LEARNING THEN AND THERE: AN EXPLORATION OF VIRTUAL REALITY IN K-12 HISTORY EDUCATION

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ABSTRACT

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Immersive virtual reality technology has the potential to change human/digital media as drastically as did the advent of the personal home computer and internet. While mostly used for gaming and film at the moment, well-developed VR software and hardware can place one anywhere in the world and experience phenomena one cannot in the physical world. Virtual reality presents an incredible opportunity for history educators around the world to take classes anywhere imaginable and provide incredible creation opportunities for students.

This thesis will provide a summary of the current virtual reality technical landscape, ways in which educators are already using the technology, a survey of history virtual reality research, the impact of virtual reality on history pedagogy and historiography, an instructional model for teachers looking to incorporate virtual reality into their lessons, and a discussion on ethical challenges virtual reality brings to education.

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Introduction

In the second half of my Junior year of High School I was privileged to spend a semester abroad in Israel. The cornerstone of this program was a high intensity Jewish History class that met for three hours a day - six days a week. For four of those days we would learn and discuss in a traditional classroom history setting. Twice each week, however, we would visit the location of the topic that we were studying. One example that illustrates this point was our study of the second century "Bar Kochva" revolt. The rebels, led by Simon bar Kochva, used an intricate and tightly cramped system of tunnels beneath the earth as a base of their guerrilla attacks against the Roman Empire. Climbing on our hands and knees, through pitch black tunnels gave me firsthand knowledge of the dedication, fear, and cramped conditions in which these rebels fought.

While I could have read a well written description of climbing through tunnels in a book, I would not have been imprinted with the same multi-sensory association that helped me personally remember details of this important revolt. Having the ability to put a physical location to a historical place I had read about changed my perception of how one can study history. It is a fundamentally different experience to be somewhere; to see, feel, and touch something that we had merely read about the day before in class. To engage all five senses and have a spatial memory associated with abstract concepts makes history that much more realistic. Not everybody has the opportunity, and not every place is accessible. However, with the advent of the immersive experience provided by virtual reality (VR) technology, teachers and students can delve deeper into history.

Since 2014, virtual reality has been among the forefront of new technological developments. The dreams of science fiction writers are possible today with personalized stereoscopic headsets. Like with any new technological advancement, educators are thinking

carefully about how this new technology can be used to promote learning among students. In this thesis, I will present a collection of knowledge about current virtual reality, explore how teachers are currently using it in the classroom, and look ahead to what educational theories and research says about future application of this technology.

The first section will define virtual reality - what it is and what it is not - and provide a brief history of the technology itself. While VR has been used for years in the past, only recently have consumer computers and hardware reached a point where it is possible to create and experience true seamless virtual worlds and experiences. I will examine the current popular consumer technologies as well as cutting edge software for developing VR content. I will talk about the differences between 3D videos, photography, and digital simulation.

In the second section, I will provide a sampling of how VR technology is being used in the classroom today. This section will include examples of ways in which teachers have incorporated VR into their lesson plans and curriculums. It will also list specific companies are developing educational content for the VR platform as well as several educators already using the technology in their classes.

In the third section, I will provide a broad survey of history-related VR research. This will cover everything from a critical look at the effectiveness of the Google Expeditions app, student interaction with VR, VR as a standard for consistent classroom controls, virtual learning environments, proper mobile VR implementation, and narrative possibilities of VR content.

The fourth section will explore history pedagogy and VR's impact on historiography - the study of historical documentation. It will take three pedagogical history "habits of mind" from the National Council for History Education applied to VR use. Those pedagogical habits of mind will be applied to research on how VR will change the study of history as a subject.

The fifth section will provide a series of instructional suggestions for educators looking to implement VR into their own classrooms adapted from Roblyer and Hughes' (2019) technology integration model. The sixth section will discuss ethical implications and challenges to using VR in a history setting.

While there certainly are effective and ineffective ways to use any technology in the classroom, this thesis will focus on possible educational benefits of VR and its unique place within the curriculum and materials available to educators. Like any technology, what matters most is the influence and imagination of an effective educator in designing lessons centered around learning; not the tool itself. I firmly believe, and will hopefully prove, that VR is a transformative technology which can have a positive impact on our own lives through inspiring imagination, creativity, critical thinking, and perspective.

Section 1: Summary of Current Virtual Reality Landscape

VR 101: Definitions and Equipment

Definition of VR. What is Virtual Reality? According to Cochrane (2016), it "involves the use of a computer to create an interactive immersive experience via some form of head mounted display (HMD) unit, such that the user feels part of the virtual or simulated environment." From a broad definition of virtual reality, there are many different ways in which to measure the qualities and characteristics of a given virtual world.

Simulations. There are two primary ways that one experiences VR content. The first is through computer-generated simulations. In these programs, software-created 3D environments respond to a person's movements and location. This can be as straightforward as a re-creation of a real-world place, imaginary environment, or something completely abstract, like the inside of a molecule. This is what one traditionally thinks of when they think of virtual reality, as in science fiction. This digitally animated medium is used primarily in film, gaming, and simulation.

360 video/pictures. The second kind of simulation used currently in virtual reality platforms is that of 360 degree video and photography. In 360 degree video and photography, a real life location is captured by a single-camera or multiple camera rigs and stitched together on a computer. These videos and photographs are programmed to respond to head movements and the user's perspective. 360 degree photographs and videos are different than traditional virtual reality because they are not interactive and limit the user's perspective to a singular point in three-dimensional space. For example, in a 360 picture of video, one couldn't pick up an object or move a few steps in front of themselves. In contrast, computer simulations allow users to move to different locations and interact with their environment. Technology is not yet at a point

where a basic 360 degree camera can seamlessly recreate the objects and textures of a location from all angles, although it may be possible in the near future.

VR Hardware

Head-mounted displays (HMD). The means by which people experience VR is through head-mounted displays. In these HMDs, individualized screens show stereoscopic images split between each eye on LCD mounted screens or projections. Internal sensors within the goggle's setup or external room sensors correspond with software that can track head or body movement if there are the accompanying peripherals. To be truly effective, the technology needs to be responsive to one's movements in real time.

Mobile VR. Mobile VR works by way of placing a smartphone, or similar personal device such as an iPod Touch, into a peripheral display with stereoscopic lenses. The motion sensors within the device as well as the device's computing power makes possible the ability to see in 360 degrees. These headsets are either designed to accommodate specific devices, as in the case of the Samsung Oculus Gear VR headset, or are designed to fit any cell phone running a VR program, as in as is the case for Merge VR phone headset. More and more companies are investing heavily in creating mobile VR software ecosystems, standardized digital platforms for developers and users.

