2024

Introduction to Past and Future Presence: Approaches for Implementing XR Technology in Humanities and Art Education

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INTRODUCTION

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Extended reality (XR) technology (that is, virtual reality, augmented reality, mixed reality, and other 3D technologies) offers many opportunities and benefits for education in the humanities and arts. However, after attending many education-technology workshops and having read countless books and journal articles on the uses of XR in education over the past decade, it has been overwhelmingly apparent that most of the research and conference presentations tend to focus on the use of this technology in science, technology, engineering, and mathematics (STEM) education. While in many ways this is understandable, given the obvious applications of the technology to the fields and study of science, engineering, technology, and mathematics, the focus is still too limited and even to some extent exclusionary, failing to see and/or acknowledge the potential benefits and creative opportunities in education outside of these areas of research and teaching. Additionally, though a multitude of digital humanities projects exist at many, if not all, institutes of higher education, the push

for STEM education and careers in colleges and universities can be viewed as contributing to the lack of concentration on innovation in humanities education, as well as to declining enrollments in many non-STEM courses. Finally, for many scholars and teachers in fields outside of STEM, who are already incorporating this and similar types of technology into their teaching and research agendas, their work may not always be recognized or appreciated as scholarly effort in the same sense or worth as traditional research methods by those judging tenure cases, grant proposals, funding opportunities, and the like.

In this volume we aim to counteract some of the narrower views mentioned earlier through highlighting how XR technology can be used in (sometimes) less obvious but equally sophisticated and fruitful ways to create innovative, immersive, and interactive learning experiences for students in the arts and humanities.[1] By presenting case studies from several arts and humanities fields at the undergraduate and graduate levels, our goals are to help: 1) inspire outside-the-box thinking; 2) move conversations from isolated silos into national and international discussions (and eventual collaborative projects) among researchers, scholars, teachers, and developers about how to best utilize this technology to complement and enhance current humanities teaching and learning practices in higher education and beyond; and 3) argue that performing research and creating teaching materials with this technology qualify as important scholarly endeavors and ought to be judged and valued as such by university administrators, faculty and other colleagues, grant committees, and more. This collection incorporates academic sources, project write-ups, and case studies that are intended to be used by instructors and administrators in secondary and post-secondary education to introduce or procure a better understanding of the benefits and drawbacks of XR technology in the humanities classroom. While academic in nature, this volume is also intended to be read as a practical document, and we encourage the reader to learn from the authors' successes and

mistakes which they encountered in the process of exploring this emerging medium.

DEFINITIONS AND DESCRIPTIONS OF CONTEMPORARY XR TECHNOLOGY

Most people understand XR through the context of consumer technology, entertainment, or the past few decades of literature, which often portray immersive virtual technology with a degree of fantasy, whimsy, or societal dread. But XR technology has a long lineage of academic study and research fueled by interest in innovative technologies that aim to immerse people into virtual worlds, augment their perception of the world around them, or use any number of novel technologies to create some hybrid of the two.

The term XR has been adopted as a catch-all term for a myriad of related technologies, including virtual reality (VR), augmented reality (AR), or mixed reality (MR). And while the approaches differ considerably in execution, these technological concepts are taxonomically placed on what can be called the "mixed-reality continuum" or "virtuality continuum," a heuristic model for understanding where a technology exists between virtual and real world environments.[2]

This continuum is useful when trying to contextualize how people understand immersive technology. VR is likely the easiest

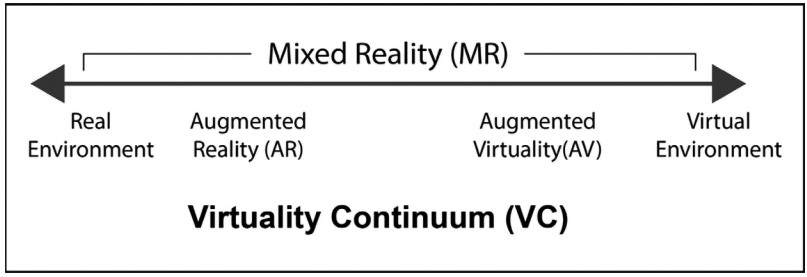

Figure 1: The Virtuality Continuum as presented by Milgram and Kishino, 1994.

