

Open the Door to the Museum with Virtual Reality

Using Google Virtual Reality Applications to Bring Immersive 3-D Images
into the AP Art History Classroom

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Author's Statement

The idea for this capstone project grew organically in my AP Art History classroom when I ordered a Google Cardboard viewer after reading about the technology in the *New York Times* in November 2015. Much like the story recounted by a journalist in this paper, as soon as I experienced Cardboard I was compelled to share it with a young people—in this case, my students. Although Street View had very few images useful to my classroom at the time, over the last two years the image database has grown exponentially, making it a valuable tool for teaching art history.

It cannot be overstated how important my students have been to this project as I have watched them navigate, intuitively as digital natives, Cardboard in the classroom. They have shown me which teaching methods work best with VR and they have made it abundantly clear to me that sometimes the best lessons are learned while wondering/wandering off-script. The joy of teaching and learning has been rediscovered in my AP Art History classroom with Google Cardboard and Street View and my students have taken ownership and pride over their learning. I hope that the successes of this capstone project can be shared widely by teachers, students, and museums.

Lastly, this paper would not have been possible without the generous and thoughtful feedback received from Sis Hight, who encouraged me to think big (and to lose my fear of commas); Kathy Jones, who kept the paper cohesive and relevant; and Erica Lawton, whose MLA formatting knowledge is unrivaled; or without the culminating assignment in Joe Greene's writing seminar that provided the first structure to the organic idea at the core of this capstone project.

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Introduction: The Case for Using Virtual Reality to Bring the Museum to the Classroom

Engagement is critical to learning, but a two-dimensional image has a limited ability to engage, as the experience of teaching and learning art history using flat images of art and architecture is surely different, and inferior to, a physical visit to see the actual work. While students who have easy access to large cities in the United States and abroad might experience a post-Impressionist masterpiece, a Gothic cathedral, or large-scale public artwork in person, for students without the same access, it is difficult or nearly impossible to understand the impact of painterly quality of a Van Gogh, the soaring verticality or *lux nova* in a cathedral, or the emotional power of the Vietnam Veterans Memorial. Even for those with access to museums, some works cannot be appreciated fully due to the security measures and crowding that prevent close inspection. Add to the mix ephemeral installations and performance art that are largely dependent on the ability of the viewer to be present for a specific and limited time, and the challenge of access becomes more evident. When the audience is a high school student of art history, the instructor must find a way around the barriers to access in order to more deeply engage his or her students in the course content. This paper details a prototype template for teachers of Advanced Placement Art History to use Google Virtual Reality applications—as 3-D digital surrogates for the works studied—to break down the barriers by bringing the museum into the classroom virtually, while simultaneously opening the door to the physical museum.

Before outlining the plan, it is important to define the terms “museum” and “Virtual Reality.” For the purposes of the paper, the term “museum” refers to art museums, architectural sites, and public artworks. The term “Virtual Reality” (also referred to as VR) refers to digital

photographic surrogates for artworks and architectural sites, especially—but not limited to—three-dimensional images viewed with a head-mounted display unit (Rouse “Virtual Reality”). Any departure from these definitions will be explained within the relevant section.

The ultimate goal of the project is to make the teaching and learning of art history more effective and engaging through the use of immersive Virtual Reality images that bring the museum into the classroom while also opening the metaphorical door to the museum so that students feel a sense of belonging in all museums. A collateral benefit of this prototype is that it also serves as a model for ways in which local museums might develop programs for high school students. In an ideal world, each student of art history would visit every work of art studied in the course, but the nineteenth-century version of the Grand Tour is dead. Instead of lamenting the loss of the old, this project envisions a new, more inclusive Grand Tour made possible by the rapid development of modern Virtual Reality.

The AP Art History Course

The AP Art History exam is offered by the College Board, the same educational company that writes and administers the SAT college admissions exam, as a way for high school students to demonstrate proficiency in a college-level art history survey course. As stated on the College Board AP Art History course webpage:

The AP Art History course is equivalent to a two-semester introductory college course that explores the nature of art, art making, and responses to art. By investigating specific course content of 250 works of art characterized by diverse artistic traditions from prehistory to the present, the course fosters in-depth, holistic understanding of the history of art from a global perspective. Students become active participants in the global art

world, engaging with its forms and content. They experience, research, discuss, read, and write about art, artists, art making, responses to, and interpretations of art. (“Art History”)

Before 2015, students were expected to be superficially familiar with between 500 and 750 artworks selected autonomously by each instructor. Today, the College Board provides a list and set of images for just 250 required works with which students need to become deeply familiar (Appendix A) (“Required Works of Art for AP Art History”). In addition to limiting the scope of artworks the College Board has shifted the course focus from the traditional European-influenced canon to a more progressive and globally-distributed body of work (“Key Changes”). The combination of fewer works studied with the need to understand each more deeply makes the need for student engagement more critical than ever. Add to the need for engagement the fact that not all of the required works are well-known or covered in the widely-used college-level art history survey textbooks, and thus, there is a need to build or add to the instructor’s visual teaching resources (Spivey, et al.). Fortunately, the advent of the digital revolution means the days of painstakingly building a visual slide library are over.

The list price to purchase an art history textbook, updated to include the newly-required works, is about \$200.00 per student (“Gardner’s Art Through the Ages”), but in many public schools the money is not available (Semuels). Fortunately, the cost of building a new, digital, visual library is free to the user who can locate suitable resources online. The College Board does provide digital two-dimensional images on its course website (“Art History”), but many of these leave the instructor and student wanting for more visual information. By using free images from Google the instructor can add to the College Board images by creating a virtual visual library (*Google Arts & Culture*).

This prototype template focuses on the AP Art History classroom, but the template, in the form of an in-person presentation or with instructions on a yet-to-be-created website, can be easily modified for other art history courses or for courses covering other subjects altogether. The prototype has been designed for a group of seventy-five students in three sections, but it can be scaled up or down with ease. The College Board course revisions have driven this project out of necessity so the project goal is to have a fully functional and practical template, not a hypothetical plan. As such, this prototype template has been crafted with technology available today but with an eye towards the future development of VR technology.

The Significance of the Physical Museum Space

Museums have historically served as the stewards, interpreters, and presenters of art. The most obvious significance of the physical museum to the instruction of art history is that the museum is where the art is. There really is no substitute for the physical experience of viewing an artwork. In person, a work of art carries the richness of contextual information that does not transfer over to a static image in a textbook. Alexandra Korey, the creator of the blog *ArtTrav*, writes in a post called, “Art and Travel: The Authenticity of Seeing Art in Person,” that “There are some ‘ooh’ and ‘ah’ moments when you see certain works of art in person. I can’t explain it, but hope it’s happened to you at some point...” Another blogger, Ellen Oredsson—an art historian who is “passionate about making art and culture more accessible and letting more people have the opportunity to bore their friends with art history facts,” writes on the experience of seeing the Sistine Chapel in person, “Certain individual parts of the ceiling—such as the image of God giving life to Adam— have been widely circulated, but the entirety of the space is hard to convey through reproductions. The overall effect in the physical space is that art seems

almost three-dimensional, coming out of the ceiling in a pretty fantastic way” (“The Top 7 Artworks”). Avid visitors of art museums know of what these bloggers write, that words or still images cannot adequately describe the feeling one gets when experiencing art in person.

But the significance of the museum goes beyond the obvious. The museum has become a place that can serve as the “third space” (Oldenburg) (sometimes also referred to as the third *place*) for members of the community. The term was coined by urban sociologist Ray Oldenburg, who states in his book, *The Great Good Place: Cafes, Coffee Shops, Bookstores, Bars, Hair Salons, and Other Hangouts at the Heart of a Community*, that “...daily life, in order to be relaxed and fulfilling, must find its balance in three realms of experience. One is domestic, a second is gainful or productive, and the third is inclusively sociable, offering both the basis of the community and the celebration of it” (14). So it is not work and not home, but rather a space in between where everyone is welcome and feels a sense of belonging. In a safe space like the one described here, the visitor is comfortable and secure enough to be open to discourse with other visitors and to tackle new, and even uncomfortable, ideas. But one cannot know that the museum can be this “third space” unless he or she walks through the door in the first place.

Adding to the strength of the idea that the museum can serve as a “third space” is the argument from museum expert Gail Anderson that the museum plays the role of community educator. She states in the introduction to her edited book, *Reinventing the Museum: The Evolving Conversation on the Paradigm Shift*:

Collections—historically viewed as the center of museum activities—have moved to a supporting role that advances the educational impact of the museum. The collection holdings are no longer viewed as the sole measure of value for a museum; rather the

relevant and effective role of the museum in service to its public has become the central measure of value. (5)

The education and service to the public mentioned by Anderson can take the form of instruction about the collection, social awareness programs, or the third space—the community gathering space. Anderson’s argument of the museum as educator-at-large is not a new one. Museum pioneer John Cotton Dana foresaw the future in his 1917 essay, “Gloom of the Museum,” when he wrote:

Museums of the future will not only teach at home, they will travel abroad through their photographs, their textbooks, and their periodicals. Books, leaflets, and journals—which will assist and supplement the work of teachers and will accompany, explain, and amplify the exhibits which art museums will send out—will all help to make the museum expenditures seem worthwhile. (30)

Precisely one-hundred years after he wrote these words museums have VR as a new tool for outreach.

Museums are constantly looking for ways to attract new visitors, and most are eager to let the community know that all are welcome. Therefore, this capstone project benefits not only the classroom, but museums as well, by helping them to expand their audiences and develop new programming relevant to their audiences. In targeting high school students, the museum may run into roadblocks that impede a physical visit. Already mentioned is the geographical distance between a student and the museum, but this cannot be addressed directly in the scope of this project. Of greater relevance to this project are two reasons that AP Art History students who live close to a museum, even a small museum, might not visit—scheduling difficulty for field

trips and a lack of awareness, both the teacher's and the student's, of the relevance of the museum collection to the AP Art History course content.

With the rise of standardized testing in schools has come the pressure for a teacher to stay on a strict schedule and routine to check off all of the required course components. There just does not seem to be enough time to do everything. This may not stop the AP Art History teacher from wanting to schedule a field trip to the local museum, but students are often pressured by their other teachers not to miss class, even for an academic field trip. Beyond the scheduling issues due to school day obligations, there are also difficulties in setting up transportation for the museum visit.

This project uses for its prototype a medium-size, college-affiliated art museum in Winter Park, Florida, the Cornell Fine Art Museum at Rollins College (known as CFAM). CFAM is in Central Florida, home to Disney World and over 200,000 public school students ("About Us"), yet the small number of field trips and the tracked student attendance to the Museum reflect anemic attendance by high school students (Coulter, 5 Oct.). The prototype school, Winter Park High School, is just three miles from CFAM, but due to transportation difficulties—school buses are available for field trips for only a narrow timeframe during the school day, personal transportation is not allowed, and a lack of public transportation—field trips are difficult to plan. Add to that a busy standardized testing schedule that makes it challenging to schedule a field trip date that is not in conflict with a district-mandated test, and it is not surprising that there have been no AP Art History class field trips during the school day for several years. The cost to hire a charter bus and the bureaucracy associated planning a school day field trip have practically relegated it to the land of nostalgia (Reeves and Rodrigue). A field trip to the local museum may once have been the way to the museum door, but this can no longer be counted on.

Even without a school field trip, instructors and students may still choose to visit the local museum on their own in order, especially if they understand that the collection housed in the museum is relevant to the AP Art History course. A local house museum, for instance, might be viewed by the instructor as irrelevant to the course curriculum but the museum might contain objects that are, in fact, appropriate for the course. However, if the museum educator or curator and the AP Art History instructor work together with the template provided in this paper, they can quickly determine which objects may be relevant to the AP Art History curriculum. Instead of targeting all high school students with a blanket outreach campaign, the museum educator or curator can quickly sort through the list of 250 required works for the AP Art History course to determine what in the museum collection is most relevant, thereby attracting the teacher and student to the door of the museum.

In her recent work, *The Art of Relevance*, Nina Simon mentions “the desire to belong” (89) as one reason a person who is a museum “outsider (77)” may want to become an “insider” (77). With the museum targeting the AP Art History community directly, the teachers and students will likely feel that the door has been opened specifically for them (99). This project introduced the local AP Art History teachers to the project museum during a school district professional development meeting, with the museum planning to follow up directly with the individual teachers through outreach letters or emails (Coulter 5 Oct.). The museum may even help build a local AP art community that might lead to students feeling they belong not just to the museum community but also to the larger community—including the global community—of their peers from different schools.

Once the door to the museum is open to the AP Art History community, either with a field trip or individually, it is hoped that the visitors will see this museum space as a “third

place” where they will return and then, by extension, visit other museums in the future. In their report, “Investigating Sustained Visitor/Museum Relationships: Employing Narrative Research in the Field of Museum Visitor Studies,” Australian researchers Michele Everett and Margaret S. Barrett show that the visitor who feels he or she belongs in the museum will visit again and again (10). It has been stated already that the goal of this project is to bring the museum into the classroom today with the expectation that the virtual visit will lead at some point in time to the physical visit. To be clear, the physical visit, even if it is years away, is the ultimate goal. Before moving on, it is important to understand the history of stereoscopic technology and, more specifically, to learn how stereoscopes were first used in the classroom.

A Brief History of the Stereoscope in Education



Figure 1. Children in geography class viewing stereoscopic photographs, (Underwood & Underwood, 1908), *Library of Congress*, www.loc.gov/pictures/item/96525688/.

VR in the classroom is not a new concept. The stereoscope—a device that creates the illusion of a three-dimensional object by allowing the viewer to look at two separate but adjacent photographs using binocular vision—was used in classrooms over one hundred years ago (Figure 1). According to Oliver Wendell Holmes, the nineteenth century American doctor, writer, and inventor, the effect was, “The shutting out of surrounding objects, and the concentration of the whole attention...produces a dream-like exaltation...in which we seem to leave the body behind us and sail into one strange scene after another, like disembodied spirits” (Sacks 65.) Adding to Holmes’ words are these written in 1909 by Frank Morton McMurry, a professor at the Teacher’s College at Columbia University in New York, on the importance of engaging the senses in education:

Every well-informed teacher now realizes that the pupil’s shortest and surest road to correct knowledge is through sense experience. ‘The child’s whole mental life,’ says Bolton in his *Principles of Education*, ‘is determined and circumscribed by the range of his sensory experiences.’ Without these perceptions, not only would the lower powers of the mind be lacking, but the growth of the higher powers, like judgment, reason and volition, would be impossible. (ix)

Even though these works were written over one hundred years ago, they still ring true to educators today. In the classroom of today students are likely to spend hours sitting at a desk in an enclosed classroom looking at a computer screen. Lessons that appeal to the senses have been all but abandoned—replaced by a crammed checklist of a curriculum for which the student is endlessly, and perhaps often needlessly, assessed with a battery of standardized multiple-choice tests. McMurry wrote his extensive book, *The World Visualized for the Classroom: 1000 Travel*

Studies through the Stereoscope and in Lantern Slides, Classified and Cross Referenced for 25 Different School Subjects-Teachers' Manual, to bring lessons that appealed the senses to the American classroom in the early twentieth century, showing the cyclical nature of pedagogical practice.