At the most basic end, Google's Cardboard Peripheral will fit almost any cell phone and cost next to nothing. This form of VR does not have the current frame rate or computing power to run more advanced VR programs, but it is currently the most inexpensive and accessible form available today. Hundreds of millions of people own smartphones and, as a result, they possess the ability to see and experience VR anywhere. Table 1 provides a list of the most common mobile VR platforms as recently as December, 2017.

Table 1

Most Common Mobile VR Platforms as of December, 2017

Platform	Description
Cardboard Peripheral	Basic cardboard HMD that fits virtually any smartphone. Used primarily for viewing VR content with minor interactivity.
Samsung Gear VR	HMD produced by Oculus and Samsung exclusively for Samsung Galaxy brand phones. Comes with a remote control for limited interactivity.
Google Daydream VR	Google-produced VR platform exclusively for high-end Android mobile devices. Comes with remote controls for limited interactivity.

Three hundred and sixty degree videos are currently limited by the capture quality of cameras and pixel density on viewing screens. Kavanagh (2016) found that although cell phones work for simple 360 video viewing, the resolution and individual pixels are still visible to the human eye. Companies may brag about a particular cell phone having a display so dense that one's retina cannot recognize the pixels, but that assertion falls flat when the screen is two inches from your face. This is known as the screen door effect, "an effect whereby the individual pixel arrays of the display become noticeable, resulting in an output akin to looking through a screen door" (Kavanagh, 2016, p. 3). As a result, smaller details, like writing on a whiteboard, are unreadable on the Gear VR.

High-end VR. The next level of hardware available today are high-end devices made specifically for the use of virtual reality. These headsets require a very powerful computer with a sophisticated graphics card. As a result, they can produce a much more detailed and life-like simulation than is possible on a mobile platform. The two main devices from this group, The Rift made by Facebook-owned Oculus, and the Vive made by HTC partnered with the gaming company Valve, have handheld controller switches simulating the movements of the user's

hands. By moving a controller through space, room scale sensors track depth and motion. The sensors also allow for full body movement, something that is not currently possible on a mobile platform. Initially created for gaming, these headsets have also been adapted to applications and development for the education sector. While these high end units are designed for use by the general public, they are prohibitively expensive for most people. The current cost of running a high-end VR device is approximately $1,000 minimum for a computer plus an additional $600 to $800 for the headsets. In most educational environments, these costs are too expensive for each student to have their own equipment.

360 cameras. The mass adoption of 360 degree cameras will accelerate VR content creation and development. Inexpensive cameras like the Samsung Gear 360 and the Ricoh Theta S are relatively affordable adoption points for VR producers. These cameras are linked to mobile phones, which makes production and sharing on social media more accessible. On the high end of the camera Spectrum, companies like Nokia, Facebook, and Google all have their own high-end VR camera rigs. These cameras can shoot in high definition and capture 360 degree audio, both of which are important for very immersive VR experiences.

Economic Impact

Goldman Sachs predicts the VR/AR market could be worth $80 billion dollars by 2025 (Goldman Sachs, 2016). As VR technology becomes more inexpensive and software responds more accurately to human interaction, the VR experience will become increasingly immersive. Accordingly, decreased costs and technological innovation will remove barriers to consumer adoption.

As mobile phones get increasingly powerful and displays get higher pixel density, many people will use their cell phones as the primary entry point for VR. Samsung, through their Gear

VR, has already sold over five million units (Jagneaux, 2017). Google's new Daydream platform is also attracting talent and more development partners. The level of computing and processing on mobile devices will grow significantly in the next five to ten years and they will be able to run many of the programs that are only available on dedicated graphics PCs today. Just as smartphones and the internet radically changed society, VR and AR "have the potential to be the next big computing platform" (Goldman Sachs, 2016). This translates into potentially huge investments and dispersion, with the possibility that VR devices could become as common as personal computers and smartphones are today.

The main concern about the mass adoption of this technology, especially within the education sector, is cost and researched effectiveness. Currently, VR is expensive. Although low-cost solutions like Cardboard have made it more accessible to almost anyone with a smartphone, it requires someone to actually own a smartphone. More expensive mobile headsets can cost an additional $100 (Google, 2017). Furthermore, there are not many long-term research studies on VR effectiveness in the classroom. While many are currently underway, no formal longitudinal studies with large numbers of students currently exist. While some educators are using VR in the classroom, and smaller studies do exist, there is not accurate data to date to show us if it will be an effective tool and more than just a gimmick. In section three of this paper, I will gather the current wealth of studies about VR's effectiveness in learning environments.

Section 2: How VR is Currently Being Used in Classrooms

Introduction

As the market for virtual reality grows, companies are increasingly developing content and platforms specifically for the use of VR in schools. This section provides an overview of how teachers and students are using virtual reality in their classrooms today. I present an overview of current popular software for development and consumption in the classroom. Some of these examples come from industry, while others come directly from the classroom. Some students use VR technology in a constructivist manner, creating their own VR experiences with 360 cameras and modeling software, while others consume VR content in the form of videos, 360 photo field trips, and interactive simulations.

VR Educational Content

Several companies in the private sector create pre-packaged VR lessons. These are curated experiences designed by educational content companies to be utilized either as a self-contained lesson for the classroom or a supplementary resource to be applied by educators as they see fit.

Google Expeditions. The most widespread use of VR in the classroom today has been through a Google program called Expeditions. The Expedition program is an app used by teachers and students to go on virtual field trips around the world. The students use a smartphone paired with a cardboard, head-mounted display and look at 360 panoramas. The students' head-mounted displays are synced to a teacher tablet which controls the scene and environment. This means that everything a student does or sees on their smartphone is ultimately controlled by the teacher.

Through the teacher's master control tablet, the teacher can see the number of participating students as well as where each student is focused, represented by a small smiley face. Within each Expedition, the teacher has the ability to point out specific spots in the area which appear as arrows in the student's head-mounted displays, directing their attention. For example, on one Expedition about the Battle of Gettysburg, the teacher, referred to as a "Guide," can point to the positions of the Union and Confederate armies. In addition, the teacher, through their use of the master control tablet, can pause and block the view of every student to regain their attention and direct it to a discussion or another class activity. Table 2 summarizes various history-related Google Expeditions.