to understand, as it involves placing an individual into an immersive virtual environment using a head-mounted display (HMD). It is also the most mature of the technologies that exist along the virtuality continuum. At the time of writing, the world's largest social network has recently made a pivot fully into virtual reality with the sustained support and development of the Quest-branded headsets, the best-selling VR headset in history. By putting on these VR "goggles," users can be instantly transported into artificial yet realistic worlds. What users can view in these virtual worlds typically falls into two categories: 360° capture, and 3D-rendered immersive virtual environments (IVR). 360° cinema is the simplest form of VR, in that it uses specialized cameras to capture footage instead of creating 3D geometrical models. The strength of this is that one can make content quickly and affordably, but it is limited to head rotations with only three degrees of freedom (3DoF). It is less interactive than IVRs, which utilize computer graphics to render environments in 3D and can offer six degrees of freedom (6DoF). IVRs are typically built using game engines and involve the use of more computer software engineering, user experience design, and more "gamified" experiences.

Augmented reality is more difficult to define,[3] as the technology exists more broadly along the virtuality continuum. AR can be fully integrated into an HMD, such as Microsoft's HoloLens or the Magic Leap, or it can be an application that uses the various sensors embedded into a smart phone. Common uses for AR utilize the camera of a smartphone to manipulate pictures or videos of faces posted on social media platforms, or add a new image or animation to a piece of art or a billboard. Companies like Apple and Google have invested in making their iOS and Android operating systems "AR-capable" as the cameras and sensors on their devices follow a trajectory of nearly exponential improvement. All of the AR-related projects in this volume use smartphone-based technology to create their experiences. Because of the ubiquity of smartphones in modern society, AR is often seen as the more

democratized XR platform when compared with other immersive technology platforms, such as VR.

Similarly, mixed reality (MR) can also be hard to define. While historically this term has been used for projects like immersive art installations, which use projection mapping in the vein of work produced by art collectives such as teamLab or Meow Wolf, hardware companies have also begun designating the term 'mixed reality' for wearable hardware that is capable of both augmented and virtual reality.[4] While MR is not an umbrella term like XR, it covers a lot of ground. In the context of this volume, we will consider MR anything that significantly alters the real environment to create an immersive experience that is interpreted as a different space or world without putting participants in a fully virtual environment (cave systems also fall into this category). This volume will focus on VR and AR projects, but understanding the whole virtuality continuum is important when developing any XR project.

WHY XR IS USEFUL IN HUMANITIES AND ART EDUCATION

Over the past twenty years, a multitude of researchers and scholarship have recognized the benefits of XR technology for education; this brief literature review section can hardly claim to be a comprehensive review of all (or even some) of the research, but it will attempt to cover those benefits particularly pertinent to education in the humanities and arts. However, it is important to recognize that potential benefits applicable to STEM fields are typically also useful for the humanities and arts, and will be discussed below as such. As a group of scholars argued recently:

> If entering 3D virtual worlds assists students with understanding scientific language, then what could a 3D VR to teach reading or writing add to this preliminary knowledge related to language acquisition? Additionally, using a 3D VR for students to

> not only enter an environment, but a community of people in a place and time, could offer powerful social and historical learning experiences.[5]

Recent teaching and learning practices in both STEM and humanities classrooms have trended toward collaborative or social constructivist learning (knowledge actively constructed in one's mind through interaction with others in a specific social context),[6] problem- or inquiry-based learning, and blended online/in-person learning environments (particularly after the beginning of the COVID-19 pandemic).[7] XR technology lends itself well to these practices with its many learning affordances in cognitive, affective, and social domains. To start, VR has been shown to increase student motivation and engagement in learning through its collaborative[8] and immersive nature, leading to high level interaction[9] and more concrete realizations of abstract concepts.[10] Immersion is attained in part through the simulation of reality, particularly with first-person avatars, causing users to feel as if the scenarios are not removed from life, but in fact true to life or even part of it.[11] These virtual scenarios, because of their lifelike character, and a user's presence within them, then enable the user to more directly transfer the knowledge or skills gained through the virtual experience into real life scenarios.[12] Additionally, the presence of classmates and teachers in the virtual experience creates community and offers opportunities for immediate feedback.[13] The communal aspect, involving role play and mentoring, allows for new opportunities for creativity,[14] while individual users themselves are given virtual and cognitive space to experiment, explore, research, investigate, and create content, engaging in what is known as self-guided or even autonomous learning.[15] Exposure to virtual scenarios can help to enhance spatial knowledge and improve problem solving skills.[16]

