knowledge Creation at the Intersection of Digital Humanites and Digital Pedagogy." in *Social Knowledge Creation in the Humanities: An Open Anthology.* https://ntmrs-skc.itercommunity.org/.

[ii] For a discussion of problems and considerations specifically related to the construction of historical 3D spaces, see Elaine Sullivan, Angel David Nieves, and Lisa M. Snyder, "Making the Model: Scholarship and Rhetoric in 3-D Historical Reconstructions," in *Making Things and Drawing Boundaries: Experiments in the Digital Humanities,* ed. Jentery Sayers (Minneapolis: University of Minnesota Press, 2017) 301-16.

[iii] For more detail, see the *Immersive Pedagogy* collaborative notes: "Shared Notes Wrap Up Session." 2019. https://drive.google.com/drive/folders/1TSv8jrQlOlbPwi-TyvyOfV1_ZvA9I4y8.

[iv] *#DLFteach Toolkit 1.0: Lesson Plans for Digital Library Instruction.* https://dlfteach.pubpub.org/toolkit. (accessed 16 March 2020).