Table 2

Eight Examples of History-Related Google Expeditions (Google Expeditions, 2017)

Expedition	Description
1066 Battle of Hastings, Abbey and Battlefield	This Expedition explores the aftermath of the Battle of Hastings in October, 1066 when the forces of William, the Dutch of Normandy, defeated the army of Harold Godwinson, the appointed heir of the English crown following the death of King Edward the Confessor.
7 New Wonders of the World	This Expedition presents unique perspectives on the new seven wonders of the world.
Aztec and Mayan Ruins	This Expedition brings learners to ruins of the ancient Aztec and Mayan civilizations and discusses their slow erosion and destruction.
Egypt	This Expedition presents a close view of the Pyramids and their surrounding landmarks in Egypt.
Palace of Versailles	This Expedition takes learners inside the ornate Palace of Versailles which became an important representation of the wealth of the monarchy during the French Revolution.
Quiahuiztlan	This Expedition brings learners to the city of Quiahuiztlan on the gulf coast of Mexico, a city originally built by the Totonac people, conquered by the Aztecs in the 15th century, and later overtaken by Spanish conquistadors.
Salem Village and the 1692 Witch Hysteria	This Expedition brings learners to the city of Salem, Massachusetts and explores the famous witch trials of 1692.
Selma to Montgomery (2 parts)	This Expeditions follows the footsteps of civil rights leaders in 1965 as they walked from Selma to Montgomery advocating African American voting rights in the face of discriminatory policies.

Google Expeditions is purposefully designed to be a communal activity. One critique of VR is that, because students each wear their own device, it can isolate the user from social interaction. Expeditions deliberately subverts this notion by forcing a classroom of learners to experience a location simultaneously, led by their teacher, just like a real-life field trip. The software itself is also available to the 73% of teens who have access to a smartphone (Lenhart, 2015). In addition, while many multi-person VR experiences require a strong and reliable internet connection, Expeditions was designed to not be dependent on the internet, so anyone in the area can access the specific Expedition through a local Wi-Fi network produced by the teacher's tablet. Because this local Wi-Fi does not rely on internet access, it can offer reliability and consistency.

Google created Expeditions to introduce an easy way of accessing VR and utilizing its own proprietary technology to boost its education wing. The Expedition team traveled around the world visiting classrooms and ultimately showing over 2 million students how to use Expeditions (Google Developers, 2017). Since there was a prohibitive cost of acquiring all of the smartphones and tablets for the schools, Google provided all of the technology and cardboard headsets for the classrooms they visited. Retailers like Best Buy also sell complete Google Expedition kits fitted with Cardboard headsets, smartphone devices, and Chromebooks (Schumann, 2016). The fact that Google's research and development took place within a controlled environment over the course of an entire year meant that the Expedition's team was able to be nimble and flexible - iterating and making changes when necessary to their project (Google Developers, 2016). For example, by listening to teachers and reviewing problems arising from Expedition lessons, they realized that Expeditions needed a pause feature to grab student attention.

Nearpod VR. Nearpod VR provides VR content to teachers through their robust network of educational apps and various platforms. Nearpod works by releasing pre-made lessons for teachers to use. A license can be purchased by an individual teacher, an entire school, or a school district. Nearpod uses the "virtual field trip" model within their lessons. Included in each lesson is a slideshow sprinkled with facts about the subject at hand, small quiz questions, short answer questions, virtual drawings, websites, YouTube videos, and 360 images of the location being studied. The teacher controls the slideshow presentation which is linked across smartphones, tablets, laptops, and classroom computers. High definition 360 images from 360cities.net give a sense of major landmarks and locations from the subject being studied. For example, in a lesson about the Mayan Civilization, students travel to different ruins and discuss with a partner the differences in architecture they notice between a pyramid, a royal chamber, and a town square.

The main idea behind this technology is that these small 360 breaks and "tours" will increase student engagement in the lesson and give them a sense of immersion. While the VR feature can only be used by students using a smartphone in an HMD, any student can view the 360 panoramas on their device of choice. On a tablet, a student can hold up their device and look through the "magic window," moving around and observing their location as if their device was a portal into another world. Students participating on laptop computers can view the scene through directional input from mouse or keyboard. The content itself is identical, regardless of platform.

The Nearpod VR lessons are meant to be a fun and quick way to engage students in history, or any other subject they are studying. They are not designed to be a primary means of directed instruction, delivering information directly to students. Nearpod recommends at the beginning of all their pre-made lessons that students be familiar with the subject beforehand. For

example, at the beginning of their lesson on the Maya, Nearpod recommends, “pairing this lesson with a unit on cultural studies, world history, or indigenous cultures,” and that students should “research the Mayan culture and the history of their ancient civilization,” beforehand (Nearpod, 2016). These 360 panoramas are meant to be fun, immersive, and engaging for students. Before every 360 panorama in Nearpod’s pre-made slideshows, they say, “Time to explore!” (Nearpod, 2016) The VR gives teachers a more immersive way to display visuals to students than two-dimensional visuals on a projector provide.

Nearpod took a deliberately simple approach with integrating VR into their products in order to make the adoption of VR as easy and accessible as possible. Teachers are provided with simple “drag and drop” content that is readily available - making its adoption in the classroom easy. With an extensive search engine from 360cities.net and ready-made lesson plans, it is very user-friendly and attractive for teachers to use this technology without the need for extensive training. Millions of students in school districts across the country already use the Nearpod platform, so VR integration becomes instantly accessible to a huge base of students.

Brown University Gaspee VR. A group of undergraduate students at Brown University have begun developing a full-fledged VR history lesson for K-12 based around the New England Gaspee affair, an important event from the Revolutionary War. Their program is notable for using a mixed variety of 360 photography and video to narrate their lesson and photogrammetry, a process of using cameras and real-world scanners to digitally recreate physical objects, as well as native 3D computer-generated objects. They are one of the few complete VR experiences developed from the ground up for the subject of history. Unlike other current VR history lessons like Google Expeditions and Nearpod, the Gaspee project is a complete and distinct history lesson incorporating both filmed, photographed, and digitally recreated elements of VR.

360 Video Content

Along with content creation and consumption apps, there will increasingly be an abundance of virtual reality video content available. Users around the world can already upload 360 videos directly to YouTube and Facebook, creating a wide network of VR videos. New and increasingly advanced cameras are released seemingly every week.

Traditional news organizations have also invested heavily in this technology. *USA Today*, *The Huffington Post*, and *The New York Times* all have their own dedicated mobile apps through which they regularly release new VR content. Discovery Channel, through their dedicated VR app, produces VR content on everything from African safaris to industrial production lines. These videos can be valuable immersive resources for history educators and engaging tools for learners.

For example, one Discovery series explores the American Civil War with period accurate costumes, rifles, and scenery (Vlessing, 2016). These 360 videos give learners a firsthand perspective of a battle trench, urban warfare during the Battle of Fredericksburg, the strategic importance of bridges, and the consequences for deserting soldiers. These would be excellent resources for any history teacher looking to engage students in a unit on the Civil War. They bring a perspective to sensory details of the Civil War that can only be found today in reenactments.