Finally, virtual reality offers unprecedented access to users, in the sense that it enables them to experience sites and scenarios

which may be otherwise inaccessible in the real world, due to financial, time, distance, safety/security, or personal constraints.[17] For example, cultural heritage projects, such as the PARTHENOS project, SmartMarca, or *Rome Reborn*, reconstruct lost or fragmentary monuments, archaeological sites, and works of art, and allow the user to immerse themselves in the structure or artwork, not only providing an engaging experience of an otherwise unknowable place or object, but also effecting a desire in users to recognize the value in preserving what is still extant.[18] In addition to reducing limitations of time and history, virtual environments can offer access and benefits to special education students and students with physical disabilities or other learning difficulties, providing a multisensory experience in a safe environment which can aid mental health and reduce anxiety.[19]

Augmented reality also offers similar benefits to its users. As Prodromou observes, when AR technology is used in educational settings, it:

1. Helps students to engage in authentic explorations in the real world.
2. Facilitates the observation of events that cannot easily be observed with the naked eye by displaying virtual elements alongside real objects.
3. Increases students' motivation and helps them to acquire better investigation skills.
4. Creates immersive hybrid learning environments that combine digital and physical objects, thereby facilitating the development of processing skills (e.g., critical thinking, problem solving, and communicating through interdependent collaborative exercises).[20]

Like VR, AR increases the opportunities for student collaboration, student-faculty interaction, motivation, and autonomy,[21] creating experiential tasks unable to be replicated in traditional classroom

settings[22] and leading to deeper thinking and engagement in the subject matter.[23] Projects such as the EU-sponsored "Living Book: Augmenting reading for life" offer professional development opportunities for educators regarding the teaching of reading and literacy. Mobile augmented reality applications have been shown to have positive impacts on emotional, cognitive, and social development in foreign language learning,[24] and have also helped students to develop English writing and composition skills.[25] Many of these mobile AR apps (in addition to many VR applications) utilize the benefits of gamification in order to increase motivation and achieve more positive thinking regarding learning goals.[26] Additionally, the mobile AR apps enable opportunities for learning in more informal environments, such as home, library, or even outside (utilizing the same functions as games such as Pokemon GO), allowing users to educate themselves and further solidify their knowledge and skills nearly anytime and anywhere.[27]

DRAWBACKS OF XR

Although XR can offer various benefits and affordances, potential drawbacks must also be acknowledged. While some mobile AR apps may be free or low cost, much of the equipment involved in running these technologies (VR headsets and so on) can be very expensive for schools or individuals to acquire, which means that many potential users, including those in underrepresented groups, may not have access to them. Even when access can be provided, training of students and teachers can be time-consuming and costly. The current state of VR technology, where users can occasionally experience motion sickness or headaches from wearing (ill-fitting) headsets for too long, means that immersions into virtual environments have to be short in duration (typically 20–30 minutes or less). People with health concerns that could be triggered or exacerbated by use of the headset may be less inclined or even unable to use the technology.

There are also risks, and ethical and legal concerns, associated with using and abusing the immersive and sensational nature of the technology. First, issues regarding privacy, security, and the like must be taken into consideration. When using technology in the classroom it is important to know the best ways to protect students' personal information in accordance with the Family Educational Rights and Privacy Act (FERPA), and the amount of data collected by XR hardware and software should be scrutinized and carefully considered before instructors commit to incorporating the technology into their curricula.[28] Additionally, while one of the most touted benefits of VR, as promoted by content creators and media publications,[29] has been to enhance empathy in a user, which could lead to prosocial behavior, recent research has called this benefit into question, suggesting that the correlation between XR users and an increased sense of empathy is not as strong as previously thought.[30] Furthermore, personal and cultural biases can greatly affect a user's perception of the VR experience and potentially lead to negative outcomes.[31] At this time a greater, continued focus on longitudinal studies on the effects of XR exposure is needed, in order to understand its long-term effects, both positive and negative, on users.