Englishman Charles Wheatstone invented the stereoscope in 1832, and its adaptation for photographs became wildly popular when it was featured in London at the 1851 Great Exhibition at the Crystal Palace, so much so that “there were few people in Europe or America who did not have access to stereo viewers by the end of the nineteenth century” (Sacks 65). Oliver Wendell Holmes followed up with his invention—the handheld Holmes Stereo viewer that became popular for entertainment and as an educational tool (Staples) (Figure 2) when it was heavily marketed and distributed by the company Underwood & Underwood (Plunkett 389).



Figure 2. Holmes stereoscope reproduction; Davepape; *Wikipedia Commons*; 5 June 2006, https://en.wikipedia.org/wiki/Stereoscope#/media/File:Holmes_stereoscope.jpg.

Two early proponents of the stereoscope for educational purposes were Holmes and the Scottish naturalist and educator Sir David Brewster. In, *The Stereoscope: Its History, Theory, and Constructions with its Applications to the Fine and Useful Arts and to Education* (1856), Brewster writes that "...the material and tactile quality of three-dimensional pictures would be particularly valuable for sculptors, painters, architects and engineers" (183). Holmes succinctly writes that with the stereoscope, "The mind feels its way into the very depths of the picture" (148). Adding to the argument for the use of the stereoscope in education is Albert E. Osborne's, *The Stereograph and the Stereoscope with Special Maps and Books for Forming a Travel System. What They Mean for Development. What They Promise for the Spread of Civilization* (1909), where he states, "By means of these two different views of an object, the mind, as it were, feels around it and gets an idea of its solidity" (25). It is clear from these passages that much excitement surrounded the stereoscope experience from its invention and through the early twentieth century. That there were several manuals written on the use of the technology for education shows that the case was being made for the educational value of the stereoscope then, but use of the stereoscope in the classroom seems to have ended abruptly.

It may be that a combination of the rise of moving pictures, the dissemination of photographs through newspapers and magazines, and the mass-production of textbooks with photographic images in the first half of the twentieth century made the stereoscope seem quaint (Montgomery 18). Or, it may be that with the expansion of public education, the study of far-away places depicted in stereographs may have seemed out of reach for the typical student. Whatever the cause, the stereoscope disappeared from classrooms about a hundred years ago, but the cause for excitement over the original stereoscope, the haptic experience, is relevant today: "The appeal of the instrument could be regarded as stemming from a deep-seated western desire

to erode the gap between the viewing subject and non-local object, particularly as the device gained success during a period marked by globalization...” (Plunkett 396). Fortunately, many of the immersive qualities of the stereoscope lived on in the View-Master, a stereoscope marketed as a toy in the mid-twentieth century (Arce)—a popular toy well-known to the Baby Boomer generation that paves the way for the next generation of stereoscopes.

The Google Cardboard Viewer

The stereoscope lives again in the form of Google Cardboard. The Google Cardboard viewer is an HMD, which stands for head-mounted display, made with corrugated cardboard (Figure 3). Google makes the plans for making the viewer available for free online to encourage mass-production, and because of this, there are several versions of Cardboard readily available on the market (“Get Cardboard”). A viewer can even be made at home from a small amount of cardboard, some glue, and a set of biconvex plastic lenses. However, the user experience is dependent on a strict interpretation of the Google-provided plans, so it may be prudent to buy a viewer online.

A recent search on Amazon.com using the term “Google Cardboard” turned up viewers ranging from under two dollars to over one-hundred dollars with most available for under ten dollars (“Google Cardboard”). Some units are made of sturdy plastic instead of cardboard and many offer head straps, but the basic design is same for all (see Figure 3). No matter which style of viewer is selected, the magic happens once the user downloads the free Google Cardboard application—and any other desired Cardboard compatible application—and inserts his or her smartphone into the viewer (“Get Cardboard”). It does seem like magic, but the question remains as to the ultimate staying power of Cardboard beyond its initial novelty. Google’s much

ballyhooed augmented reality glasses, the “crashed-and-burned Google Glass,” seemed full of promise but have not become commercially popular (Farago), but Cardboard may well find its way to popularity.

Cardboard-Compatible Headset Mounted Display Units



- Google Cardboard, made by Google
- \$15.00 (includes shipping) at GoogleStore.com.
- Other manufacturers sell viewers made from the same design on Amazon.com for as low as \$2.00.
- (“Get Cardboard”)



- View Master Cardboard compatible viewer
- Retails for \$29.99 in stores
- Based on the design of the original View Master
- (Mattel)



- Homido brand
- Minimalist design, clips to smartphone, does not wrap around eyes
- Retails for \$9.99
- Similar to Holmes stereoscope design
- (Homido)

Figure 3. Various Cardboard compatible HMD viewers. Source: C. Payne.

Created by engineers at the Google Cultural Institute’s Lab in Paris (“The Lab”), Cardboard was designed to be a conduit for the rapid development of VR technologies. The openness of Google, combined with the lack of financial commitment needed for the user to try out Cardboard have resulted in a technology moving so quickly that it seems like a plane being built while already in the air. Brian May, the rock star who became a physicist, said in a 2015 article in the *Boston Globe*, “At this point, Cardboard looks to me like an accelerant” to which a

reader responded, "...gasoline to the virtual-reality bonfire which is set to burn down convention in both entertainment, information consumption, and, quite frankly, the way we interact with the world as a whole" (qtd. in Kreitner).

The excitement over Cardboard erupted in October 2015 with the announcement of a partnership between Google and the *New York Times* (Somaiya) in which the newspaper would distribute, at no cost, over one million Cardboard viewers to print subscribers with the November seventh newspaper delivery. Although the delivery of the viewers coincided with a specially made immersive video about child war refugees and linked on the online version of the newspaper (Silverstein), it did not take long for users to figure out, starting with the Google Cardboard application demos, that there was a whole (virtual) world out there.

For *New York Times* subscribers of a certain age, there must have been a flood of childhood nostalgia with the memory of the View-Master. The nostalgia likely disappeared once the video article was underway and the emotion related to the seriousness of the topic overrode the initial wonder. For the digital-only *New York Times* subscribers who did not receive the free viewers, there was mention of the viewers for which a quick internet search could find for sale.

By November 2015, the online technology magazine *Wired* followed up the *New York Times* announcement with an article titled, "Google Cardboard's *New York Times* Experiment Just Hooked a Generation on VR" (Wohlsen). Wohlsen describes the scene repeated in homes across the country the morning the viewers were delivered:

...the first thing I did was to put it on my kid. And I'm pretty sure that means everything.... 'Yes, you think your dad's iPhone is pretty cool. But then yesterday you put on Google Cardboard and watched a train come hurtling toward you before you flew

up into the sky and into the embrace of a giant baby. And you said, “Yeah, now we’re talking.””

Wohlsen goes on to say:

...in the case of this particular technology, accessibility translates almost immediately into visceral intimacy. Experiencing VR for the first time isn’t just cool; it’s revelatory. This is why so many of us made sure to capture the moment of our kids’ first encounter. Most parents, I hope, don’t make videos of their kids’ reactions when we unbox our latest iPhones. But I believe we had a collective sense that our kids were experiencing something meaningfully new—not just an encounter with a new technology, but with a new way of relating to technology....I believe the hype that VR can act as a powerful empathy engine, a uniquely direct way to put us in someone else’s world. This makes me hopeful that VR will become much more than the next level of escapism for an already screen-addled generation.

Following up with the *New York Times* as an example of an early adopter of Google Cardboard, in a recent interview, Marcelle Hopkins, the deputy video editor at the paper who is responsible for VR content on the Times’ VR application (NYTVR), discusses the experience of using VR and Cardboard as digital media. She says, “V.R. is great for creating a sense of place. We often use it for stories in which the place is important to the story and being there can create a visceral experience that is rare in other mediums. V.R. can transport our audience to places they otherwise couldn’t or wouldn’t go...” (Hopkins). Both Hopkins and Wohlsen use the word “visceral” to describe the perceived sensory experience with Cardboard. On the future of VR as media, Hopkins predicts:

...the first immersive media wearable to be widely adopted will look and function more like a pair of reading glasses than like the V.R. headsets we have today. The first generation of modern V.R. and augmented reality headsets are too clunky to go mainstream. They're heavy and awkward, sometimes connected to a computer by a cable. They're good prototypes for getting us started in immersive platforms, but I hope someone builds something that's more convenient for everyday use.

If one pauses here for a moment to think about the world before the internet and the smartphone it is conceivable that the immersive platforms that Hopkins refers to, including three-dimensional images in the classroom, will become as natural as the iPhone is today. It is because Cardboard may be a member of the "first generation" of VR headsets (Hopkins) that it should be seen as a stepping stone that will need to be updated at some point with the technology that replaces it.

As the initial excitement of Google Cardboard as a low-cost VR technology spread, likely due to the New York Times collaboration with Google, it did not take long for classroom teachers to catch on. Ways to use this new and cheap tool to bring technology into the classroom have started to appear in teacher-generated, education-centered publications such as blogs. Cardboard-compatible viewers are readily available through online marketplaces ("Get Cardboard," "Google Cardboard"), and images can be downloaded or created easily and for free (*Google Arts & Culture*).

Virtual Reality Applications in the Classroom Today

This paper uses a limited definition of VR that includes only digital photographic images, although the broader definition of VR is often expanded to include augmented reality applications and computer-generated creations or simulated reality of real and imaginary worlds

(Shieber). Augmented reality, a technology that overlays digital content over what the user sees in his or her physical space in real time (Rouse “Augmented Reality”), is particularly useful as a tool within physical museum spaces, especially in house museums and historical sites. However, it has limited use within a traditional classroom space because it requires specialized costly and labor-intensive computer programming for each module, so it will not be explored in this paper as an option for classroom use (Landi). Three-dimensional images and user-manipulated 360 degree images are readily available online at no cost and are useful in the classroom so they are the main VR focus of the project. This section makes the case for using Google applications in today’s classroom. It also works to dispel the idea that VR in the classroom is just another educational fad. In 2006, the famed neurologist Oliver Sacks wrote in an article for *The New Yorker*, “In nature, binocular vision—stereoscopy—is anything but a gimmick. It makes possible our three-dimensional world” (65). The trick is to “put virtual reality in the service of something more complex (than mere illusion), for it would be a pity if wonder was all we got” (Farago).

The term Virtual Reality is used for a variety of applications and there is at least some disagreement about what qualifies as VR, with one article even imploring the reader to, “Stop Calling Google Cardboard’s 360-Videos ‘VR’” (Smith). It seems that a healthy debate about the term itself is a good sign that this technology might stick around long enough to evolve into a clearly defined phenomena with further defined categories. One characteristic of VR that seems to span most current definitions is the creation of an immersive three-dimensional environment with a head-mounted display. The display can be used to project a computer-generated or photographic image and is either connected to a computer or used with a smartphone inserted into the HMD. Often times binaural stimulus, via stereo headphones, is incorporated into the

visually immersive experience with earbuds or headphones. The resulting experience for the user is immersive and intimate.

The history of VR is quite long, as discussed earlier with the stereoscope in the nineteenth century (Staples). With the invention of moving pictures came films for which visitors to the theater donned special glasses that resulted in an immersive three-dimensional experience. Science fiction depictions of VR range from the Star Trek holodeck to blockbuster films like the Matrix (“Holodeck;” *The Matrix*). While not exactly the virtual reality imagined in film, today’s VR technology does allow the user to experience art, artifacts, and architectural spaces in three dimensions and on demand and at his/her own pace. Several companies are now developing VR hardware and software with great emphasis on the lucrative gaming industry. The technology developed for that industry can also be utilized for cultural applications that would otherwise lack funding.

A small but growing band of teachers has latched on to Virtual Reality in the classroom. Not surprisingly, institutions with larger resource pools have jumped directly into the deep end of the VR pool while those with fewer resources are starting in the kiddie-pool. College level instructors have been experimenting with VR technologies targeting lecture hall-style uses while K-12 teachers have experimented with scaled-down handheld versions of VR.

In his 2012 article titled “Digitizing the Humanities” in *Harvard Magazine* (the online version), Jonathan Shaw discusses the current state and future possibilities of the digitization of humanities-based archives and collections. Shaw details the collaboration between Harvard Egyptologist Peter Der Manuelian’s and Paris-based software design firm, Dassault Systèmes, to create a virtual ancient Egyptian recreation of Giza. Der Manuelian is able to guide his class through a digital recreation of the necropolis of Giza, made of archived research material and

detailed photographs, from the perspective of the cockpit of a small aircraft. The resources required for this collaboration, from the access to archival material to the cost of the specially designed software—not to mention the cylindrical room needed for the projections—make it an unrealistic tool for most educators at this time.

In addition to the work of Der Manuelian, other researchers have also approached VR with the same goal of recreating an archaeological site digitally. Like the tour of Giza, some of these, like, *A New Roman World: Using Virtual Reality Technology as a Critical Teaching Tool*, from the University of California, Los Angeles, require significant computer-modeling experience to create, making it out of reach for typical high school teachers due to the limited resources (Kuo 4). Besides the resources involved, these also leave out the feeling of intimacy found with the use of an HMD, like the Google Cardboard viewer. Of note is that much of the current research focuses on the digital recreations of archaeological sites, making the results useful in the art history classroom. Fortunately, for primary and secondary teachers, the work colleges are doing to make archived humanities materials available globally will pay off in the K-12 classroom even if not in the same way the technology is being used at the post-secondary level.

While college researchers have been at work leading the digitization of archives and collections, K-12 teachers have been busy blogging about Google Cardboard and Google Expeditions, a Google-created application designed for visits to sites around the world. In her October 2016 post, “8 Tips for Teachers Using Google Cardboard in the Classroom,” Dr. Monica Burns, an education consultant and former classroom teacher, extolls the virtues of Cardboard: availability, ease of use, low cost, and the variety of school subjects that can be incorporated. Another teacher blogger, Ronnie Burt, posts in February 2016 in “Getting Real?

Google Cardboard and Virtual Reality in Education,” about his experience using a pre-launch Oculus Rift (a competing VR provider, but one that currently relies on equipment that costs thousands of dollars) with a primary class in Israel and his opinion that Cardboard can be a worthy stand-in for Rift. Finally, *M2 Presswire*, an online technology magazine, discusses in the September 2016 article, “Teaching in Virtual Reality,” the use of Google Expeditions for virtual field trips. The idea of the virtual field trip will play a prominent role in this project to build a bridge from the classroom to the museum.