In the classroom, social studies teachers Neil Solomon and Paul Howard used 360 videos to teach their students about the Syrian refugee crisis and how empathy impacts decision making (Howard & Solomon, 2016). They watched the VR films *Welcome to Aleppo* (produced by *The Huffington Post*-owned RYOT) and *Clouds Over Sidra* (produced by the United Nations) which detail life in Syrian refugee camps. In groups of three, students shared Google Cardboard

viewers and each watched the video independently. While using this material, one student watches the film while the two others write down the viewing student's observations. The first student describes what they see, the second student describes what the narrator says, and the third student describes what they observe children in the camp doing (Howard & Solomon, 2016). This method of watching the 360 video encourages deep observation from students and makes an activity that can only be done by one student at a time, watching 360 video through a Google Cardboard, a more collaborative effort. Upon conclusion, one student reflected that the VR "...put us in [the Syrian Refugees'] shoes….It makes you more sympathetic to [the Syrian Refugees'] circumstances" (Howard & Solomon, 2016). This student's response seems to support the argument that 360 video and VR increases empathy.

VR Creation Tools

Students and teachers can develop their own VR experiences with specialty software. Some apps are simple and easy to use, while others utilize high level gaming graphical engines.

RoundMe. The first of these apps is called RoundMe, which uses 360 pictures to deliver content. Users can upload their own 360 photographs or select from RoundMe's stock library to create immersive VR tours of their own. While looking around in a single picture, a creator can put little information bubbles to include facts or interesting tidbits about a subject in the picture. RoundMe is designed to present this information in boxes on the screen. Additionally, users can upload proximity triggered sound-files that get increasingly louder as a user's head looks in a particular direction. For example, one could place a sound-file of music over a picture of a band that gets louder as the user turns their head towards the band. For an added fee, you can imbed panoramas onto a map, navigating an area by its overhead view. RoundMe is meant for digital tours, so creators can include nodes and links to connected panoramas within a project.

RoundMe provides an excellent platform for student created projects. Students with access to 360 cameras can create interactive tours of their classroom, buildings around town, and be tasked with thinking critically about space and the objects around them. Students can then easily share and comment on each other's creations. Additionally, teachers can find and use content created by others around the world and share their own tours with colleagues and fellow educators. Like other similar technologies, RoundMe was not initially developed for educational purposes. It was created by real estate investors and brokers who wanted to display property to potential clients. RoundMe is a singular experience and does not support simultaneous multi-person VR experiences. Nevertheless, RoundMe is a user-friendly, multi-platform VR app that can be used for little or no cost.

CoSpaces. Another platform of note is called CoSpaces. CoSpaces lets users create a 3D, VR-ready world using prefabricated 3D components that can be dragged and dropped into a blank slate. It is essentially like building a model of something, but instead of creating it in the "real world," it is in VR. Created with educational purposes in mind, CoSpaces lets users place 3D objects in space and arrange them in any way they want. This empowers students to think in three dimensions about communicating information while utilizing creative application of materials learned in class. For example, a student could create a virtual museum exhibit, filling the walls with curated pictures and objects relevant to the subject at hand. For example, if this were an ancient civilization, a student would have to think critically and carefully in order to place objects in their place and explain why they put them there. This would involve a student curating primary sources and deciding where in 3D space to place them.

CoSpaces is also an easy platform in which to create three-dimensional dioramas, allowing students to think about placement, space, and composing scenarios that they could not

otherwise create in a real-world, physical diorama. Objects can float in midair or seamlessly move from location to location. In a history course, students could recreate rough models of historical places, or integrate 3D characters into a pre-existing 360 panorama. In a collaborative project, students can also use the coding languages Javascript and Blockly to animate their models.

For example, students at Calvert High School in Tiffin, Ohio used CoSpaces to make virtual models of battles from the American Revolution (Krause, 2017). Students used resources from their textbook to bring these battles to life. The use of CoSpaces engaged students who were not normally engaged in history enjoy the material. In addition, successful completion of the project required students to read their textbooks with great detail and relate to the material in spatial terms.

Advanced VR production software. There are more robust graphical engines that require a higher level of technical knowledge and skill, such as Unity, Unreal, and ENTiTi. With the right knowledge and training, students can create significantly more immersive, detailed, and interactive 3D VR environments than possible with simpler apps like CoSpaces. ENTiTi Creator is a user-friendly, cloud based VR and AR creation application that requires little to no programing experience. It is similar to CoSpaces' drag and drop approach, although with significantly more features. Schools with robust digital design programs (and the budgets to support them) could use Unity or Unreal to design interactive VR experiences supported by high-end HMDs like the HTC Vive and Oculus Rift. Unity and Unreal are the industry standards when it comes to interactive and highly detailed simulations.

VR Worlds

One of the large promises of VR is its use for placing learners into "new worlds." Several software companies have already crafted virtual historical locations and experiences. These simulations either transport learners to a current location or bring them to historical locations recreated. Simulations are different than virtual "tours" or "field trips" because they are dynamic and interactive, whereas many current virtual "tours" and "field trips" are a collection of static panoramas and environments. In a simulation, learners can view a place from a stationary point of view, "teleport" to different locations, or "walk around" inside of a virtual environment. In many ways, these educational historical simulations have a similar interface to that of a video game - a platform that many students find inviting - in that learners inhabit a digital avatar that operates within the three-dimensional virtual environment. They are different than video games because there does not have to be an objective and nothing is scored with points. Since many students are familiar with a video game environment, utilizing a VR interface that mimics the gaming experience is yet another way for educators to entice students into learning in a manner that is fun and educational.

As an aside, some video games do present a great deal of historical thought and a degree of accuracy. For example, in the popular game *Assassin's Creed Unity*, the player moves through a detailed recreation of revolutionary France. Because of its large budget and huge staff of designers, they can afford to give a greater degree of detail to recreating the architecture and aesthetic of a city than companies creating strictly educational content can at this time. One designer took two full years to painstakingly recreate Notre Dame Cathedral in order to provide a deep sense of immersion and historical accuracy (Makedonski, 2014). Large video game companies have multi-million dollar budgets and some of the most talented animators and 3D

designers in the world because they are economically lucrative. The immersiveness in current high production video games is a current model for what future simulations can strive towards.

While some are well funded, educational simulations do not have hundreds of millions of dollars to develop historically accurate worlds populated by characters and incredible detail at the same scale as a game like *Assassins Creed*. As a result, most modern educational simulations operate with lower fidelity graphics due to the fact that it is not economically viable to invest in such creations yet. This is even more so the case with VR development; because it is more expensive, there is a smaller market, and it also has an added layer of complexity not present in standard 3D animation. Nevertheless, educational simulations can still provide a deep sense of immersion and value if done tastefully, accurately, and with thoughtfulness to their subject matter. Table 3 provides a list of five current educational simulations.