Misinformation in VR is yet another concern for would-be XR educators. In 2022, 90 percent of all VR headsets were sold by either Meta or ByteDance, two of the largest social media companies in the world. With so much misinformation originating in social media, pairing these social issues with the immersive potential of XR can create a scenario where people experience things that are perceptually "real" but are factually incorrect.[32] This scenario, coined "mis-experience" by Brown et al., is not well-researched or documented. However, when comparing existing misinformation in online spaces, it is not unreasonable to believe a scenario where bad actors influence beliefs and behaviors in realistic virtual environments. To combat these scenarios, social media companies continually require more validation for online accounts, which

further complicates the structural implementation of wearable XR hardware in the classroom. As technology becomes more internet-connected, the greater safety risks it poses to students, which necessitates organizational solutions for widespread adoption.

From a pedagogical, ethical, or inclusive standpoint, educators, researchers, and developers should not consider these technologies as a one-size-fits-all tool capable of benefiting or transforming any lesson plan or pedagogical goal. They are best used in collaboration with or as a complement to other established or traditional teaching methods—not as replacements for these methods. Context, pedagogical approaches, and learning theories are all necessary for best usage and practice with XR technologies, allowing for customization within a range of educational settings and to best suit each user.[33] Additionally, if a lesson plan or unit utilizing this technology seeks to elicit empathy, XR and VR content developers should "design experiences that challenge people to engage in empathic effort."[34] While the pitfalls of XR are a valid concern for many educators, we believe that for this volume it is more helpful to focus on how VR *can* be successfully implemented in the classroom. We encourage all educators to observe the risks and benefits of this powerful medium and proceed accordingly.

THE CONTRIBUTIONS

In this volume, we present contributions comprised of a broad range of disciplines under the larger scope of the humanities and arts in higher education, with chapters focused on English and world language arts and instruction, art and art history, women's and gender studies, history, archaeology and architecture, classics (ancient Greek and Roman studies), and American studies. In order to provide a wider array of perspectives and possibilities for the use of XR technology, we also looked to be inclusive in representation within the authorship; the authors come from diverse backgrounds, locations (both within the United States and

internationally), and stages of their careers (graduate student to full professor; early career to mid–late career). Some of the authors work at universities in other educational settings (libraries, for instance), and others are artists who have worked at or in collaboration with universities. Some of the chapters are more theoretical in nature, while others offer case studies and preliminary results. Yet even with the variety of backgrounds, fields, and approaches, similarities and common themes occur throughout the chapters. First of all, an eye toward creativity, ingenuity, and teamwork has helped to make these projects possible. The flexibility offered by XR technologies allows for instruction to occur in a variety of locations, from traditional classroom spaces to the library to one's home to a museum to other public buildings to outside in nature. As educators we celebrate the opportunities afforded by the ability for students, users, and participants to learn anywhere at any time, but we also note the efforts involved in the collaboration between those various formal and informal learning environments to create a cohesive educational experience. Perhaps most significantly, the projects discussed in this volume demonstrate how XR technology and experiential learning can help put *humanity* back into the humanities, creating deeper connections between participants and the people (or topics) they are learning about, with several of the projects actively engaging in social justice aims and facilitating more accurate understandings of cultures, places, and peoples across time and space.