Why Use Google Over the Resources Available Today?

Google currently leads the way in adapting VR technology for cultural education through its Google Cultural Institute initiative, started in 2011 make global cultural heritage accessible, for free, to a global audience (*Google Arts & Culture*). The Google Cultural Institute lab in Paris, mentioned briefly earlier, serves as a global hub for developers, researchers, and educators collaborate to maximize the spread of culture through the use of VR technology. The applications created in this lab are integral to this capstone project.

One of the first products from the lab was the Google Cardboard HMD. Originally designed to work with the Google Street View application, it now can be used with a growing number of applications. Want to walk through Rome from the Pantheon to the Colosseum? You can, with Google Street View. Have you ever wondered what it would be like to stand at the steps of the Parthenon—and maybe see the Elgin marbles that came from the pediment? Street View can take you there, too. The application allows the user to go on a virtual walking tour of cities and cultural institutions around the globe. Beyond the Street View application, Google’s Power Zoom feature, available through the Google Arts & Culture website or application,

enables the viewer to enlarge areas artworks for extreme close-up viewing so that each brushstroke can be seen, with colors so clear and vibrant you can imagine you are Vincent applying just one last touch. A visitor to MoMA could never get so close to Van Gogh's *Starry Night* without drawing the attention of security staff. Google Expeditions, an application that allows the teacher to lead a class through a world heritage site, is now available for free and is compatible with Cardboard ("About Google Expeditions").

With over eleven-hundred partners and growing, Google Arts & Culture is increasing access to museum collections and archives exponentially (*Google Arts & Culture*). The website is perpetually in beta version, perhaps because it is evolving so rapidly. Aside from the depth of current applications available and the fact that the applications are free to the end-user, Google is a leader in developing open-source access to world culture and it has invested its resources to provide us with access to a toolbox previously unthinkable. The case for Google is strong on the cultural front, and it currently seems a natural fit for the classroom teacher.

Using Google Applications to Bring the Museum to the Classroom

K-12 teachers are known for their ability to adapt to changing pedagogical practices. "Move or get off the tracks" is a familiar feeling to most teachers, and it must be exhausting to keep up with technological advances, administrative expectations, and upwards of one-hundred fifty students (depending on the grade level taught). The good news with Google Cardboard and its associated applications is that the teacher can wait comfortably at the train station until the right train, or application, comes along. Based on the bloggers cited earlier, there are plenty of teachers willing to share in a peer-to-peer format information on how to use Cardboard in the classroom. The basics of how to get started in specifically the AP Art History classroom with

this innovative project using Google Cardboard, Google Street View, and the Google Arts & Culture website are covered below.

Technology Requirements

The basic technology requirements necessary to bring Cardboard to the classroom are the viewer; a smartphone; the Google Cardboard and Street View applications; and internet access. Most high school students in the United States now have a smartphone, and the Google applications are free to download, so the main technology left to provide is Wi-Fi internet access. Cellular data can be substituted for Wi-Fi, but there may be data charges involved, so it should be avoided unless the student confirms that he or she has ample data available. As for internet speed, if a classroom of students can individually stream video simultaneously, the Wi-Fi speed is adequate.

Before proceeding with Cardboard in the classroom, it is advisable for the teacher to download the required applications and use them beforehand, with or without a Cardboard viewer, to ensure the applications are not blocked by the school district and that the Wi-Fi is functional. Once access to the sites is confirmed, the teacher simply asks students to download the Google Cardboard and Google Street View applications to their smartphones. The applications can be downloaded for free and there are no in-application purchases to worry about.

Logo/Icon	Google Application	Functions
	Cardboard	<ul style="list-style-type: none"> • Runs in the background for all 3D viewing
	Street View	<ul style="list-style-type: none"> • Searchable 360/3D images • Easy-to-use camera to take 360/3D images • View above/below/all-around • Google-created images can be “walked” through
	Cardboard Camera	<ul style="list-style-type: none"> • 3D image camera • Option of 30-second audio loop with image • Easier to capture seamless image than with Street View Camera • View directly above/below not captured
	Arts & Culture	<ul style="list-style-type: none"> • 1100+ global institutional partners • 360 views of historical sites and museums • Limited number of 3D images • Extreme Close-up views of paintings with Power Zoom feature
	Expeditions	<ul style="list-style-type: none"> • Limited number of VR trips for teachers leading classes • High-value images that can be “walked” through

Figure 4. Chart of Google VR Applications. Source: C. Payne

Beyond the Cardboard and Street View applications, there are several other free applications offered by Google that may be of use either with or without a smartphone and viewer (Figure 4). Although not essential to experience the VR images, they provide extension opportunities after viewing works with Street View. Google Arts & Culture does have a few three-dimensional images that can be viewed with the Cardboard viewer, but its most useful feature to the art history classroom is the Power Zoom feature that allows the student to zoom in to a painting so closely that small cracks and even imbedded paintbrush bristles can be examined. Google Expeditions is an application that is particularly useful if the teacher wants to

guide a class through a location preloaded by Google, and it might be particularly helpful if the teacher wants the entire group focused on a specific view all at once. The downside of Expeditions for this project is that there are not many locations available to visit, and the whole-group experience might take away from the ability for the student to wander from view to view as his or her curiosity dictates—much in the way the requirement to follow a tour guide on a physical trip who holds a flag you must follow makes it impossible for you to follow your curiosity down a side street when the urge strikes. Google Street View has a camera feature included, but Google Cardboard Camera may be preferred because it allows the teacher to capture an image with thirty seconds of audio, so it is included as a useful application that is not required. No matter which applications are selected to download, the technology requirements are easy to access and free of hard charges to the teacher and students as long as Wi-Fi is available, making only the acquisition of the head-mounted viewer a major concern for the teacher.

Acquiring Google Cardboard Viewers

Because the Cardboard headset viewer is made of corrugated cardboard, it is sturdy enough to last several years if the units stay in the classroom (as opposed to being carried in a backpack where it is likely to be crushed). At approximately fifteen dollars per headset, a class set of thirty can be purchased from the Google Store online for under five hundred dollars (“Get Cardboard”). It is recommended that students work in pairs to share a headset to encourage collaborative critical thinking, but by purchasing enough for the entire class there will be extras in case some are damaged due to heavy use. Because Google Cardboard design is open-source, there are many models made outside of Google available in stores and online for under ten dollars. Be cautioned that if you plan to purchase a set of low-cost units, buy one unit first to test

the quality before order the rest of the class set. Several models were purchased from vendors on Amazon.com that had varying user-end experiences, such as blurriness and flimsy materials.

Several sturdier Cardboard compatible headset viewers made of plastic are available online and in stores, and some can be found on sale with deep discounts because they are geared for gamers, and as the gaming industry improves technology, the gamers tend to purchase the latest models. One caveat is that if one chooses to invest additional resources to purchase viewers, understand that technology will likely continue to accelerate, rendering the viewer obsolete within a few years.

Funding may be a challenge for some schools, but the payoff is immediate. It is recommended that the instructor starts with one or two viewers that can be used to demonstrate to colleagues and administrators the education value of the images. With others on board, procuring funding may be easier. Consider writing, as an individual or with teachers from another department or with the parent association, a grant proposal. Another solution is to purchase a few viewers and allow students to take them home overnight, perhaps as a library loan, with a letter asking the parent to purchase a headset if they think it is of educational value. A final option is to ask the local museum to invest in a set that can be loaned to the class.

It is important to know that if you have not heard of the Cardboard viewer before, you might think it will be difficult to find them, but once you start looking, they are everywhere. As mentioned earlier, they can even be made by a class if biconvex lenses, cardboard, glue, and Velcro can be gathered—think cross-curricular for STEAM (the acronym for Science, Technology, Engineering, Art, and Math) subjects. (“Get Cardboard”).

Image Selection and Dissemination

Once viewers have been procured, Finally, the image selection process for images for the visual library can proceed. A sensible approach is to decide which of the College Board's 250 required artworks is best understood in three-dimensions and start with those. Architecture and sculpture may be at the top of this list because it is inherently difficult to teach or learn using two-dimensional images. This paper uses images of the *Chartres Cathedral* in France as exemplars for images of required works that are well-suited for VR lessons (Appendix B).

Once the Cardboard application is on the smartphone, it is not necessary to open the application, as it will run in the background any time Street View is open. Begin by opening Street View by tapping on the icon, and then tap on *explore* under the search window. Next, type *Chartres Cathedral* into the search window and scroll through the images that appear. Images with the Street View logo are uploaded by Google and often have the option to move through the three-dimensional image. The Google-supplied image allows the user to walk around the exterior of the building and directly to the Royal Portal, which results in a rich contextual experience.

Beyond the images captured by Google are hundreds uploaded by users. Some are of better quality than others but you can quickly scroll through several and choose the ones best suited to the lesson. After selecting a few images based on the lesson goal (e.g., interior, exterior, Royal Portal), the link to each image can be sent to the teacher as a message or email or simply copied as a link by tapping on the *forward* icon.

The teacher can post these links to a class website or on any visible place in the room. The links can also be transferred onto a QR code or a similar dissemination tool for ease of use for students. Images are constantly being uploaded to Street View, so it is advisable to return to the search each time the artwork is taught to select preferred views. Depending on the time

available, allowing students to search on their own or in pairs to find images can be fruitful for guided-inquiry discussions involving critical thinking skills. It takes more planning time to select specific images and create links to them than it does to allow students to search for the images and scroll through views, but more time is needed in class for students to search. Both have advantages and teachers know their students best, so the method of image selection and distribution should be treated with flexibility.

Not all required artworks are available on Street View at this time, but based on the current rate of expansion, in a short time they will likely all be included. For artworks not available because of lack of access due to photographic restrictions or because the work is not on view, the next step is to search on the Google Art & Culture website or application. At the time this paper is written there are no Cardboard compatible images available on the Arts & Culture site, but there is a treasure trove of 360-degree and close-up images for many artworks, including Van Gogh's *Starry Night*. 360 and close-up views are virtual visits, so they are not as immersive as a three-dimensional image, but it can be argued that it is better to see the *Mona Lisa* virtually up close than to experience the crowds, smartphones, and selfie sticks that await the visitor to the physical gallery space at the Louvre Museum in Paris. Ultimately, each of the AP-required 250 works of art demands its own method of inspection, and Street View 3-D images are options beyond the projected slide or textbook image inset. There is a resource, Smarthistory, that already serves as a "virtual bookshelf" for resources for the entire set of the College Board's required 250 images, and it can also accommodate links to VR images.

Smarthistory/Khan Academy as a Virtual Bookshelf for AP Art History

Smarthistory is a non-profit "collaboration of more than two-hundred art historians, archaeologists, curators, and other specialists who want to make the highest-quality art history

learning content freely available to a global audience” (“About Smarthistory”). Because Smarthistory has created content for each of the AP-required 250 artworks, the site has been used by teachers as a substitute for a physical textbook (Harris 5 Oct.; Mumma). As AP Art History teachers are already aware of Smarthistory, it is a logical choice to use the website as the repository for links to selected Street View images that can serve as a visual library for images that stand out as exemplars and that can serve as a jumping-off point for lessons before students are encouraged to “wander” through Street View searches for the required objects.

Currently, there is at least one static image on Smarthistory for each of the AP 250 required works, along with a video and/or essay and links to other relevant resources for each work. Art historian Beth Harris—one of the two founders of Smarthistory.org—is excited to extend the webpage to offer links to Street View Cardboard compatible images (Harris, via Skype). As of October 2017, a plan is in the works for this project to facilitate the addition of selected Street View three-dimensional image links to the Smarthistory/Khan Academy website’s AP Art History webpage. Harris and co-founder Steven Zucker have worked closely with the Google Cultural Institute and have already incorporated into Smarthistory some Google Maps 360-degree images of architectural sites and they are enthusiastic about the potential of Cardboard and Street View in the AP Art History classroom (Harris 17 Nov.). It is likely that three-dimensional VR images will begin to be linked by spring 2018, with more images being added until nearly all 250 AP-required works have links to Street View images. Works that have photography/copyright restrictions will be more challenging to add to the list, but these will likely be few in number. The popularity of Smarthistory—the site had over fifteen million visitors in 2015 and a Google search with the term *art history* places the Khan Academy link to Smarthistory content third behind Sotheby’s and the Wikipedia entry for *Art History* (“About

Smarthistory”)—makes it the ideal virtual bookshelf for AP Art History resources, including Street View links. The current working plan to add VR links to Smarthistory is addressed further in the conclusion section.

What the Cardboard Classroom in Action Looks Like



Figure 5. AP Art History students using Google Cardboard to view the *Great Pyramids at Giza*, Taken 5 Oct. 2017 by C. Payne with parental permission.

In the Cardboard classroom, students ask many questions, sometimes in a barrage, that provide evidence that they are examining their current understanding as they try to add the new content to their existing knowledge of art historical objects and events. There is much pointing while students look into their viewers (Figure 5). Students will naturally work collaboratively as they pass the viewer back and forth and ask each other questions. Teens are used to exchanging their smartphones during conversations, so this is natural for them. As students delve deeper into understanding an art work with Cardboard, the room can become very quiet as students quietly discuss the work on view with their collaborative partners. It is not uncommon for students to open their physical textbooks to search for answers. This does not necessarily mean they are

bored, but that they are either ready for more guiding questions, ready to be assessed for their understanding of the stated goals of the viewing session, or that they have wandered off virtually and are exploring the area near the target object. It is a good idea to watch the clock carefully, as time will pass quickly as it does when one is deeply engaged in an activity. Expect two-dimensional works to require less time than those in three-dimensions.

In order to keep the students' attention focused on the lesson elements without losing the excitement generated with VR images, guiding questions should be provided to them to ensure their curiosity is channeled towards deeper understanding of the desired learning goal. The College Board provides a list of twenty questions (Appendix C) that helps the teacher and students to facilitate critical analysis discussions. Without guiding questions to serve as guardrails, the art history lesson can easily become a classroom management lesson as students may stray from the lesson objective as they follow their curiosity in different directions.

Working with the Local Museum to Extend the VR Experience

Because a goal of this capstone project is to have students of AP Art History feel a lifelong sense of belonging in museums, it is now important to look away from the wonder of Cardboard and look to the physical museum. After all, Cardboard is magical, but the magic is that it makes one feel as if the students are in the museum. Peter Samis, the associate curator of interpretation at the San Francisco Museum of Modern Art ("Peter Samis"), writes of technology in his essay, "The Exploded Museum," that "In a technological world, the museum visit no longer begins when a person enters the building, nor need end when she or he leaves. The museum's physical space is but one site—albeit a privileged one—in the continuum of the visitor's imaginative universe" (3). Note his insertion of, "albeit a privileged one," into the

visitor's "continuum" of experience. It cannot be overstated that if the physical space of the museum is able to be reached, it should remain as a goal to eventually do so, even if it is met years after the student completes the AP course. It is easy to forget in today's technological world that sometimes one must look up and away from the ubiquitous digital screen. By working directly with the museum, the teacher can help the student look up from the that digital world and move through the door into the physical museum.