One such example is Arnswalde VR for the Oculus Rift, a recreation of a Polish town destroyed in WWII. Using this app, students studying early 20th century Europe can walk through the streets of the city, enter buildings and experience a place that no longer exists. Utilizing advanced graphic techniques found in many video gaming platforms, the developers of Arnswalde VR have painstakingly recreated the city through the use of photographs, personal narratives and historical documents with attention to every detail. A recreation of this destroyed European city can serve a history class studying Polish culture, or as a secondary document in a unit discussing pre-WWII Poland. Students can walk through the town to get a physical sense of what it was like and also spark discussion about how one might go about re-creating a lost city. This engages student critical thinking skills and an understanding of witnessing history. While this particular program is unique in its attention to detail, it is an indicator for future technological innovation.

Odyssey, the same company behind Arnswalde VR, also created a virtual model of the Auschwitz extermination camp. The model itself is not populated by people or objects, but does provide a sense of scale and location. This allows teachers to provide context and reference points to remove abstraction from an historical crime that seems incomprehensible. I can foresee this virtual model being used in a school unit about the Holocaust. Students reading Elie Weisel's *Night* could be provided with awareness through standing in locations mentioned throughout the book.

While visiting a Nazi concentration camp can be of educational value, as many people do visit Auschwitz in person to learn about the atrocities of the Holocaust, it would be inappropriate to give a user an "immersive experience" of a victim. In another section of this paper, I will discuss the ethical slippery slope inherent in immersive experiences. One such example is a simulation called "8:46" which puts the user inside one of the Twin Towers on September 11th, 2001. In the simulation, you play the role of an office worker trying to escape one of the towers after being hit by an airplane. While there is value in exploring the fear and emotion present on 9/11 in many Americans, it is questionable whether or not VR's best use is in placing oneself in the position of such an atrocity.

Table 3

Examples of Current VR Simulations (Immersive VR Education, 2018; Unimersiv, 2017)

Simulation	Publisher	Description
Titanic VR	Immersive VR Education	Explore the wreckage of the Titanic.
Apollo 11 VR	Immersive VR Education	Simulate the Apollo 11 moon landing with authentic designs and real astronaut audio.
Rome VR	Unimersiv	Explore a recreation of the major sites in ancient Rome.
The Acropolis	Unimersiv	Explore the features of the Greek Acropolis in a recreation of ancient Athens.
Stonehenge	Unimersiv	Explore Stonehenge.

Section 3: Survey of History-Related VR Research

Expeditions Study

An exploratory study conducted by researchers at The Open University in the United Kingdom in partnership with Google found several ways in which Google Expeditions benefitted K-12 pedagogy and learning (Minocha, Tudor, & Tilling, 2017). Their study was based on observations, interviews, and surveys from students and teachers at UK primary and secondary schools. From their data, they derived several different affordances of VR experience through Google Expeditions. While their research observed science and geography classrooms, their results I will explain how these affordances are applicable to the study of history. They found that VR-based Google Expeditions revealed ten different learning affordances.

First, Google Expeditions provides **360-degree visual authenticity**. In other words, the natural feeling that one is in another environment and can understand spatial depth and feels immersed in a 360 degree view makes the learning experience much more real. Second, Google Expeditions allows for **360-degree navigation.** This means that students are provided with the ability to freely choose where to look; up, down, left and right. This contributes to a spatial understanding and sense of scale. Third, Google Expeditions provides a **3D view** HMD to get a 3D view of a 360 environment through stereoscopic Cardboard HMDs. For history classes, the 360 sensory immersiveness of Google Expeditions places students within historical locations that feel much more accessible and concrete than simple pictures, videos, or written descriptions would.

Fourth, Google Expeditions allows for **teacher emphasis**. Through use of guided instruction, teachers have the ability to highlight various parts of the environment for students to observe. For tours through historical locations, teachers have the ability to point out specific

places in the scene and direct student attention. Fifth, the app provides a **first-person perspective**. This allows students to imagine themselves in a character roles leading to imagination and role-playing. For example, students on an Expedition aboard the International Space Station could envision themselves as astronauts or as members of the Constitutional Convention on an Expedition at Independence Hall in Philadelphia. Sixth, Google Expeditions creates **in-situ contextual information**. This refers to the included content on the educator's home screen which can be used for lesson planning and valuable information mid-Expedition. This accessibility of information is invaluable to teachers when leading tours around detailed historical scenes.

Seventh, Google Expeditions is perfect for **simulations**. While, in the context of this study, researchers looked at the observation of scientific processes like the respiratory system, it could also easily be applied in a social-studies context to include cultural practices and events. For example, an Expedition in Mexico takes students through the practices and traditions of Dia de Los Muertos. Eighth, the app paves the way for **single-user handling.** Students can look through their own field of view, simultaneously together in the classroom and free of the distractions of their peers and classroom environment. In history classes, this means that students visit historical locations on both a communal classroom and individual level.

Ninth, Google Expeditions helps students to find **synthesis.** The use of multiple Google Expeditions or other additional media materials is a powerful way to add meaning and to supplement the initial lesson. Finally, the app is an important pathway to provide students **visualizations.** The ability to "access and experience places that may be hard or impossible to visit in real life" is a valuable tool for a more dynamic classroom (Minocha et al., 2017, p. 6).

Visiting a historical site after studying about it in class can be an invaluable way to put a concrete face on abstract concepts or foreign locales.

Google Expeditions can be used as a resource for before, during, and after real physical field trips. The Expedition helped train students to understand where to go and what to do as a prelude to physical field trips. During a field trip, the Google Expedition was used as a supplementary tool to the physical visit.

Pedagogically speaking, Minocha et al. (2017) found that these Expeditions helped students with simulations, with visualizations, and through inquiry-based learning. Through simulations, the Google expeditions helped learners in the study to understand complex abstract thought and processes that are difficult to explain orally or with other media. They also noted that Google Expeditions were most valuable when students already had "some basic understanding of the concept or the process in the simulation" (Minocha et al., 2017, p. 7). This finding suggests that simple VR trips like Expeditions should not be a singular source for presenting content, but they can be valuable complementary tools, not the primary source of historical knowledge.

Observations on VR-Pupil Interaction

In 1991, Meredith Bricken presented a forward-thinking view of virtual learning environments (VLE) technology. Though her access to technology was dated by today's standards, her insights into the future of VLEs can be useful for determining long term trends and how our predictions from 2017 might hold up 26 years from now. Bricken rightly observes that the way we interact with VR should be intuitive enough that a child could do it because "The skills needed to function within a virtual world are the same skills we've been practicing in the

physical world since birth" (Bricken, 1991, p. 179. As a means of displaying and transmitting information, VR is most similar to the workings of our own physical world.