CHAPTER SUMMARIES

Laura Surtees' and Molly Kuchler's chapter, "Coloring Outside the Classroom: Digital Technology Restores Color to Ancient Sculpture in the Library," discusses the implementation of the "Coloring the Past" project at Bryn Mawr College. This project uses augmented reality and 3D modeling to noninvasively project hypothetical, but historically accurate, reconstructions of color and pigmentation

onto ancient Greek and Roman sculptural reliefs, which have lost their original polychromatic natures. Surtees and Kuchler highlight the interdisciplinary nature of the project, as well as the collaborative process among students, faculty, and library staff to research and set up the installation in the Rhys Carpenter Library on campus. The authors also trace the problematic history of the reception and idealization of ancient "white" sculpture, from early Renaissance to modern-day white supremacist groups, and explain how XR and 3D technologies can be utilized to reshape the conversation surrounding color in antiquity and to help us come to a more realistic understanding of the past (and its effects on the present).

In the second chapter, "Beyond Reconstruction: Alternative Realities and Breaking Barriers in Classical Archaeological Pedagogy," by Elizabeth Wolfram Thill, Matthew Brennan, and Ryan Knapp, the authors explore the technical and ideological challenges inherent in the traditional teaching methods and goals of classical archaeology courses, and argue that VR enables the students to better understand and engage with ancient archaeological material in more meaningful and sophisticated ways. They stress the collaborative process involved in creating 3D VR builds of ancient Greek and Roman architectural structures for use in the classroom, and explain how various types of VR experiences are utilized to fulfill pedagogical goals in the traditional classroom setting. The authors conclude by discussing future possibilities and goals.

Similar to the previous chapter on classical archaeology, Brian Beams and Lissa Crofton-Sleigh's chapter, "*Lingua Vitae*: Teaching the Latin Language in Virtual Reality," explains the challenges involved in teaching what is considered a "dead language", and advocates for VR as a useful and plausible methodology by which to engage students in meaningful dialogues with humans of the past. In support of VR as a tool for learning ancient languages, the authors present their development of a VR learning experience in

conjunction with *Wheelock's Latin*, a traditional introductory Latin textbook. The experience allows students to develop conversational skills and learn more about ancient Roman culture through the completion of task-based exercises in a virtualized Roman Forum with ancient Roman characters. Beams and Crofton-Sleigh offer a synopsis of relevant literature, then discuss the development of the project, preliminary user results, and future goals, arguing that VR cannot replace traditional teaching methods for language instruction, but can supplement and enhance them.

In "Designing and Teaching a Virtual Field Trip Course in American Studies," Tim Gruenewald explains how the COVID-19 pandemic-related cancellation of a US study abroad program for his students at the University of Hong Kong led to his creation of a two-week intensive virtual study abroad program, or field trip course. After a brief summary of relevant scholarship, the author discusses the guiding pedagogical philosophies and principles behind his design of the VR experience, then highlights two of the units of the virtual field trip as example case studies, followed by a review of student experience and feedback as well as key lessons learned from teaching the virtual field trip course. Gruenewald recognizes that VR travel certainly cannot replace real-life travel, but advocates for using these immersive experiences as a supplement for either traditional abroad programs or regular courses in classrooms.

David Lindsay and Ian R. Weaver's chapter, "Developing a Site-Specific Art and Humanities Platform," explores the evolution of the Popwalk mobile app, which offers an augmented reality platform for the exhibition of more than 450 pieces of art at specific locales and the exposition of such art through artist-created cultural videos. Site-specific art, as well as its meaning and interpretation, is inherently linked to the environment in which it is exhibited, and benefits in its viewing from the dialogue created between the visual art and the artist's audiovisual component in the app. Lindsay and Weaver discuss three case studies in various

national and international university and public settings, which aided in the understanding of site-specific cultural video, and thus, in the development of Popwalk.

Another AR project is presented in Elham Hajesmaeili's chapter, "An Embodied Arts-Based Research Methodology: Augmented Reality (AR) Portrait Painting in Dialogue," in which she describes the theoretical and philosophical frameworks used in the creation of AR companions for physical paintings of Iranian women living in the United States. She uses a combination of audio and visual augmentations to the original artworks to create new contexts and immersive engagement with the artwork. This, she argues, creates a cyclical, dialogic relationship between the viewer, the art, and the researcher, leading to increased engagement with the artwork.