Contacting the Museum

Museum professionals are much like classroom teachers in that they have chosen a profession that allows them to share a passion for art (or history, or science, or anthropology...) with the local community. For the classroom teacher, the local community of students is brought through the classroom door for a set amount of time each school day. Unlike the teacher, the museum professional, oftentimes, must lure the community through the door and then entice them to stay for an hour or two. So when the teacher contacts the museum, it will most likely be a warmly received call or email.

Some museums have only a handful of staff members, while others extensive departments full of staff. No matter what the organizational structure of the museum you contact, the teacher should start by seeking out the education department or staff member first as the educators are already in the outreach business. It is sensible for the teacher to make initial contact merely to introduce of the goal of bringing the museum to the classroom and not to schedule a field trip, as the museum professional may have a busy schedule. The goal of the first contact should be to set up a time to meet in person to set up a collaborative plan between the teacher and museum professional to bring students through the museum door, virtually and

physically. Building an informal relationship with a loosely defined timeframe will allow for the flexibility in planning needed when the education staff member works with the curatorial and/or collection management staff to help the teacher select artwork from the museum's collection that is relevant to the artworks for the AP-required list of 250 works of art. It may be prudent for the teacher to lay the groundwork in the spring for the course that begins in the fall.

Working with Museum Staff to Choose Artworks

The AP Art History teacher may very well have all of the required artworks memorized, but keep in mind that most museum educators are not generalists, as many teachers of AP Art History are. This means that he or she will rely on the classroom teacher and museum curator and/or collections manager to fill in the gaps. Most museums have only a fraction of its collection on display at any given time, so it will take some sleuthing to find which works match up to those on the required list. So, a first step would be to provide the museum with the list with images both in printed form and digitally. Importantly, many museums have limited staff resources, so anything the teacher can do to make the art work search go quickly and smoothly for the museum will be helpful, from offering to search manually through object files—either digital or physical files—to setting a wide time frame goal for the search. The teacher should keep in mind at all times during the search process that the museum may be able to facilitate viewing sessions for the class to study works not on view, so detailed notes should be kept about potential works for private viewing.

There are a number of ways to approach the AP-required works list: by media, time period, culture, subject, function, and so forth. A good starting point is to first break up the required list in the order of artist, movement, culture, and time period. Look first for works by

the same artist found on both the AP-required list and in the museum's collection. If there are no matches, move onto a search of the collection for a work from the same artistic movement.

Continue through in this manner with culture and time period before moving to form, function, content, and context. If the educator can provide the teacher with access to digital images of the entire collection, even if it means sitting at a computer in the museum for a few hours, the effort may pay off. In the collection of the prototype museum, there are prints by Goya, Hokusai, Kara Walker, and Daumier (Figure 6) (Appendices A and D), artists studied on the AP-required list of art.



Figure 6. The CFAM Print Study Room with works by Kara Walker, Goya, Daumier, and Hokusai ready to be viewed by students, 16 Oct. 2017.

None of these are the same as the works by the same artist on the required list, but for students to know that the collection of the local museum has art by the same artists studied in AP

Art History, the door to the museum has been opened a crack. The point is, be creative with the connections made to the work at the museum. If the local museum is a house museum, focus on the architecture, context, and function as these will certainly align with architecture on the required list.

Do not try to decode the entire museum collection but look to start with a handful of objects with which to start. Over time, it is essential to have a relationship between the classroom teacher and museum staff so that more work may be added organically as new connections between the AP-required works and the museum's collection are noticed. Each visit might include additional selected equivalent art works.

Capturing the VR Image at the Museum

Once the most relevant objects have been selected, the image capture process can commence. In the course of working with the museum to select artworks to share with the class, it must be determined and noted if the works are on view or in storage. If on view, the decision will need to be made on whether to capture the images during regular visitor hours or to come in when the galleries are free of visitors. Most museums are closed to the public at least one day each week, and this may be a good time to schedule the image capture. For works in storage, the collections department or equivalent will need to move the works into a study room or other suitable space to be photographed.

In the case of CFAM, which has a study room, a visitor-free day was selected, and a group of five works selected for the study room. The idea is to take a three-dimensional image of the study room where students will be brought in person for the image capture so that the students feel a sense of belonging as soon as they enter the physical space. Present for the image

capture at CFAM were the Education Outreach Fellow, the Collections Manager, and the teacher.

There are two options at this time to take three-dimensional images: Google Street View and Google Cardboard Camera. The advantage Street View has over the Cardboard Camera is that Street View allows the image to be fully immersive in all directions, while the Cardboard Camera capture a cylinder of space with no ability for the user to look directly up or down, but it makes up for the missing views with the ability to record thirty seconds of audio with the image. Cardboard Camera image capture takes less time to complete—thirty seconds versus about two minutes—than one taken with the Street View camera, so if time is a barrier, then Cardboard may be the way to go (see Appendix E for examples of images taken with each camera).

Image Capture Best Practices

Both Google Street View and Google Cardboard cameras—both of these are functions of the applications that use the smartphone’s camera—are intuitive and provide constant prompts to the user to move the smartphone along either a line (for the Cardboard camera) or by following and framing an orange dot (for the Street View camera). It takes some practice to capture seamless images for Street View because the application stitches together multiple images into one cohesive image, while Cardboard works like the iPhone panoramic camera feature with less seams for the application to cover.

Note: Before going to the museum, practice using these camera applications in the classroom or at home to capture images and try them with the Cardboard Viewer. For Street View, the images will remain private unless you choose to make it public by uploading it to Google. With Cardboard, the image scan be shared but not uploaded publicly at this time. Step-

by-step instructions for the Google Street View camera and the Google Cardboard camera are attached as an appendix (F).

Legal and Privacy Concerns

The ubiquitous smartphone allows students and teachers to capture images so they may share their museum visits with others. However, teachers and students need to be made explicitly aware of copyright and privacy concerns when they capture images in museums or at architectural sites. The museum or other entity that owns the copyright to the work has the right to prohibit or restrict the use of the image of the work, but if it is permitted to photograph the image and there is no statement of restriction of use provided by the museum, the image captured may be used by the photographer for educational purposes, and possibly used for other purposes as well, but only educational use is of concern for this project. If the image is made available to the public on Google Street View—by the user selecting *publish to Google maps* after capturing an image instead of keeping the image private, Google will then have the right to publish the image or to deny the image (“Maps Photo and Video Policy”).

At the site of the work of art or architecture, the photographer should ask a staff member upon entering the site if photography in general is allowed. If it is permitted, the photographer will need to check to make sure that any art work captured, even if in the background, is allowable. Museums usually make clear with signage, either on the wall or on a stand, the art works for which photography is not permitted. This is especially important for capturing 360 degree or three-dimensional images captured in galleries with numerous works.

As far as privacy is concerned, it may not be possible to always have a space clear of other visitors. If someone is in a public space such as a museum, it is acceptable to capture them in the image as the expectation of privacy in a public space is limited. Children should be

avoided, if possible, out of an abundance of caution as many parents are not comfortable with their children being photographed without permission. Taking a Google Street View image is a noticeable act, so be prepared to explain to others, especially to the gallery guard, the activity. If visiting the site with the sole intention of capturing 360-degree or Street View images, it is a good idea to have a Cardboard viewer on hand to demonstrate how the image will be used. It is not legally necessary, but it is a great time to share the technology to encourage its spread to increase access to the art.

The Physical Museum Visit

The physical connection between the student and the museum is now ready to be made, and the true test of the VR bridge can be evaluated. Working with the same museum staff member who has served as the main point of contact until now, arrange a date for either a class field trip or a drop-in visit. A drop-in visit happens when works to be studied are left in a study space or in a gallery on display for a determined amount of time, and students may drop in when they are able to do so after school or on a weekend. The drop-in is not the most desirable visit, as the classroom teacher might not be present, but it at least allows for the students to visit the physical museum, and it works around the barriers to field trips mentioned earlier.

Evidence of the difference between experiencing art in a static two-dimensional image and in person can be seen when the visitor approaches the physical object for the first time. While on a pre-AP exam study trip with a small group of students to the Smithsonian National Museum of African Art in Washington, D.C., a student from the prototype school noticed a ceremonial mask that had been studied in class earlier in the school year and as soon as she noticed it she squealed with delight as she rushed over to it before exclaiming that is was so

much more relatable in person. She then proceeded to give an impromptu, and accurate, lesson about the mask to the security guard who was watching over the gallery (Figures 6 and 7). The guard stated something to the effect that she had no idea what the object was before, but that after the student lesson, she would be reading more of the labels. After the lesson, the student gathered up other members of the class to bring them to the mask and the scene of excitement was repeated. The object achieved a sort of celebrity status that can be called the “rock star effect.”



Figure 7. AP Art History student visiting a *Pwo mask*, object #173 from the AP-Required art works, at the Smithsonian National Museum of African Art in Washington, D.C., with parental permission, 17 Apr 2016.



Figure 8. *Pwo mask* from the AP Art History Course and Exam Description, (College Board, 2015), <https://apcentral.collegeboard.org/pdf/ap-art-history-course-and-exam-description.pdf?course=ap-art-history>.

Without some pre-visit guidance from the teacher to the students, it is unlikely that the “rock star effect” will happen when visiting an artwork that is not the exact work that is on the AP-required list. This is where the pre-visit image capture and share comes in. As the teacher shares the local museum images for the students to view with the Cardboard viewer (or in 360

degrees for those with difficulty using three-dimensional images) a specific lesson can be used to link the works to those on the AP-required list. It may be helpful to intersperse images of the required works through the lesson as comparison tools. Besides creating a sense of familiarity of the museum space before the visit, the preview lesson may indeed set up the conditions for the “rock star effect” to happen during the physical visit. For the prototype visit, one of the images the students will be shown before the visit is a Cardboard Camera immersive view of a Roman Sarcophagus equivalent to the AP-required Ludovisi Battle Sarcophagus (see Figures 9 and 10).



Figure 9. *Ludovisi Battle Sarcophagus*, from the AP Art History Course and Exam Description, (College Board, 2015), <https://apcentral.collegeboard.org/pdf/ap-art-history-course-and-exam-description.pdf?course=ap-art-history>.



Figure 9. Cardboard Camera image of *Roman Sarcophagus*, first century C.E., Cornell Fine Arts Museum, Winter Park, FL, 17 Oct. 2017.

Following Up with the Museum Staff

It is important to follow up with the museum to ask about the perceived level of student engagement of the prototype students versus the typical student visitor. With this information, both classroom teacher and museum educator can make refinements to the prototype for improved results. Did students return on their own to the museum at some point after the initial

visit? Perhaps coupons or some other indicator can be given to the prototype students to be turned into the museum as a method of tracking return visits. AP Art History student visitor surveys can be given by the museum for feedback on the visitor's experience, the likelihood of a return visit, and the impact of the pre-visit immersive image on the visit. The idea of the survey will be addressed in the conclusion.

It is hoped that at this point the teacher and museum contact will have established the beginning of what will become a long-term collaboration. It is a good idea for the teacher and museum contact to stay in touch periodically to share ideas and feedback about how to improve the student visit experience. The teacher can post information in the classroom about upcoming events at the museum and the museum should provide a safe, comfortable environment for students who visit on their own. Most importantly, by following-up with the museum, the teacher will come to see the museum as a long-term resource, and vice versa.

Case Studies/Observations of Participants

The initial feedback about the project prototype experience is positive. Seventy-seven students in the prototype group at Winter Park High School are using Cardboard on a regular basis, and all have come to accept the format as part of the classroom routine. Many students ask to borrow viewers to take home to share with their parents, with most returning to class to report that his or her parent ordered one or more viewers online after the student demonstrated the technology. Students have no difficulty using their smartphones and Cardboard viewers to study images in the classroom and they have readily accepted VR as a digital surrogate by allowing the teacher to “make it happen” in the classroom (Anderson 9). The observed behaviors of several

prototype users are worth sharing—those of two students, a group of AP art history teachers, and a museum outreach fellow.

Student One

The first student discussed, referred to as Student One, initially used Cardboard to view a home in Pompeii, Italy, during a lesson during the 2016-2017 school year on the architecture elements of the Colosseum in Rome. A few days before the lesson on the Colosseum, the class had studied the domus, a typical home for wealthy residents of ancient Roman cities, that involved an examination of a floorplan and the identification of the impluvium—a shallow basin in the floor designed to catch rain, the atrium, and the courtyard with its surrounding rooms. Although the class had been asked to visit a specific image of the Colosseum using the newly acquired class set of Cardboard viewers, student one instead wandered away, virtually, to Pompeii where she searched for the domus studied earlier in the week. She loudly exclaimed to the class that she had found the domus and went on to show her collaborative work group the VR image (the class was working in trios that day). Knowing that the domus studied in class was not available on Street View at the time, the teacher asked probing questions of the student—“How do you know this is the same domus?” “Can you use the location of the columns and impluvium as evidence this is the same domus?”—as the student turned around looking for the evidence. Student One referred to the floorplan studied earlier and came to the conclusion after looking quickly back and forth from the VR image to the floorplan that this was not the same domus studied earlier. From that day forward, student one was much more engaged in daily lessons in class and she volunteered to help after school to search for Street View images to use in class lessons. She also stopped skipping class, a well-developed habit at that point, and her

performance improved from just barely doing enough to get by to leading the class in discussions. Cardboard cannot necessarily be credited with turning around a student's behavior and performance, but the transformation for student one was directly correlated to the day Cardboard allowed her to more fully engage in the lesson. There are other students who have had similar reactions, but student one was the trailblazer who dared to defy the teacher's instruction to visit just the Colosseum. For the record, Student One passed the AP exam.