Bricken also notes the benefits of working collaboratively in that VR can allow for cooperation and teamwork among students unbounded by the constraints of geography. For a history or social studies course about global cultures, "Students become active in the process of culture and can see more clearly their relationship to the whole of humanity" (Bricken, 1991, p. 179). The advantage of VR is that it gives these interactions more than just audio or the narrow field of view possible from a video chat, but a larger spatial understanding and interaction with international peers, leading to greater collaboration and student learning.

While VR can eliminate geographic boundaries, Bricken (1991) notes that it can also eliminate boundaries of physics and the limits imposed by our physical world. In VR, it is possible to fly, teleport, change shapes, be anything, or make anything. In VR, one can execute actions that are either impossible or too dangerous to perform in the real world.

When you can go wherever you want and summon whatever object you desire, it fundamentally changes the mentality of lesson planning. The physical limitations of the traditional classroom are essentially irrelevant. With VR technology, teachers have (theoretically) infinite possibilities of places to go, objects to view, and ways to interact in a physical-like environment with their students. They are limited only by creativity, imagination, and available VR content. If you can do anything, how does that change how you approach lesson planning and pedagogy? The underlying values and outcomes of a history education are the same. But, suddenly, if teachers have the ability to do whatever, go wherever, and interact with whomever seamlessly, they do not limit themselves and their lesson planning by cost or resources. This, of course, assumes that consumer-level VR reaches a point of technological

proficiency and affordability that parallels other recent mass adopted technology like computers and smartphones.

Virtual Reality as a Standard for Consistent Controls

Jim Blascovich and Jeremy Bailenson (2005) of the Stanford Virtual Human Interaction Lab identify the positive uses of VR for replicating identical educational experiences for purposes of classroom learning and research. In physical world simulations, such as psychological experiments, it is very difficult to have consistent controls. There may be several administrators who each do things slightly differently. There may be several different rooms being used that each create a slightly different ambiance, possibly affecting the results. They explain:

> One cannot control all aspects of a mundanely or ecologically realistic experimental environment easily, especially if that environment is one in which other humans (e.g., a teacher, other students) are present. One cannot be sure that the actions of the other humans (I.E., confederates) will occur in precisely the same way experimental session after experimental session. (Blascovich & Bailenson, 2005, p. 241)

This means that VR has the potential to be an ideal method with which to conduct research.

Taking that idea one step further, VR can act as a hyper controlled environment for historical educational experiences because it is possible to track every movement of the head and limbs in the case of positional tracking VR units. Educators can have the ability to understand in very scientific terms how their students are interacting with a given virtual experience almost immediately. While analyzing this data may be beyond the scope and responsibility of a traditional classroom teacher, knowing specifically how students interact can be incredibly valuable to serious full-time developers of these programs.

While there are significant educational benefits for creating identical VR experiences for each student, the possibilities for individualization should not be ignored. Through controlling every aspect of a simulation, educators can change the sex, race, and ethnicity of any virtual characters or avatars. For example, "members of a nonstigmatized group can be given a stigmatized identity in an IVE (immersive virtual environment) and vice versa. Individuals can walk a mile in someone else's shoes and experience the social world from quite a different perspective" (Blascovich & Bailenson, 2005, p. 244). In the context of teaching social studies and sensitive topics of race, this can be a valuable tool for teaching empathy and power dynamics.

Blascovich and Bailenson also note the potential for altering the dynamic between teacher and pupil. For example, although students may be spread out in their physical classrooms, each one could have a prime seating location in a VR classroom or other VR environment. Similarly, an instructor's gaze can be programmed to always be making eye contact and engaging directly with every student, which Blascovich and Bailenson call a "non-zero sum gaze" (p. 244). This has the potential to "increase the impact of what she or he has to say to members of the group or students in the class," (Blascovich & Bailenson, 2005, p. 244). The customization and personalization of classroom VR technology has the ability to both make a student a controlled set of data points while also making them feel personally involved. For teachers, proper interpretation of this data and physical measurements of class participation will influence pedagogical approach and lesson design. For example, if teachers receive data that students spent most of their time investigating adobe ovens during a VR experience in a Native American pueblo, teachers can use that data to gear future lesson plans towards Puebloan food and culture.

Virtual Learning Environments

A defining characteristic of virtual reality technology is that it is three dimensional. A three-dimensional virtual environment (3D VE) is defined as an environment that "provides the user with access to information that would not otherwise be available at that place or time, capitalizes upon natural aspects of human perception by extending visual information in three spatial dimensions…[and]may supplement this information with other stimuli and temporal changes...a virtual environment [that] enables the user to interact with the displayed data" (Wan & Mon-Williams, 1996, p. 833). In other words, a 3D VE emulates the physical dimensions of our own three-dimensional world. That being said, not all 3D VEs are VR, but all VR is a 3D VE.

Fowler (2015) asks the question of how one should implement pedagogical strategies into the use of 3D virtual learning environments (VLE). To do so, he takes a model of learning in 3D virtual worlds created by Dalgarno and Lee (2010) which identifies learning outcomes from lessons integrated in a 3D VLE. Dalgarno and Lee identify two distinct characteristics of a VLE. The first is *representational fidelity*, which is a measure of the extent to which a 3D virtual world looks and acts realistic. Photo realism does not necessarily translate into deeper learning or understanding so long as a 3D virtual world is consistent and acts the way our world should. The second is *learning interaction*, i.e. the extent that one can interact with the VLE.

Dalgarno and Lee identify five educational benefits of a VLE. These are measured and proven learning outcomes. They are:

1) Spatial knowledge representation
2) Experiential learning
3) Engagement

4) Contextual learning
5) Collaborative Learning

Fowler suggests that practitioners should identify which of these learning goals they want to achieve and to what depth they want to go before committing to using a VLE. “The practitioner designs a specific learning experience that best meets the pedagogical needs of the learner.” (Fowler, 2015, p. 415). While many learning outcomes are possible, it is important to identify the specific strengths of a VLE and to make sure they match the teacher’s intended pedagogic goal.

Fowler’s key contribution to the discussion is putting the emphasis on incorporating pedagogical concerns first and foremost before identifying the specific technological possibilities. Fowler offers his own framework designed to incorporate psychological learning into lesson planning. He characterizes the learning experience in three ways:

1) Learners go through the process of **conceptualization** where they encounter an example and are “immersed in this primary representation of the concept or concepts.” (Fowler, 2015, p. 416).
2) Learners go to the **construction** phase where they “perform some action on, or with the new concept in a way that will provide feedback” (Fowler, 2015, p. 416). In a traditional classroom setting this could be lab or field work. In a 3D virtual environment this would be where the learner is on their own and allowed to experiment.
3) The concept is processed through a **dialogue** where a learner interacts with others and discusses implications of the concepts in a wider context. For example, in a 3D virtual environment one might interact with another using a digital avatar of some sort.