Finally, the chapter "The Imperative of Preparing Language Teaching Professionals for XR/VR Environments", by Fabiola Ehlers-Zavala and Jay Schnoor, considers how technology, particularly XR technology, can enable more meaningful and valuable conversational skills in foreign language learning. However, the training curriculum for foreign language instructors, particularly in the United States, has not typically included study and preparation in these types of technologies, unless the faculty and the instructors in training take a personal interest in learning the technologies on their own time and through their own expertise. The authors argue that these technologies must become a formal part of the curriculum in order to better prepare students for foreign language interaction in the digital age. They provide a literature review highlighting the benefits (as well as challenges) of XR technology in foreign language teaching and learning, then advocate for partnerships between universities and the public and private sector in order to bridge the digital divide and the often exorbitant costs of acquiring these technologies at a large scale, and conclude by offering future avenues for research.

These chapters have been grouped into two sections, *Reinvigorating and Reinvestigating the Past,* and *Considering and*

Questioning the Present, followed by a concluding chapter on *Preparing for the Future*, where we mull on some of the possibilities of XR in times to come.

NOTES

1. This volume is, of course, not the first to include studies in humanities-based fields. For example, an early systematic review (Hew and Cheung, "Use of three-dimensional (3-D) immersive virtual worlds") explores the use of 3D environments in the arts as well as health and environmental fields. Special issues in educational and pedagogical journals (for example, *The Journal of Interactive Technology & Pedagogy* 17, edited by Licastro et al.) and volumes concerning VR and 3D applications in library settings (Grayburn et al., eds., *3D/VR in the Academic Library*) have looked into extended reality in humanistic projects, while a recent volume, *Virtual and Augmented Reality in Education, Art, and Museums,* edited by Guazzaroni and Pillai (2020), offers another type of model for our project. Individual case studies (e.g., Wilson, "Immersive Education"; Biedermann, "Virtual museums"; Kim, "Another Type of Human Narrative"; Rose and Hedrick, "Multisensory and Active Learning Approaches"; Bozia, "Reviving Classical Drama"; see also the review by Hutson and Olsen, "Digital Humanities and Virtual Reality," 491–500) can also be found if one knows where to look. But by and large, recent systematic reviews of XR technology in education, including Kavanagh et al., "A systematic review of virtual reality in education", and Siposova and Hlava, "Uses of Augmented Reality," indicate that the majority of studies are completed in STEM subjects.
2. Milgram and Kishino, "A Taxonomy of Mixed Reality Visual Displays."
3. And should not be confused with augmented virtuality, which incorporates elements, including objects and people, from the physical world into the virtual world and allows for user interaction and manipulation of those real-world elements within the virtual world. It differs from augmented reality, because in AR interaction occurs in the real world. For recent studies of augmented virtuality, see, e.g., Gonzalez, Richards, and Bilgin, "Making it Real."
4. Devices such as the Lynx R1 are capable of both augmented and virtual reality: https://www.lynx-r.com/
5. Tilhou, Taylor, and Crompton. "3D Virtual Reality," 181–182.
6. For more on the constructivist learning theory, see, e.g., Liu et al., "Potentials and Trends."
7. For more on these trends, with particular relevance to language learning, see Chong, "Ten trends and innovations."