Student Two

The second student discussed, referred to as Student Two, is a current student of the 2017-2018 school year and, as such, she has viewed images on Cardboard from the start of the year. Unlike Student One, this student has been a conscientious member of class from the start of the year, participating often in class discussions and stopping by after school to ask questions about works studied that day. During one of these after-school chats, the teacher showed her a Cardboard Camera image of a gallery in the current exhibition at CFAM, explaining that one artwork on display was created by an artist the class had just studied in class and another, a Roman sarcophagus, is similar to one studied in class (see Appendix E). The student asked where CFAM was located and the teacher supplied directions and the Museum hours without any discussion or expectation of an anticipated visit. The next day, Student Two reported to the teacher that she went directly to CFAM after school and that she had also signed up to become a teen docent for the Museum. Two weeks later the student arrived to class with notes in hand from a lecture at Rollins College, the home of CFAM, on the content of the relief sculpture on the front of the first century Roman sarcophagus in the collection of CFAM. She excitedly discussed the similarities and differences between the work studied in class and the work on

view at CFAM. Three weeks after the lecture, student two took two friends to CFAM after school to introduce them to the Museum. Much like Student One, Student Two already had an intrinsic intellectual curiosity, but she lacked focus. The fact that student two is now a volunteer docent, that she attended an evening lecture on a two-thousand-year-old coffin, and that she has taken other students to the Museum, without being prompted by the teacher on either count, supports the idea that the museum can be a “third space” once the door to the museum is open. It does seem in this case that the VR image opened that door.

The Museum Professional

As for the initial reaction of a museum professional on the effectiveness of VR images viewed with Cardboard, the outreach fellow for CFAM, Elizabeth Coulter, reports that after the meeting with the researcher to capture images for the prototype, she captured a Cardboard Camera image—with no audio recording—and shared it the next morning at a previously scheduled meeting with a local Rotary club to introduce the newly-installed exhibition using just one Cardboard viewer she was provided by the researcher. On using the Cardboard Camera to bring the museum to the potential visitor, Coulter states:

The Cardboard Camera enhanced the Cornell Fine Arts Museum outreach at local high schools, libraries, and Rotary Clubs in the Orlando area. Viewers were dazzled by the technology and the way it instantaneously transported them to the Museum. It especially peaked (sic) the interest of one Rotary Club board member, who after the presentation asked to look through the Cardboard Camera a second time, and he hopes to organize a group tour as one of the club’s annual outings. (“Re: Cardboard Camera”)

Although designed for high school students, the prototype segment that uses VR images of the museum collection seems promising for teens and adults alike.

AP Art History Teachers

Lastly, six AP art history teachers participated in a presentation of the prototype to use in their class rooms. Although two of them had some limited experience with Cardboard at a meeting held during the previous school year before the prototype was developed, the other four had never heard Cardboard or Street View. After some glitches with slow internet service at the host school that day, the teachers were enthralled with the possibilities of Cardboard as a component of their visual libraries. For over an hour, the room was mostly silent as six adults stood with a viewer held over their eyes while their mouths were agape with wonder. Standing inside *Chartres Cathedral* proved to be a favorite spot. By the end of the session, several of the teachers had ordered Cardboard viewers online for their person use and ideas to receive grant money were being shared. Like the experiences of the students and the outreach fellow, the teachers' experiences were those of immediate engagement.

Conclusion

The process of developing the prototype template—selecting images on Street View; introducing students, colleagues, and museum professionals to Cardboard; capturing and sharing image of the local museum with students; and incorporating the Cardboard images into daily lessons—has proven to be surprising. Gail Anderson succinctly states in *Reinventing the Museum* that, “Public engagement is on site, off site, and online and is defined and created where

people decide to make it happen” (9). The prototype has been received enthusiastically by every teacher, student, and museum professional who has experienced it, demonstrating that Anderson’s observation that engagement can occur wherever the public decides it can happen holds true. There has been a sort of mass suspension-of-belief much like that of an audience in an engrossing film, only the engagement is happening in classrooms instead of a theater.

Because the goal of this capstone project is only to create the prototype, not to measure its efficacy, due to the timing of the school year and the AP Art History exam given only in May, the conclusion focuses on the lessons learned during the development of the prototype, the observations made of participants during the rollout of the prototype, and future steps to improve, share, and measure the effectiveness of the prototype.

The idea for this project came about organically, and it continued in the same way as work and research progressed. While many projects are planned out meticulously and followed scientifically, this project was at the mercy of a rapidly evolving technology and term-to-term infusions of graduate coursework that informed its course. Instead of working with fixed variables, the target—to use Google VR technology—in the classroom was constantly moving. Fortunately, with a mixture of diligence and serendipity, much observational data has been collected. This observational data provides a wealth of practical knowledge that can serve as a launch pad for future improvements and research opportunities.

Lessons Learned

As with any project in development, there were plenty of surprises. Some were happy accidents—when students, unprompted, share class lessons with parents—while others were frustrating dead ends—like disrupted Wi-Fi connections in class while using Cardboard. The

most significant lesson by far is that the teacher needs to let the students' enthusiasm and curiosity lead the class lesson. While it is important to provide the guiding questions mentioned earlier, it is perhaps more important to give up the desire to control every minute of instructional time to let students have autonomy, and thereby ownership, over their learning. There is no script that can be followed when a student decides to wander off in VR, so the teacher needs to be prepared to encourage the student from the sidelines with guiding questions to lead the journey to the lesson objective. The prototype classroom experiences ultimately led to the practice of setting clear objectives and a time limit for each art work viewed. A typical learning objective would be to understand how to identify, describe, and explain the function of the nave or aisle of a basilica plan. After the time goal is reached, it was found that the students need to record in a notebook the new knowledge with a labeled sketch to commit the new information to memory.

Another meaningful lesson learned is the need to have a flexible attitude towards Google applications, or any technology of this sort, many which seem to be in perpetual Beta mode. After finding a useful image on Street View or an interesting page on Arts & Culture, it is not unusual—although not common—to return to view it again only to find it moved or even removed altogether. In each instance a suitable replacement was found, but searching for an image that has been removed is time-consuming and frustrating. The lesson learned resulted in a change in the teacher's behavior so that links to interesting images and pages are now copied and saved immediately and referred to when needed.

On a lesson learned about the technology itself, there are some participants who feel unsettled—nauseous or dizzy—when viewing images with Cardboard. For these participants, 360 images can be viewed and manipulated on Street View in a two-dimensional format by simply not tapping the Cardboard icon on the image and viewing it without Cardboard. It was

determined through trial-and-error that five minutes of continual viewing is the threshold for most users to view a Cardboard image before negative effects are felt, but that if the user shifts from the image to a notebook or static image then viewing can be sustained for about thirty minutes. It is also reported that between five and seven percent of the population does not see in full binocular vision (Sacks 66). These participants can also use Street View without tapping the Cardboard icon.

The most important lesson learned is that Google Cardboard, in the classroom specifically, successfully moves students from engagement to deeper learning. All of the people studied during the course of this capstone project became excited when introduced to Google Cardboard. Teenagers and adults alike—no participants under the age of fifteen were observed for this project—all exhibited similar behavior when viewing VR images with Cardboard for the first time. Gasps of disbelief, followed by periods of calm, and then with questions about the image, were evidence of the immersive quality of the technology. There is also evidence that even though the experience is immersive and intimate for the user, it calls out for a person to be nearby to share the experience in order to process the experience fully. This other person can be the teacher or a peer. Moving forward, the prototype will suggest that students work in groups to facilitate processing and that the teacher circulates constantly throughout the classroom during the lesson to serve as a guide on the sidelines.

In the classroom, after the initial shock of the immersive quality passes, the awe factor moves from the technology to the art studied. Paul Wilhite, Ed.D., a Winter Park High School administrator and long-time social studies teacher, observed a prototype class several times as they used Cardboard in the class room and he wrote on the observation that, “the use of the view finders, I think, has made a huge difference in the students’ understanding of the material

covered. The use of the view finder to look at different structures just brings it all to life for the students (Wilhite “Observation Results).” On his specific comparison of the use of Google Cardboard versus the traditional slide image, he later goes on to say:

When I have visited her classes this year I have noticed that the “novelty” has worn off (the novelty of using Cardboard) yet the students’ interest in the images and the depth of their engagement has increased tremendously. They are now pointing details out in the images that are of higher order rigor and requires a level of academic conversations that I don’t see in other courses. (Wilhite 22 Nov.)

In support of the administrator’s comments about the students’ acceptance of the integration of Cardboard into the classroom, several students have mentioned to one another that other methods of learning (that is, methods other than VR) are now boring and less effective and they wish that every class incorporated VR.

Future Steps

Building on the foundation set in the prototype roll-out, the template will be modified with adjustments driven by the lessons learned. Of equal importance to these immediate adjustments is the need to plan to keep up with the development of VR technology as it evolves. Because it is challenging, if not impossible, to plan for the unknown it is essential that all future steps are treated as preliminary and flexible. The future steps are very simply to improve, to share, and to measure the efficacy of the prototype.

Improve the Prototype

Smartphones have become an extension of the individual and as such are with each of us constantly. With the phone comes camera technology that is improving rapidly, and along with

these technological enhancements comes the ability to capture more detailed and rich images. As word spreads about the ease of use for the Cardboard camera and Street View camera applications, individuals may capture and share images from around the world in even greater numbers than today.

In addition, every day that passes brings additional images to Google Street View and to the Google Arts & Culture website. Therefore, making a visit to both websites during the planning process for each lesson module essential to improved images that will enhance the teacher's visual library. Over time, the individual instructor can also add to his or her visual VR library by capturing images in person and linking the images to the personal library database. By choosing to make the image public on Street View the image will also be available to other instructors.

Of great importance to the future of sharing of the template is the need to make the immersive VR experience accessible to those with visual disabilities. The company Aria provides accessibility to the vision-impaired by interpreting verbally, in real time, views from a small camera—Google Glass is one option—worn by the client as he or she moves through a physical space. Most Cardboard viewers are able to be used with eyeglasses in place, so the service provided by Aria would be possible (“About” Aria).

Share the Prototype

Starting on the local level and then moving outward, this template will be shared within the school, within the local school district and local arts community, and finally on the national level. In addition to its function as a resource for the AP Art History student, Google VR applications can be used for other courses offered on campus and throughout the school district. History courses can utilize the archives of several of the existing Google Arts & Culture partners.

Performing arts courses might visit the Royal Shakespeare Theater or the Metropolitan Opera. Language courses might travel abroad to explore with Street View. In-school and school district-level professional development learning communities can serve as conduits for local sharing of the template, which can be housed on a WordPress website, or similar. On the national and global outreach front, the template will be made available on Smarthistory.org and on the College Board's *AP Central* webpage for AP Art History instructors. As mentioned earlier, Beth Harris, of Smarthistory, is working on a plan to incorporate this prototype into the AP Art History section on the Khan Academy website. Continued communications with Harris suggest the targeted goal of posting the prototype information by early 2018 is on target (Harris 17 Nov. and 3 Dec.). If success is found within the art history classroom, the template should spread organically to other subject areas.

Moving outward from sharing with high school teachers, the prototype can be shared beyond the prototype museum to other local museums through personal visits from the researcher. To reach a large number of museum educators, the template can be made available through meetings and publications facilitated by American Alliance of Museums and the College Art Association by writing articles and/or making presentations at annual conferences that each organization hosts. Regional museum associations should also be considered as sharing opportunities for their accessibility.

In addition to using the established methods of sharing the template, there is an innovative idea to create opportunities for teachers and museums to work collaboratively to identify connection points between the AP-required works and museum collections. Museums need to complete collection inventories on a regular basis, and most teachers have months-long summer vacations. Two grant programs exist—the Museums for America grant through the

Institute of Museum and Library Services (also known as the IMLS) (“Museums for America”), and the Digital Humanities Advancement grant through a collaboration between the IMLS and the National Endowment for the Humanities (“NEH Grants”)—that could fund paid summer internships for AP Art History teachers to assist museums with VR image digitization of collection objects and with inventory activities. The application cycle is too far along to apply for the NEH grant for 2018, but if it is offered for 2019 and beyond, it can be considered by a museum as a way to fund the internship. The image capture component is straightforward and practical while inventory assistance would allow the experienced AP Art History, the expert on the AP-required artworks, to identify which collection objects connect to the required works. Albeit a novel approach to outreach, if the teacher feels a sense of belonging in the museum as a contributor, the teacher may very well hold open the door to the museum for his or her students.

Measure the Prototype Efficacy

To date, there has been little scholarly research done on the use of Google Cardboard in the classroom. One study used a lesson with three-dimensional images viewed with an HMD as compared to a control group that had only lecture-based instruction with two-dimensional images, and the conclusion was definitive in demonstrating that learning with VR three-dimensional images was deeper and longer-lasting than learning in a lecture format (Webster). The study, *Declarative Knowledge Acquisition in Immersive Virtual Learning Environments*, was conducted with adult members of the military who were learning about metal corrosion control, so this is not exactly similar to instruction in the visual arts where we might need to compare a static two-dimensional image to a three-dimensional immersive image. Still, it is encouraging that some research is occurring.

It will be useful to study the effectiveness of the use of Google Cardboard images in the AP Art History classroom in an educational research setting. The simplest start would be with user surveys of teachers and students. These can be studied and then added to annual AP exam pass rate and average passing score data. One setback to this research plan is that the AP Art History exam is given just once each year to an average of 23,000 students. The College Board reports test data—student demographics and detailed score reports—so this type of research can be tracked and measured each year as new data are added.

Added to the formal educational study is the need for museums to do long-term visitor studies of the students who work through the steps of the prototype. Does outreach with VR lead to a lifelong visitor? Does the sense of belonging extend from the local museum to global museums? Is the prototype visitor more likely to add museum visits to future trips taken for business or pleasure? The opportunity for visitor studies is rich.

No matter what research into VR technology yields, the fundamental question still remains: will the current iteration of stereoscopic technology endure or will it suffer the same fate as the stereoscope of the nineteenth century? The English writer Charles Dickens, commenting on those nineteenth century stereoscopes, said:

It is a delightful characteristic of these times, that new and cheap means are continuously being devised, for conveying the results of actual experience to those who are unable to obtain such experiences for themselves; and to bring them within the reach of the people—emphatically of the people; for it is they at large who are addressed in these endeavours, and not exclusive audiences. ...Some of the best results of actual travel are suggested by such means to those whose lot it is to stay at home. New worlds open out to them, beyond their little worlds, and widen their range of reflection, information,

sympathy and interest. The more man knows of man, the better for the common brotherhood among us all. (qtd. in Johnson)

Indeed, stereoscopic technology today aims to replicate precisely the access to the “new worlds” to which Dickens refers, and that access is for all people equally. Perhaps Cardboard will be only a stepping stone to future VR technology—think holograms—but initial feedback on the prototype suggests that stereoscopic technology in the form of Google Cardboard and Street View does work to make lessons more engaging and therefore more successful in the AP Art History classroom today.

Appendix A

Required Works for the AP Art History. Source: The College Board (*AP Art History: Course Exam and Description*).