Where Fowler succeeds at creating a framework for evaluating the effectiveness of VLEs and how one should consider designing them, he fails to give any specific examples and guidelines for determining when it is appropriate to use a VLE and its unique benefits relative to other media.

Mobile VR

Thomas Cochrane (2016) outlines a learning framework around student generated mobile VR. He sees the potential in designing learning experiences around the smartphones that a large number of students presumably have. He sees this as the most cost effective and immediate use of smartphones as the display for a low-end virtual reality headset such as Google Cardboard or Samsung Gear VR. The advantage of using smartphones as the primary VR learning device is their cost, distribution, and connection to cloud-based content-hosting platforms and social media.

Cochrane's framework is based upon "[enabling] networked and student-centered pedagogies that focus upon developing student creativity and capability" (Cochrane, 2016, p. 47). Network pedagogies are ways in which students can collaborate seamlessly through online tools such as Google Docs, Facebook, and YouTube, where an instructor can view their work as it is happening and they can provide instant feedback to one another. This can take place among students in the same class and also allows for collaboration across the globe with students from any classroom. Cochran also emphasizes that the benefits of using mobile VR through this specific framework is that assignments and projects are created by students themselves as opposed to pre-packaged content provided by a learning company or created by the instructor. This enables student self-determination and a more authentic learning experience.

Narrative in VR: Passive vs. Active Participation

One valuable method of teaching history is through the act of narrative. Both consuming and constructing historical narratives have educational value. Storytelling and the oral tradition have transmitted history from one generation to the next for thousands of years and still have a place in the modern classroom. Colby (2008) argues, "Through historical narrative inquiry, students deepen their historical knowledge, identify the steps of historical investigation, acquire research skills, and generate historical arguments" (p.77). Virtual reality as an exceptionally immersive medium offers exciting new possibilities for historical storytelling in the narrative that are of educational value. However, virtual reality is in its infancy stage where different narrative structures are being experimented with.

Dolan and Parets (2016) create a framework for narrative VR content and identify two dimensions of interaction. The first is *Influence* which measures the extent to which a viewer can change the outcome of a story. One can either be *Active*, where the viewer's choices affect the outcome of the story, or *Passive*, where the viewer has no effect on narrative. The second dimension is *Existence*, which is whether or not a viewer is *Participant*, an established character within the narrative, or *Observant*, watching what happens completely disconnected from the inside of the narrative. Combining these two dimensions creates four possible options for interaction: Observant Active, Participant Active, Observant Passive, and Participant Passive (see Table 4).

Table 4

Dolan and Parets' (2016) Axis of VR storytelling

		Existence	
		Observant	Participant
Influence	Active	Observant Active "Choose your own adventure"	Participant Active "Active character"
	Passive	Observant Passive "Omniscient observer"	Participant Passive "Mute character"

Observant Active. Observant Active narratives are similar to a 'choose your own adventure' kind of story. A viewer can influence how a story progresses through their own choices, but is not participating themselves. This is possible within VR programs and 360 video with the help of linked nodes. While history learners cannot choose what happens (because it already happened), they can choose an order in which they view/experience related events. Furthermore, this narrative dimension lends itself to historical fiction/simulations, which have a different educational value in teaching possible outcomes of decisions and the influence of choice.

Participant Active. Participant Active is where a viewer can interact with the world, is acknowledged as a character within it, and can influence the story. Dolan and Parets (2016) note that "A character has the ability to go off on a tangent, but the story will reset, adapt or evolve based upon certain parameters." The most common example of this narrative form is in video games where a character interacts with the digital world and impacts events. For applications within history, there is the potential for active and intelligent VR role playing scenarios from historical time periods or even taking on the mantle of specific historical figures. For example, one could take on the role of Napoleon marching to Moscow and make decisions along the way.

Observant Passive. Observant Passive is a tried and true form of observing actions within a story and not existing in its world. A director determines where the story goes and everything the viewer can see or hear. This is the narrative form of the overwhelming majority of movies and television shows. Within VR and 360 degree video one can easily make Observant Passive stories. Applied to history content, this could be as simple as a narrative tour through an historical place or a vivid recreation of an ancient battle.

While traditional filmmakers control attention through careful camera angles and visual cuts, 360/VR producers rely on different techniques to capture situational awareness. Dolan and Parets (2016) note that in 360 degree video/VR "the storyteller directs the viewer's gaze through this situational content by using elemental cues, such as light, sound, and stage movement. The traditional notion of a fourth wall has been eliminated." 360 filmmakers and VR producers of simulations must rely more heavily on natural environmental indicators to direct attention because the participant has control over where they look. There is more room for ambiguity in 360/VR content, because the participant may not always be looking where a creator wants them to. In traditional media like books, pictures, and film, there is a singular and limited order in which one understands the content, while anyone could be looking anywhere at any time in 360/VR.

Participant Passive. Finally, Participant Passive is a narrative in which you are a character within a story but have no agency. Examples from TV and film could be the movie, Annie Hall where Woody Alan's character talks to the camera or scenes in Ferris Bueler's Day Off where the fourth wall is broken and you are addressed directly by the Ferris Bueler character. Within VR, this has great creative potential for experiences where "The viewer exists in the world as a character, or a story device, but the story does not ask anything of the viewer, or

permit them to inform the course of events. The viewer functions as a silent bystander, or pure recipient of action" (Dolan & Parets, 2016). Applied to a history setting, one can walk in another's shoes in VR and feel like a participant in a specific historical time period or event.

Section 4: History Pedagogy and Historiography in VR

History Pedagogy and "Habits of Mind"

For a thoughtful discussion on the impact of VR on K-12 history education and student learning, it is vital to first understand the underlying philosophy of history education and how some pedagogical methods meet the needs of a history education more than others. One should have an understanding of why history is even worth studying and the ways in which a history education can shape one's life, self-understanding, and relationship to the world around them.

To answer the question of why one should study history, the 1987 Bradley Commission on History in Schools lists the basic function and aims of a history education. The findings of the commission serve as the foundational document for the National Council for History Education (NCHE) (National Council for History Education [NCHE], 2016). The Bradley Commission says that history, "is vital for all citizens in a democracy, because it provides the only avenue we have to reach an understanding of ourselves and of our society, in relation to the human condition over time, and of how some things change and others continue" (Bradley Commission on History in the Schools, 1989). In other words, an understanding of history and its themes is fundamental to proper functioning within a democratic society. Without a history education, citizens and individuals have no context within which to understand where they come from and no well from which to draw knowledge about how the present came to be and how our past influences decisions in the present.