8. To name just a few references: Freina and Ott, "Literature Review"; Dalgarno and Lee, "What are the learning affordances of 3-D virtual environments?"; Huang, Rauch, and Liaw, "Investigating learner's attitudes"; and Ott and Tavella, "What makes young students genuinely engaged in computer-based learning tasks."
9. Lau and Lee, "Use of virtual reality."
10. Also known as reification: Dalgarno and Lee, "What are the learning affordances?"
11. Fedeli, "Virtual Body."
12. See also Dede, Jacobson, and Richards, "Introduction"; Slater, "Implicit Learning through Embodiment"; Pederson and Irby, "VELscience Project"; and Mikropoulos and Natsis, "Educational virtual environments."
13. Monahan, McArdle, and Bertolotto, "Virtual reality for collaborative e-learning."
14. DeFreitas and Veletsianos, "Editorial: Crossing boundaries."
15. DeFreitas and Veletsianos, "Editorial: Crossing boundaries." For more on autonomous learning, see Liu et al., "Potentials and Trends."
16. Leite, Svinicki, and Shi, "Attempted validation of the scores."
17. For more on accessibility, see, e.g., Geris and Özdener, "Design Models," 4; Tilhou et al., "3D Virtual Reality"; Todd, Pater, and Baker, "(In)Accessible Learning"; Freina and Ott, "Literature Review"; Pederson and Irby, "VELscience Project."
18. Pierdicca et al., "Evaluating Augmented and Virtual Reality," 234 (this article also discusses SmartMarca in greater detail). For more on the Parthenos project, see Cook and Lischer-Katz, "Integrating 3D and VR." For further benefits and discussion of cultural heritage in relation to VR and AR technology, and gaming, see Mori, "Gamification," 87; Tilhou et al., "3D Virtual Reality," 176–81; Bekele et al., "Survey"; Bertacchini and Tavernise, "NetConnect Virtual Worlds"; Mortara et al., "Learning cultural heritage"; Frischer et al., "New digital model," 167–9.
19. Anderson, *Virtual Reality*.
20. Prodromou, "Introduction," xxix.
21. Siposova and Hlava, "Uses of Augmented Reality," *passim.* They also recognize that, given the greatest benefits of AR (visualization and interaction with virtual content), it is typically implemented into courses of fields that are, "logically, based on working with concrete objects built from real matter" and acknowledge the challenge to aid learning processes in disciplines grounded in "abstract concepts and multidimensional systems of relations" (196). In many ways, the challenges they recognize occur in disciplines common to the

humanities; however, as we see above, AR has been successfully implemented into many humanities-based courses and pedagogy.

22. Schachter, "How AR and VR will revolutionize the classroom"; Bower et al., "Augmented Reality in education."
23. Kamarainen et al., "Using mobile location-based augmented reality."
24. Diță, "A foreign language learning application"; Liu, Holden, and Zheng, "Analyzing students' language learning experience"; Perry, "Gamifying French language learning"; McGonigal, *Reality is Broken*.
25. Liu and Tsai, "Using augmented-reality-based mobile learning."
26. For more on gamification and its benefits, see, e.g., Mori, "Gamification"; and Klopfer, "Massively Multiplayer Online Roleplaying Games." Mori also considers cultural heritage in relation to gamification and VR/AR, with her discussion of the *Assassin's Creed Odyssey Discovery Mode Tour* exhibit at the British Museum in 2018, which combined meticulous digital reconstructions of Ancient Greece with opportunities for engaging, self-guided, subjective learning, where one can repeat their experiences, for instance walking through the same building twice, and move at will.
27. For more on the uses of XR technology in informal environments, such as libraries, see Varnum, ed., *Beyond Reality*.
28. For more on these ethical and legal concerns, see Royakkers et al., "Societal and ethical issues"; Tabatabaie, "Introduction to Laws"; Madary and Metzinger, "Real virtuality."
29. Three such examples (of many) are Bailenson, "How to create empathy in VR"; Zhang, "Can VR really make you more empathetic?"; and Milk, "How virtual reality can create the ultimate empathy machine."
30. On this topic, see, e.g., Sora-Domenjó, "Disrupting the 'empathy machine'"; Martingano, Hererra, and Konrath, "Virtual Reality Improves"; Rose, "The immersive turn"; Bollmer, "Empathy machines"; Nash, "Virtual reality witness"; and Sutherland, "The Limits of Virtual Reality."
31. Sora-Domenjó, "Disrupting the 'empathy machine'."
32. On this topic, see Brown, Bailenson, and Hancock, "Misinformation in Virtual Reality."
33. On the necessary collaboration between XR technology and learning/teaching goals, see, e.g., Meccawy, "Creating an Immersive XR Learning Experience"; Rizk, "Considerations for Implementing Emerging Technologies"; Southgate, *Virtual Reality in Curriculum and Pedagogy*; Farley, "The Reality of Authentic Learning"; Eutsler and Long, "Preservice Teachers"; and Fowler, "Virtual reality and learning."
34. Martingano et al., "Virtual Reality Improves."

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