1. Apollo 11 stones. Namibia. c. 25,500–25,300 B.C.E. Charcoal on stone.
2. Great Hall of the Bulls. Lascaux, France. Paleolithic Europe. 15,000–13,000 B.C.E. Rock painting.
3. Camelid sacrum in the shape of a canine. Tequixquiatic, central Mexico. 14,000–7000 B.C.E. Bone.
4. Running horned woman. Tassili n'Ajjer, Algeria. 6000–4000 B.C.E. Pigment on rock.
5. Beaker with ibex motifs. Susa, Iran. 4200–3500 B.C.E. Painted terra cotta.
6. Anthropomorphic stele. Arabian Peninsula. Fourth millennium B.C.E. Sandstone.
7. Jade *cong*. Liangzhu, China. 3300–2200 B.C.E. Carved jade.
8. Stonehenge. Wiltshire, UK. Neolithic Europe. c. 2500–1600 B.C.E. Sandstone.
9. The Ambum Stone. Ambum Valley, Enga Province, Papua New Guinea. c. 1500 B.C.E. Greywacke.
10. Tlatilco female figurine. Central Mexico, site of Tlatilco. 1200–900 B.C.E. Ceramic.
11. Terra cotta fragment. Lapita. Solomon Islands, Reef Islands. 1000 B.C.E. Terra cotta (incised).
12. White Temple and its ziggurat. Uruk (modern Warka, Iraq). Sumerian. c. 3500–3000 B.C.E. Mud brick.
13. Palette of King Narmer. Predynastic Egypt. c. 3000–2920 B.C.E. Greywacke.
14. Statues of votive figures, from the Square Temple at Eshnunna (modern Tell Asmar, Iraq). Sumerian. c. 2700 B.C.E. Gypsum inlaid with shell and black limestone.
15. Seated scribe. Saqqara, Egypt. Old Kingdom, Fourth Dynasty. c. 2620–2500 B.C.E. Painted limestone.
16. Standard of Ur from the Royal Tombs at Ur (modern Tell el-Muqayyar, Iraq). Sumerian. c. 2600–2400 B.C.E. Wood inlaid with shell, lapis lazuli, and red limestone.
17. Great Pyramids (Menkaura, Khafre, Khufu) and Great Sphinx. Giza, Egypt. Old Kingdom, Fourth Dynasty. c. 2550–2490 B.C.E. Cut limestone.
18. King Menkaura and queen. Old Kingdom, Fourth Dynasty. c. 2490–2472 B.C.E. Greywacke.
19. The Code of Hammurabi. Babylon (modern Iraq). Susian. c. 1792–1750 B.C.E. Basalt.
20. Temple of Amun-Re and Hypostyle Hall. Karnak, near Luxor, Egypt. New Kingdom, 18th and 19th Dynasties. Temple: c. 1550 B.C.E.; hall: c. 1250 B.C.E. Cut sandstone and mud brick.
21. Mortuary temple of Hatshepsut. Near Luxor, Egypt. New Kingdom, 18th Dynasty. c. 1473–1458 B.C.E. Sandstone, partially carved into a rock cliff, and red granite.
22. Akhenaton, Nefertiti, and three daughters. New Kingdom (Amarna), 18th Dynasty. c. 1353–1335 B.C.E. Limestone.
23. Tutankhamun's tomb, innermost coffin. New Kingdom, 18th Dynasty. c. 1323 B.C.E. Gold with inlay of enamel and semiprecious stones.
24. Last judgment of Hu-Nefer, from his tomb (page from the *Book of the Dead*). New Kingdom, 19th Dynasty. c. 1275 B.C.E. Painted papyrus scroll.
25. Lamassu from the citadel of Sargon II, Dur Sharrukin (modern Khorsabad, Iraq). Neo-Assyrian. c. 720–705 B.C.E. Alabaster.
26. Athenian agora. Archaic through Hellenistic Greek. 600 B.C.E.–150 C.E. Plan.

27. Anavysos Kouros. Archaic Greek. c. 530 B.C.E. Marble with remnants of paint.
28. Peplon Kore from the Acropolis. Archaic Greek. c. 530 B.C.E. Marble, painted details.
29. *Sarcophagus of the Spouses*. Etruscan. c. 520 B.C.E. Terra cotta.
30. Audience Hall (apadana) of Darius and Xerxes. Persepolis, Iran. Persian. c. 520–465 B.C.E. Limestone.
31. Temple of Minerva (Veii, near Rome, Italy) and sculpture of Apollo. Master sculptor Vulca. c. 510–500 B.C.E. Original temple of wood, mud brick, or tufa (volcanic rock); terra cotta sculpture.
32. Tomb of the Triclinium. Tarquinia, Italy. Etruscan. c. 480–470 B.C.E. Tufa and fresco.
33. Niobides Krater. Anonymous vase painter of Classical Greece known as the Niobid Painter. c. 460–450 B.C.E. Clay, red-figure technique (white highlights).
34. *Doryphoros (Spear Bearer)*. Polykleitos. Original 450–440 B.C.E. Roman copy (marble) of Greek original (bronze).
35. Acropolis. Athens, Greece. Iktinos and Kallikrates. c. 447–410 B.C.E. Marble.
36. Grave stele of Hegeso. Attributed to Kallimachos. c. 410 B.C.E. Marble and paint.
37. *Winged Victory of Samothrace*. Hellenistic Greek. c. 190 B.C.E. Marble.
38. Great Altar of Zeus and Athena at Pergamon. Asia Minor (present-day Turkey). Hellenistic Greek. c. 175 B.C.E. Marble (architecture and sculpture).
39. House of the Vettii. Pompeii, Italy. Imperial Roman. c. second century B.C.E.; rebuilt c. 62–79 C.E. Cut stone and fresco.
40. *Alexander Mosaic* from the House of Faun, Pompeii. Republican Roman. c. 100 B.C.E. Mosaic.
41. Seated boxer. Hellenistic Greek. c. 100 B.C.E. Bronze.
42. Head of a Roman patrician. Republican Roman. c. 75–50 B.C.E. Marble.
43. Augustus of Prima Porta. Imperial Roman. Early first century C.E. Marble.
44. Colosseum (Flavian Amphitheater). Rome, Italy. Imperial Roman. 70–80 C.E. Stone and concrete.
45. Forum of Trajan. Rome, Italy. Apollodorus of Damascus. Forum and markets: 106–112 C.E.; column completed 113 C.E. Brick and concrete (architecture); marble (column).
46. Pantheon. Imperial Roman. 118–125 C.E. Concrete with stone facing.
47. Ludovisi Battle Sarcophagus. Late Imperial Roman. c. 250 C.E. Marble.
48. Catacomb of Priscilla. Rome, Italy. Late Antique Europe. c. 200–400 C.E. Excavated tufa and fresco.
49. Santa Sabina. Rome, Italy. Late Antique Europe. c. 422–432 C.E. Brick and stone, wooden roof.
50. Rebecca and Eliezer at the Well and Jacob Wrestling the Angel, from the *Vienna Genesis*. Early Byzantine Europe. Early sixth century C.E. Illuminated manuscript (tempera, gold, and silver on purple vellum).
51. San Vitale. Ravenna, Italy. Early Byzantine Europe. c. 526–547 C.E. Brick, marble, and stone veneer; mosaic.
52. Hagia Sophia. Constantinople (Istanbul). Anthemius of Tralles and Isidorus of Miletus. 532–537 C.E. Brick and ceramic elements with stone and mosaic veneer.
53. Merovingian looped fibulae. Early medieval Europe. Mid-sixth century C.E. Silver gilt worked in filigree, with inlays of garnets and other stones.
54. Virgin (Theotokos) and Child between Saints Theodore and George. Early Byzantine Europe. Sixth or early seventh century C.E. Encaustic on wood.
55. *Lindisfarne Gospels*: St. Matthew, cross-carpet page; St. Luke portrait page; St. Luke incipit page. Early medieval (Hiberno Saxon) Europe. c. 700 C.E. Illuminated manuscript (ink, pigments, and gold on vellum).

56. Great Mosque. Córdoba, Spain. Umayyad. c. 785–786 C.E. Stone masonry.
57. Pyxis of al-Mughira. Umayyad. c. 968 C.E. Ivory.
58. Church of Sainte-Foy. Conques, France. Romanesque Europe. Church: c. 1050–1130 C.E.; Reliquary of Saint Foy: ninth century C.E., with later additions. Stone (architecture); stone and paint (tympanum); gold, silver, gemstones, and enamel over wood (reliquary).
59. *Bayeux Tapestry*. Romanesque Europe (English or Norman). c. 1066–1080 C.E. Embroidery on linen.
60. Chartres Cathedral. Chartres, France. Gothic Europe. Original construction c. 1145–1155 C.E.; reconstructed c. 1194–1220 C.E. Limestone, stained glass.
61. Dedication Page with Blanche of Castile and King Louis IX of France, Scenes from the Apocalypse from *Bibles moralisées*. Gothic Europe. c. 1225–1245 C.E. Illuminated manuscript (ink, tempera, and gold leaf on vellum).
62. *Röttgen Pietà*. Late medieval Europe. c. 1300–1325 C.E. Painted wood.
63. Arena (Scrovegni) Chapel, including *Lamentation*. Padua, Italy. Unknown architect; Giotto di Bondone (artist). Chapel: c. 1303 C.E.; Fresco: c. 1305. Brick (architecture) and fresco.
64. Golden Haggadah (The Plagues of Egypt, Scenes of Liberation, and Preparation for Passover). Late medieval Spain. c. 1320 C.E. Illuminated manuscript (pigments and gold leaf on vellum).
65. Alhambra. Granada, Spain. Nasrid Dynasty. 1354–1391 C.E. Whitewashed adobe stucco, wood, tile, paint, and gilding.
66. Annunciation Triptych (Merode Altarpiece). Workshop of Robert Campin. 1427–1432 C.E. Oil on wood.
67. Pazzi Chapel. Basilica di Santa Croce. Florence, Italy. Filippo Brunelleschi (architect). c. 1429–1461 C.E. Masonry.
68. The Arnolfini Portrait. Jan van Eyck. c. 1434 C.E. Oil on wood.
69. *David*. Donatello. c. 1440–1460 C.E. Bronze.
70. Palazzo Rucellai. Florence, Italy. Leon Battista Alberti (architect). c. 1450 C.E. Stone, masonry.
71. *Madonna and Child with Two Angels*. Fra Filippo Lippi. c. 1465 C.E. Tempera on wood.
72. *Birth of Venus*. Sandro Botticelli. c. 1484–1486 C.E. Tempera on canvas.
73. *Last Supper*. Leonardo da Vinci. c. 1494–1498 C.E. Oil and tempera.
74. *Adam and Eve*. Albrecht Dürer. 1504 C.E. Engraving.
75. Sistine Chapel ceiling and altar wall frescoes. Vatican City, Italy. Michelangelo. Ceiling frescoes: c. 1508–1512 C.E.; altar frescoes: c. 1536–1541 C.E. Fresco.
76. *School of Athens*. Raphael. 1509–1511 C.E. Fresco.
77. Isenheim altarpiece. Matthias Grünewald. c. 1512–1516 C.E. Oil on wood.
78. *Entombment of Christ*. Jacopo da Pontormo. 1525–1528 C.E. Oil on wood.
79. *Allegory of Law and Grace*. Lucas Cranach the Elder. c. 1530 C.E. Woodcut and letterpress.
80. *Venus of Urbino*. Titian. c. 1538 C.E. Oil on canvas.
81. Frontispiece of the Codex Mendoza. Viceroyalty of New Spain. c. 1541–1542 C.E. Ink and color on paper.
82. Il Gesù, including *Triumph of the Name of Jesus* ceiling fresco. Rome, Italy. Giacomo da Vignola, plan (architect); Giacomo della Porta, facade (architect); Giovanni Battista Gaulli, ceiling fresco (artist). Church: 16th century C.E.; facade: 1568–1584 C.E.; fresco and stucco figures: 1676–1679 C.E. Brick, marble, fresco, and stucco.
83. *Hunters in the Snow*. Pieter Bruegel the Elder. 1565 C.E. Oil on wood.
84. Mosque of Selim II. Edirne, Turkey. Sinan (architect). 1568–1575 C.E. Brick and stone.
85. *Calling of Saint Matthew*. Caravaggio. c. 1597–1601 C.E. Oil on canvas.

86. *Henri IV Receives the Portrait of Marie de' Medici*, from the Marie de' Medici Cycle. Peter Paul Rubens. 1621–1625 C.E. Oil on canvas.
87. *Self-Portrait with Saskia*. Rembrandt van Rijn. 1636 C.E. Etching.
88. San Carlo alle Quattro Fontane. Rome, Italy. Francesco Borromini (architect). 1638– 1646 C.E. Stone and stucco.
89. *Ecstasy of Saint Teresa*. Cornaro Chapel, Church of Santa Maria della Vittoria. Rome, Italy. Gian Lorenzo Bernini. c. 1647–1652 C.E. Marble (sculpture); stucco and gilt bronze (chapel).
90. *Angel with Arquebus, Asiel Timor Dei*. Master of Calamarca (La Paz School). c. 17th century C.E. Oil on canvas.
91. *Las Meninas*. Diego Velázquez. c. 1656 C.E. Oil on canvas.
92. *Woman Holding a Balance*. Johannes Vermeer. c. 1664 C.E. Oil on canvas.
93. The Palace at Versailles. Versailles, France. Louis Le Vau and Jules Hardouin- Mansart (architects). Begun 1669 C.E. Masonry, stone, wood, iron, and gold leaf (architecture); marble and bronze (sculpture); gardens.
94. Screen with the Siege of Belgrade and hunting scene. Circle of the González Family. c. 1697–1701 C.E. Tempera and resin on wood, shell inlay.
95. *The Virgin of Guadalupe (Virgen de Guadalupe)*. Miguel González. c. 1698 C.E. Based on original Virgin of Guadalupe. Basilica of Guadalupe, Mexico City. 16th century C.E. Oil on canvas on wood, inlaid with mother-of-pearl.
96. *Fruit and Insects*. Rachel Ruysch. 1711 C.E. Oil on wood.
97. *Spaniard and Indian Produce a Mestizo*. Attributed to Juan Rodríguez Juárez. c. 1715 C.E. Oil on canvas.
98. *The Tête à Tête*, from *Marriage à la Mode*. William Hogarth. c. 1743 C.E. Oil on canvas.
99. Portrait of Sor Juana Inés de la Cruz. Miguel Cabrera. c. 1750 C.E. Oil on canvas.
100. A Philosopher Giving a Lecture on the Orrery. Joseph Wright of Derby. c. 1763–1765 C.E. Oil on canvas.
101. *The Swing*. Jean-Honoré Fragonard. 1767 C.E. Oil on canvas.
102. Monticello. Virginia, U.S. Thomas Jefferson (architect). 1768–1809 C.E. Brick, glass, stone, and wood.
103. *The Oath of the Horatii*. Jacques-Louis David. 1784 C.E. Oil on canvas.
104. *George Washington*. Jean-Antoine Houdon. 1788–1792 C.E. Marble.
105. *Self-Portrait*. Elisabeth Louise Vigée Le Brun. 1790 C.E. Oil on canvas.
106. *Y no hai remedio (And There's Nothing to Be Done)*, from *Los Desastres de la Guerra (The Disasters of War)*, plate 15. Francisco de Goya. 1810–1823 C.E. (published 1863). Etching, drypoint, burin, and burnishing.
107. *La Grande Odalisque*. Jean-Auguste-Dominique Ingres. 1814 C.E. Oil on canvas.
108. *Liberty Leading the People*. Eugène Delacroix. 1830 C.E. Oil on canvas.
109. *The Oxbow (View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm)*. Thomas Cole. 1836 C.E. Oil on canvas.
110. *Still Life in Studio*. Louis-Jacques-Mandé Daguerre. 1837 C.E. Daguerreotype.
111. *Slave Ship (Slavers Throwing Overboard the Dead and Dying, Typhoon Coming On)*. Joseph Mallord William Turner. 1840 C.E. Oil on canvas.
112. Palace of Westminster (Houses of Parliament). London, England. Charles Barry and Augustus W. N. Pugin (architects). 1840–1870 C.E. Limestone masonry and glass.
113. *The Stone Breakers*. Gustave Courbet. 1849 C.E. (destroyed in 1945). Oil on canvas.
114. *Nadar Raising Photography to the Height of Art*. Honoré Daumier. 1862 C.E. Lithograph.
115. *Olympia*. Édouard Manet. 1863 C.E. Oil on canvas.

116. *The Saint-Lazare Station*. Claude Monet. 1877 C.E. Oil on canvas.
117. *The Horse in Motion*. Eadweard Muybridge. 1878 C.E. Albumen print.
118. *The Valley of Mexico from the Hillside of Santa Isabel (El Valle de México desde el Cerro de Santa Isabel)*. Jose María Velasco. 1882 C.E. Oil on canvas.
119. *The Burghers of Calais*. Auguste Rodin. 1884–1895 C.E. Bronze.
120. *The Starry Night*. Vincent van Gogh. 1889 C.E. Oil on canvas.
121. *The Coiffure*. Mary Cassatt. 1890–1891 C.E. Drypoint and aquatint.
122. *The Scream*. Edvard Munch. 1893 C.E. Tempera and pastels on cardboard.
123. *Where Do We Come From? What Are We? Where Are We Going?* Paul Gauguin. 1897–1898 C.E. Oil on canvas.
124. Carson, Pirie, Scott and Company Building. Chicago, Illinois, U.S. Louis Sullivan (architect). 1899–1903 C.E. Iron, steel, glass, and terra cotta.
125. *Mont Sainte-Victoire*. Paul Cézanne. 1902–1904 C.E. Oil on canvas.
126. *Les Demoiselles d'Avignon*. Pablo Picasso. 1907 C.E. Oil on canvas.
127. *The Steerage*. Alfred Stieglitz. 1907 C.E. Photogravure.
128. *The Kiss*. Gustav Klimt. 1907–1908 C.E. Oil and gold leaf on canvas.
129. *The Kiss*. Constantin Brancusi. 1907–1908 C.E. Limestone.
130. *The Portuguese*. Georges Braque. 1911 C.E. Oil on canvas.
131. *Goldfish*. Henri Matisse. 1912 C.E. Oil on canvas.
132. *Improvisation 28 (second version)*. Vassily Kandinsky. 1912 C.E. Oil on canvas.
133. *Self-Portrait as a Soldier*. Ernst Ludwig Kirchner. 1915 C.E. Oil on canvas.
134. *Memorial Sheet for Karl Liebknecht*. Käthe Kollwitz. 1919–1920 C.E. Woodcut.
135. Villa Savoye. Poissy-sur-Seine, France. Le Corbusier (architect). 1929 C.E. Steel and reinforced concrete.
136. *Composition with Red, Blue and Yellow*. Piet Mondrian. 1930 C.E. Oil on canvas.
137. Illustration from *The Results of the First Five-Year Plan*. Varvara Stepanova. 1932 C.E. Photomontage.
138. *Object (Le Déjeuner en fourrure)*. Meret Oppenheim. 1936 C.E. Fur-covered cup, saucer, and spoon.
139. Fallingwater. Pennsylvania, U.S. Frank Lloyd Wright (architect). 1936–1939 C.E. Reinforced concrete, sandstone, steel, and glass.
140. *The Two Fridas*. Frida Kahlo. 1939 C.E. Oil on canvas.
141. *The Migration of the Negro, Panel no. 49*. Jacob Lawrence. 1940–1941 C.E. Casein tempera on hardboard.
142. *The Jungle*. Wifredo Lam. 1943 C.E. Gouache on paper mounted on canvas.
143. *Dream of a Sunday Afternoon in the Alameda Park*. Diego Rivera. 1947–1948 C.E. Fresco.
144. *Fountain (second version)*. Marcel Duchamp. 1950 C.E. (original 1917). Readymade glazed sanitary china with black paint.
145. *Woman, I*. Willem de Kooning. 1950–1952 C.E. Oil on canvas.
146. Seagram Building. New York City, U.S. Ludwig Mies van der Rohe and Philip Johnson (architects). 1954–1958 C.E. Steel frame with glass curtain wall and bronze.
147. *Marilyn Diptych*. Andy Warhol. 1962 C.E. Oil, acrylic, and silkscreen enamel on canvas.
148. *Narcissus Garden*. Yayoi Kusama. Original installation and performance 1966. Mirror balls.
149. *The Bay*. Helen Frankenthaler. 1963 C.E. Acrylic on canvas.
150. *Lipstick (Ascending) on Caterpillar Tracks*. Claes Oldenburg. 1969–1974 C.E. Cor-Ten steel, steel, aluminum, and cast resin; painted with polyurethane enamel.

151. *Spiral Jetty*. Great Salt Lake, Utah, U.S. Robert Smithson. 1970 C.E. Earthwork: mud, precipitated salt crystals, rocks, and water coil.
152. House in New Castle County. Delaware, U.S. Robert Venturi, John Rauch, and Denise Scott Brown (architects). 1978–1983 C.E. Wood frame and stucco.
153. Chavín de Huántar. Northern highlands, Peru. Chavín. 900–200 B.C.E. Stone (architectural complex); granite (Lanzón and sculpture); hammered gold alloy (jewelry).
154. Mesa Verde cliff dwellings. Montezuma County, Colorado. Ancestral Puebloan (Anasazi). 450–1300 C.E. Sandstone.
155. Yaxchilán. Chiapas, Mexico. Maya. 725 C.E. Limestone (architectural complex).
156. Great Serpent Mound. Adams County, southern Ohio. Mississippian (Eastern Woodlands). c. 1070 C.E. Earthwork/effigy mound.
157. Templo Mayor (Main Temple). Tenochtitlan (modern Mexico City, Mexico). Mexica (Aztec). 1375–1520 C.E. Stone (temple); volcanic stone (The Coyolxauhqui Stone); jadeite (Olmec-style mask); basalt (Calendar Stone).
158. Ruler's feather headdress (probably of Motecuhzoma II). Mexica (Aztec). 1428–1520 C.E. Feathers (quetzal and cotinga) and gold.
159. City of Cusco, including Qorikancha (Inka main temple), Santo Domingo (Spanish colonial convent), and Walls at Saqsa Waman (Sacsayhuaman). Central highlands, Peru. Inka. c. 1440 C.E; convent added 1550–1650 C.E. Andesite.
160. Maize cobs. Inka. c. 1440–1533 C.E. Sheet metal/repoussé, metal alloys.
161. City of Machu Picchu. Central highlands, Peru. Inka. c. 1450–1540 C.E. Granite (architectural complex).
162. All-T'òqapu tunic. Inka. 1450–1540 C.E. Camelid fiber and cotton.
163. Bandolier bag. Lenape (Delaware tribe, Eastern Woodlands). c. 1850 C.E. Beadwork on leather.
164. Transformation mask. Kwakwaka'wakw, Northwest coast of Canada. Late 19th century C.E. Wood, paint, and string.
165. Painted elk hide. Attributed to Cotsiogo (Cadzi Cody), Eastern Shoshone, Wind River Reservation, Wyoming. c. 1890–1900 C.E. Painted elk hide.
166. Black-on-black ceramic vessel. Maria Martínez and Julian Martínez, Tewa, Puebloan, San Ildefonso Pueblo, New Mexico. c. mid-20th century C.E. Blackware ceramic.
167. Conical tower and circular wall of Great Zimbabwe. Southeastern Zimbabwe. Shona peoples. c. 1000–1400 C.E. Coursed granite blocks.
168. Great Mosque of Djenné. Mali. Founded c. 1200 C.E.; rebuilt 1906–1907. Adobe.
169. Wall plaque, from Oba's palace. Edo peoples, Benin (Nigeria). 16th century C.E. Cast brass.
170. *Sika dwa kofi* (Golden Stool). Ashanti peoples (south central Ghana). c. 1700 C.E. Gold over wood and cast-gold attachments.
171. *Ndop* (portrait figure) of King Mishe miShyaang maMbul. Kuba peoples (Democratic Republic of the Congo). c. 1760–1780 C.E. Wood.
172. Power figure (*Nkisi n'kondi*). Kongo peoples (Democratic Republic of the Congo). c. late 19th century C.E. Wood and metal.
173. Female (*Pwo*) mask. Chokwe peoples (Democratic Republic of the Congo). Late 19th to early 20th century C.E. Wood, fiber, pigment, and metal.
174. Portrait mask (*Mblo*). Baule peoples (Côte d'Ivoire). Early 20th century C.E. Wood and pigment.
175. *Bundu* mask. Sande Society, Mende peoples (West African forests of Sierra Leone and Liberia). 19th to 20th century C.E. Wood, cloth, and fiber.
176. *Ikenga* (shrine figure). Igbo peoples (Nigeria). c. 19th to 20th century C.E. Wood.

177. *Lukasa* (memory board). Mbudye Society, Luba peoples (Democratic Republic of the Congo). c. 19th to 20th century C.E. Wood, beads, and metal.
178. Aka elephant mask. Bamileke (Cameroon, western grassfields region). c. 19th to 20th century C.E. Wood, woven raffia, cloth, and beads.
179. Reliquary figure (*byeri*). Fang peoples (southern Cameroon). c. 19th to 20th century C.E. Wood.
180. Veranda post of enthroned king and senior wife (Opo Ogoga). Olowe of Ise (Yoruba peoples). c. 1910–1914 C.E. Wood and pigment.
181. Petra, Jordan: Treasury and Great Temple. Nabataean Ptolemaic and Roman. c. 400 B.C.E.–100 C.E. Cut rock.
182. Buddha. Bamiyan, Afghanistan. Gandharan. c. 400–800 C.E. (destroyed in 2001). Cut rock with plaster and polychrome paint.
183. The Kaaba. Mecca, Saudi Arabia. Islamic. Pre-Islamic monument; rededicated by Muhammad in 631–632 C.E.; multiple renovations. Granite masonry, covered with silk curtain and calligraphy in gold and silver-wrapped thread.
184. Jowo Rinpoche, enshrined in the Jokhang Temple. Lhasa, Tibet. Yarlung Dynasty. Believed to have been brought to Tibet in 641 C.E. Gilt metals with semiprecious stones, pearls, and paint; various offerings.
185. Dome of the Rock. Jerusalem. Islamic, Umayyad. 691–692 C.E., with multiple renovations. Stone masonry and wooden roof decorated with glazed ceramic tile, mosaics, and gilt aluminum and bronze dome.
186. Great Mosque (Masjid-e Jameh). Isfahan, Iran. Islamic, Persian: Seljuk, Il-Khanid, Timurid and Safavid Dynasties. c. 700 C.E.; additions and restorations in the 14th, 18th, and 20th centuries C.E. Stone, brick, wood, plaster, and glazed ceramic tile.
187. Folio from a Qur'an. Arab, North Africa, or Near East. Abbasid. c. eighth to ninth century C.E. Ink, color, and gold on parchment.
188. Basin (*Baptistère de St. Louis*). Muhammad ibn al-Zain. c. 1320–1340 C.E. Brass inlaid with gold and silver.
189. *Bahram Gur Fights the Karg*, folio from the Great Il-Khanid *Shahnama*. Islamic; Persian, Il-Khanid. c. 1330–1340 C.E. Ink and opaque watercolor, gold, and silver on paper.
190. *The Court of Gayumars*, folio from Shah Tahmasp's *Shahnama*. Sultan Muhammad. c. 1522–1525 C.E. Ink, opaque watercolor, and gold on paper.
191. The Ardabil Carpet. Maq̄sud of Kashan. 1539–1540 C.E. Silk and wool.
192. Great Stupa at Sanchi. Madhya Pradesh, India. Buddhist; Maurya, late Sunga Dynasty. c. 300 B.C.E.–100 C.E. Stone masonry, sandstone on dome.
193. Terra cotta warriors from mausoleum of the first Qin emperor of China. Qin Dynasty. c. 221–209 B.C.E. Painted terra cotta.
194. Funeral banner of Lady Dai (Xin Zhui). Han Dynasty, China. c. 180 B.C.E. Painted silk.
195. Longmen caves. Luoyang, China. Tang Dynasty. 493–1127 C.E. Limestone.
196. Gold and jade crown. Three Kingdoms Period, Silla Kingdom, Korea. Fifth to sixth century C.E. Metalwork.
197. Todai-ji. Nara, Japan. Various artists, including sculptors Unkei and Keikei, as well as the Kei School. 743 C.E.; rebuilt c. 1700. Bronze and wood (sculpture); wood with ceramic-tile roofing (architecture).
198. Borobudur Temple. Central Java, Indonesia. Sailendra Dynasty. c. 750–842 C.E. Volcanic-stone masonry.
199. Angkor, the temple of Angkor Wat, and the city of Angkor Thom, Cambodia. Hindu, Angkor Dynasty. c. 800–1400 C.E. Stone masonry, sandstone.
200. Lakshmana Temple. Khajuraho, India. Hindu, Chandella Dynasty. c. 930–950 C.E. Sandstone.

201. *Travelers among Mountains and Streams*. Fan Kuan. c. 1000 C.E. Ink and colors on silk.
202. Shiva as Lord of Dance (Nataraja). Hindu; India (Tamil Nadu), Chola Dynasty. c. 11th century C.E. Cast bronze.
203. *Night Attack on the Sanjō Palace*. Kamakura Period, Japan. c. 1250–1300 C.E. Handscroll (ink and color on paper).
204. The David Vases. Yuan Dynasty, China. 1351 C.E. White porcelain with cobalt-blue underglaze.
205. Portrait of Sin Sukju (1417–1475). Imperial Bureau of Painting. c. 15th century C.E. Hanging scroll (ink and color on silk).
206. Forbidden City. Beijing, China. Ming Dynasty. 15th century C.E. and later. Stone masonry, marble, brick, wood, and ceramic tile.
207. Ryoan-ji. Kyoto, Japan. Muromachi Period, Japan. c. 1480 C.E.; current design most likely dates to the 18th century. Rock garden.
208. *Jahangir Preferring a Sufi Shaikh to Kings*. Bichitr. c. 1620 C.E. Watercolor, gold, and ink on paper.
209. Taj Mahal. Agra, Uttar Pradesh, India. Masons, marble workers, mosaicists, and decorators working under the supervision of Ustad Ahmad Lahori, architect of the emperor. 1632–1653 C.E. Stone masonry and marble with inlay of precious and semiprecious stones; gardens.
210. *White and Red Plum Blossoms*. Ogata Korin. c. 1710–1716 C.E. Ink, watercolor, and gold leaf on paper.
211. *Under the Wave off Kanagawa (Kanagawa oki nami ura)*, also known as the Great Wave, from the series Thirty-six Views of Mount Fuji. Katsushika Hokusai. 1830– 1833 C.E. Polychrome woodblock print; ink and color on paper.
212. *Chairman Mao en Route to Anyuan*. Artist unknown; based on an oil painting by Liu Chunhua. c. 1969 C.E. Color lithograph.
213. Nan Madol. Pohnpei, Micronesia. Saudeleur Dynasty. c. 700–1600 C.E. Basalt boulders and prismatic columns.
214. Moai on platform (*ahu*). Rapa Nui (Easter Island). c. 1100–1600 C.E. Volcanic tuff figures on basalt base.
215. ‘Ahu ‘ula (feather cape). Hawaiian. Late 18th century C.E. Feathers and fiber.
216. Staff god. Rarotonga, Cook Islands, central Polynesia. Late 18th to early 19th century C.E. Wood, tapa, fiber, and feathers.
217. Female deity. Nukuoro, Micronesia. c. 18th to 19th century C.E. Wood.
218. Buk (mask). Torres Strait. Mid- to late 19th century C.E. Turtle shell, wood, fiber, feathers, and shell.
219. Hiapo (tapa). Niue. c. 1850–1900 C.E. Tapa or bark cloth, freehand painting.
220. *Tamati Waka Nene*. Gottfried Lindauer. 1890 C.E. Oil on canvas.
221. Navigation chart. Marshall Islands, Micronesia. 19th to early 20th century C.E. Wood, fiber.
222. Malagan display and mask. New Ireland Province, Papua New Guinea. c. 20th century C.E. Wood, pigment, fiber, and shell.
223. Presentation of Fijian mats and tapa cloths to Queen Elizabeth II. Fiji, Polynesia. 1953 C.E. Multimedia performance (costume; cosmetics, including scent; chant; movement; and *pandanus* fiber/hibiscus fiber mats), photographic documentation.
224. *The Gates*. New York City, U.S. Christo and Jeanne-Claude. 1979–2005 C.E. Mixed- media installation.
225. Vietnam Veterans Memorial. Washington, D.C., U.S. Maya Lin. 1982 C.E. Granite.
226. *Horn Players*. Jean-Michel Basquiat. 1983 C.E. Acrylic and oil paintstick on three canvas panels.

227. *Summer Trees*. Song Su-nam. 1983 C.E. Ink on paper.
228. *Androgyn III*. Magdalena Abakanowicz. 1985 C.E. Burlap, resin, wood, nails, string.
229. *A Book from the Sky*. Xu Bing. 1987–1991 C.E. Mixed-media installation.
230. *Pink Panther*. Jeff Koons. 1988 C.E. Glazed porcelain.
231. *Untitled* (#228), from the History Portraits series. Cindy Sherman. 1990 C.E. Photograph.
232. *Dancing at the Louvre*, from the series *The French Collection*, Part I; #1. Faith Ringgold. 1991 C.E. Acrylic on canvas, tie-dyed, pieced fabric border.
233. *Trade (Gifts for Trading Land with White People)*. Jaune Quick-to-See Smith. 1992 C.E. Oil and mixed media on canvas.
234. *Earth's Creation*. Emily Kame Kngwarreye. 1994 C.E. Synthetic polymer paint on canvas.
235. *Rebellious Silence*, from the Women of Allah series. Shirin Neshat (artist); photo by Cynthia Preston. 1994 C.E. Ink on photograph.
236. *En la Barberia no se Lloro (No Crying Allowed in the Barbershop)*. Pepon Osorio. 1994 C.E. Mixed-media installation.
237. *Pisupo Lua Afe (Corned Beef 2000)*. Michel Tuffery. 1994 C.E. Mixed media.
238. *Electronic Superhighway*. Nam June Paik. 1995 C.E. Mixed-media installation (49-channel closed-circuit video installation, neon, steel, and electronic components).
239. *The Crossing*. Bill Viola. 1996 C.E. Video/sound installation.
240. Guggenheim Museum Bilbao. Spain. Frank Gehry (architect). 1997 C.E. Titanium, glass, and limestone.
241. *Pure Land*. Mariko Mori. 1998 C.E. Color photograph on glass.
242. *Lying with the Wolf*. Kiki Smith. 2001 C.E. Ink and pencil on paper.
243. *Darkytown Rebellion*. Kara Walker. 2001 C.E. Cut paper and projection on wall.
244. *The Swing (after Fragonard)*. Yinka Shonibare. 2001 C.E. Mixed-media installation.
245. *Old Man's Cloth*. El Anatsui. 2003 C.E. Aluminum and copper wire.
246. *Stadia II*. Julie Mehretu. 2004 C.E. Ink and acrylic on canvas.
247. *Preying Mantra*. Wangechi Mutu. 2006 C.E. Mixed media on Mylar.
248. *Shibboleth*. Doris Salcedo. 2007–2008 C.E. Installation.
249. MAXXI National Museum of XXI Century Arts. Rome, Italy. Zaha Hadid (architect). 2009 C.E. Glass, steel, and cement.
250. *Kui Hua Zi (Sunflower Seeds)*. Ai Weiwei. 2010–2011 C.E. Sculpted and painted porcelain.

Appendix B

Google Street View lesson exemplar images for *Chartres Cathedral* in France. 11 Nov. 2017

View of Chartres	Link to Street View Image
<p data-bbox="467 516 630 548">Royal Portal</p> 	<p data-bbox="919 575 1406 785"> https://www.google.com/maps/@48.4475258,1.4881839,0a,75y,74.23h/data=!3m4!1e1!3m2!1sAF1QipNO241p9c69gGd6ylFyHrORTWTAqNdEP9in-DoD!2e10 </p>
<p data-bbox="500 957 597 989">Interior</p> 	<p data-bbox="919 1020 1406 1230"> https://www.google.com/maps/@48.4478032,1.4878388,0a,75y,88.73h/data=!3m4!1e1!3m2!1sAF1QipPBOUxsFZxWbH9SA5tiubyA9Ku-VMpR4ER1m0ls!2e10 </p>
<p data-bbox="435 1404 662 1436">Western Entrance</p> 	<p data-bbox="919 1470 1406 1617"> https://www.google.com/maps/@48.4470715,1.4872705,0a,75y/data=!3m4!1e1!3m2!1sqxFOTPRYDOmd7pdqBvArQ!2e0 </p>

Appendix C

Inquiry-Based Teaching List of Questions. Source: College Board (*AP Art History: Course Exam and Description*).

1. What is it?
2. What does it look like?
3. What is it made of?
4. How was it made?
5. Who made it?
6. Who commissioned it?
7. When and where was it made?
8. What was happening in the artist's world when it was made?
9. Who used it?
10. How was it used?
11. Who were its audiences?
12. How did they respond to it?
13. How long does it last?
14. Is it long lasting or ephemeral?
15. What does it mean? What does it resemble?
16. How is it distinctive?
17. Who and what influenced it?
18. Who and what did it influence?
19. Why (to all of the previous questions)?
20. How do we know (to all of the previous questions)?

Appendix D

CFAM Works Equivalent to Those Required by the College Board. Source: Elizabeth Coulter and Rangsook Yoon, CFAM.

AP Art History Required Works	Connection	CFAM Works
47. Ludovisi Battle Sarcophagus	Roman sarcophagus	Sarcophagus, Roman, second century
54. Virgin (Theotokos) and Child between Saints Theodore and George	Virgin Mary with Christ Child	Cosimo Rosselli, Madonna Enthroned Nursing the Christ Child, ca. 1470
71. <i>Madonna and Child with Two Angels</i> , Fra Filippo Lippi	Florence; and Sistine Chapel	Same as above
74. <i>Adam and Eve</i> , Albrecht Dürer	Artist	Durer, The Seven Triumphs from the Apocalypse, 1498
78. <i>Entombment of Christ</i> , Jacobo da Pontormo (Mannerism	Lavinia Fontana, The Dead Christ with Symbols of the Passion, 1581
96. <i>Fruit and Insects</i> , Rachel Ruysch	Women artists	Same as above
105. <i>Self-Portrait</i> , Elisabeth Louise Vigée-LeBrun		Same as above
83. <i>Hunters in the Snow</i> , Pieter Bruegel the Elder	emergence of genre	The Bassano Workshop, Noah Leading Animals into the Ark, 1595
85. <i>Calling of Saint Matthew</i> , Caravaggio	tenebrism	Solimena, St. Francis Xavier Baptizing the Indians, ca. 1680-85
92. <i>Woman Holding a Balance</i> , Johannes Vermeer	17th-c Dutch genre	Pieter Cornelisz. van Slingeland
98. <i>The Tête à Tête</i> , from <i>Marriage à la Mode</i> , William Hogarth	artist; satire	Hogarth, Paul Before Felix Burlesqued, After 1751, engraving and etching
106. <i>Y no hai remedio (And There's Nothing to Be Done)</i> , Goya	artist; medium	Goya, Estan Calientes (from Los Caprichios, plate 13), 1797-98
114. <i>Nadar elevating Photography to Art</i> , Honoré Daumier	artist; medium	Daumier, Les Paysagiste[s] par Daumier: — N' bougez pas! ... vous êtes superbe comme ça. 1866
116. <i>The Saint-Lazare Station</i> , Claude Monet	Impressionism	Childe Hassam, Ironbound, ca. 1896
125. <i>Mont Sainte-Victoire</i> , Paul Cézanne	Impressionism	Roger Fry, Winter Landscape, ca. 1912-1914
127. <i>The Steerage</i> , Alfred Stieglitz	artist	Stieglitz, A Snapshot - Paris, 1913
147. <i>Marilyn Diptych</i> , Andy Warhol	artist	Warhol, Joseph Beuys, 1980-83
131. <i>The Goldfish</i> , Henri Matisse	artist	Matisse, Petit Bois Clair, Woodcut, 1906
235. <i>Rebellious Silence</i> , from the <i>Women of Allah</i> series, Shirin Neshat	artist, medium	Shirin Neshat, photograph
243. <i>Darkytown Rebellion</i> , Kara Walker	artist	Scene of McPherson's Death, from the portfolio Harper's Pictorial History of the Civil War (Annotated)

Appendix E

CFAM Images captured to share with students pre-physical visit. By C. Payne

	Camera Type	Image Content/Function
	<p style="text-align: center;">Street View</p> 	<ul style="list-style-type: none"> • Door to print study room • Showing students the literal door to the museum
	<p style="text-align: center;">Street View</p> 	<ul style="list-style-type: none"> • Inside print study room • Provide 360, fully 3D image of room to students for familiarity
	<p style="text-align: center;">Cardboard Camera</p> 	<ul style="list-style-type: none"> • View with CFAM staff member students will meet • Includes audio with introduction • Build familiarity
	<p style="text-align: center;">Street View</p> 	<ul style="list-style-type: none"> • Gallery with work on view by artist also in the required 250 • Generates student excitement before the physical visit
	<p style="text-align: center;">Cardboard Camera</p> 	<ul style="list-style-type: none"> • Same gallery as above with audio and CFAM staff member • Have fun with students/build sense of belonging
	<p style="text-align: center;">iPhone 6 Camera</p>	<ul style="list-style-type: none"> • Roman sarcophagus equivalent to work from required 250 • Location has moved, provides comparison to current location
	<p style="text-align: center;">Cardboard Camera</p> 	<ul style="list-style-type: none"> • Current location of sarcophagus above • Provide sense of place at CFAM entry/build familiarity, sense of belonging

Appendix F

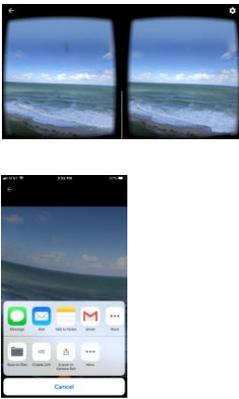
Step-by-step instructions to capture an image with the Google Street View Camera. Screen shots taken 20 Sept. 2017.

	<p>Step 1:</p> <p>Download the free Google Street View app for iOS or Android. <i>(You will also need to download the Cardboard app if you want to view the image in 3D.)</i></p>		<p>Step 5:</p> <p>...you see a green checkmark in the circle at the bottom of the screen.</p>
	<p>Step 2:</p> <p>Open the app and tap the camera icon in the lower right-hand corner.</p>		<p>Step 6:</p> <p>Wait while the app stitches the images together and then either publish to google or do nothing <i>(it will remain a private image if you do not publish).</i></p>
	<p>Step 3:</p> <p>Tap the camera icon again.</p>		<p>Step 7:</p> <p>Tap on the image (easy to do if you keep the image private) and then tap on the Cardboard icon.</p>
	<p>Step 4:</p> <p>Holding the camera as close to your head (or slightly above) pivot the phone to place the white circle over the orange dot. Continue until no dot appears.</p>		<p>Step 8:</p> <p>Access the image any time or to share a link to it by tapping on the private tab and then select the image.</p>

Tips from the Google Street application menu. Screen shots taken 11 Nov. 2107.



Step-by-step instructions to capture an image with the Google Cardboard Camera. Screen shots captured 11 Nov. 2017.

	<p>Step 1:</p> <p>After downloading the free Google Cardboard Camera app for iOS or Android, open the app and tap the camera icon in the lower right-hand corner.</p>		<p>Step 4:</p> <p>The image will appear on the home screen. Tap the image to view or share.</p>
	<p>Step 2:</p> <p>Tap the orange dot to begin the image capture. Tap the audio bars to disable audio recording. Only tap the X if you want to stop the capture before completing 360 degrees.</p>		<p>Step 5:</p> <p>Tap the left icon to share. Tap the Cardboard icon to view.</p>
	<p>Step 3:</p> <p>Follow the orange arrow until it reaches the end.</p>		<p>Step 6:</p> <p>Insert the phone into a Cardboard viewer to view or select the preferred method to share.</p>

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