The NCHE expands on the work of the Bradley Commission and posits that history and other social studies courses should be taught in such a way as to teach students large, thematic ideas about self and the effects of change on the past. They suggest a collection of "habits of mind," patterns of thinking "that leads towards engaging with and understanding the

contemporary world and serves as a foundation for life-long, productive learning and active citizenship" (NCHE, 2016). When one receives a history education, one should gain the skills to think critically from a historical perspective. The following habits of mind from the NCHE are most applicable to the unique benefits of VR:

1. Perceive past events and issues as they might have been experienced by the people of the time, with historical empathy rather than present-mindedness
2. Interrogate texts and artifacts, posing questions about the past that foster informed discussion, reasoned debate, and evidence-based interpretation
3. Recognize that history is an evolving narrative constructed from available sources, cogent inferences, and changing interpretations

For each habit of mind identified by the NCHE, I will explore the possibilities and affordances of VR in relation to their educational benefits.

Empathetic views of past events and issues. The goal of the habit of mind, "perceive past events and issues as they might have been experienced by the people of the time, with historical empathy rather than present-mindedness," is for students to be fully in the engaged as they learn so that they can develop the mental capacity to imagine and analyze history without the benefit of knowing what comes next (NCHE, 2016). For example, students studying the causes and build up to American involvement in Vietnam should not view Ho Chi Minh's early support from the United States through the knowledge that he would later lead a guerrilla insurgency against them a few years later. Rather, learners improve their understanding of history and increase their ability to understand the present by actively struggling to put themselves in the "shoes" of past historical figures and situations and develop empathy for the situation and people.

VR enables students to, almost literally, inhabit the "shoes" of those in the past. When used as a tool to visit other locations, VR can place students in another time and place. Were we to apply this concept to the Vietnam war, using VR, students could be present the moment that the French left the country, or when Saigon was evacuated by the US military. This immersion in a different environment applies a physical, spatial dimension to student comprehension and understanding. Occupying the physical spaces of history can open up students' imaginations for those with difficulty reading or connecting to narrative literature.

In history classes, this has traditionally been accomplished by close examinations of primary sources and objects from that time. However, reading about the imposing stature of the Acropolis in Athens from an account of a common Athenian citizen versus actually *going* there and associating some first-hand sensory knowledge of the building are two fundamentally different forms of learning. In the first example, students look through the experience of others. VR helps students perceive past events as they were experienced by people at the time - it helps develop historical empathy because of its immersiveness.

Sourced based discussion. The purpose of the habit of mind, "interrogate texts and artifacts, posing questions about the past that foster informed discussion, reasoned debate, and evidence-based interpretation," emphasizes the importance of using primary source documents and artifacts to construct arguments for oneself rather than relying on secondary or tertiary sources (NCHE, 2016). While analyzing the written word continues to play a vital role in any history education, VR can expand possibilities of artifact research through objects and locations that would otherwise be unavailable to classrooms due to the constraints of distance and resources. For example, students studying ancient Egypt could examine a scanned statue of Ramses II as a primary source object. This is one of currently 239 objects viewable in VR from

the British Museum on the platform Sketchfab, a 3D object library (The British Museum, n.d.). Viewing this Pharaoh head in VR from all angles is significantly more dynamic than viewing the same Pharaoh head on a two-dimensional picture.

Evolving historical interpretation. The habit of mind, "recognize that history is an evolving narrative constructed from available sources, cogent inferences, and changing interpretations," emphasizes critical thinking about historical bias and interpretation (NCHE, 2016). Many historical details are the product of selective and deliberate choices on behalf of historians. This is especially true in a VR simulation or recreations of historical locations and objects. Students of history should enter an immersive VR experience with a healthy skepticism that they are about to witness one particular perspective and not "history" itself. Furthermore, students and teachers creating VR simulations and environments must be aware of their own biases and use educated inferences while developing.

VR's Effect on Historiography - The Study of Historical Documentation

John Allison (2008) discusses the impact of VR on history pedagogy and learning. He demonstrates how VR will "allow students to question what is real and to explore a multiplicity of different pasts in an immersive experience" (p. 344). In the study of history, what is "real" and what is "the past" has always been a subject of debate since the beginning of documented history. Virtual reality is the next step in historical preservation and interpretation following the development of the written word, the printing press, the photograph, the phonograph, motion pictures, and video. VR can be used to present simulations of historical events and locations and in recreating these, educators can recreate events from using a multiplicity of sources.

Allison (2008) sees a future where instead of "referring to several history books to access multiple points of view, researchers can access distinctive perspectives from one simulation" (p.

346). Although no form of documentation is totally objective, VR gives the participant the freedom to investigate and explore from multiple angles. Allison examines that one "can also see cities and places through a variety of cultural and ethnic perspectives and understand why certain groups have different historical memories and affiliations with places" (p. 347). Within the study of history, it is crucial to be able to see multiple perspectives of the same place or event.

Allison identifies the contributions of VR to historiography. VR can preserve the feeling of the past better than any other current media. In this way, the question arises of what impact VR will have on humanity's understanding of "the past" and "history." With the documentation of VR, future generations will have a clearer sense of the audio visual documentation of our own present. Allison (2008) rightly observes that "having different tools with which to present the past reality may provide for a further change in humanity's understanding of the present and future as well" (p. 349). In other words, the availability of VR material provides a concrete experience through which students can access first-hand exposure to materials covered. The debate on historiography encourages deeper reflection, metacognition, and promotion of critical thinking skills.

Allison (2008) advances many of the arguments found in the book *Computers, Visualization, and History* by David Staley (2003). Staley argues that engaging visual representations of history, like those found in VR, should be taken as seriously as written works. Written works of history are simply interpretations of the past filtered through the perspective and biases of the historian writing the account. Traditional history textbooks are second hand sources in that they are "an arrangement and juxtaposition of primary sources." (Staley, 2003, p. 11). Just as recorded one-dimensional histories are carefully selected and convey information, so too are visualizations and other visual means of communication. While many might contest that

words can only express the abstract ideas like *hate* or *fear* or *economics*, "A virtual recreation is as abstract as a written narrative, only rather than being a model constructed from words it is constructed from three-dimensional images." (Staley, 2003, p. 90). Staley challenges the reader to consider how visualizations can be serious forms of history.

For an historian, reconstructing a building, object, or person from the past, can require as much research from primary sources and serious scholarship as would a book. For example, a recreation of the original forty acres of the University of Texas campus would require intimate knowledge of the architectural plans available from blueprints, photographs, and first-hand descriptions. In order to capture more than just the physical environment, but also depictions of the flora, fauna, people, styles, and other aspects, a historian would have to make editorial decisions on what to include and how best to convey a certain attitude. Although the recreation could never capture the complexity and true feeling of an era and location, "A virtual reality model, then, could . . . serve as a visual ideal type, a useful simplification of a complex, real situation" (Staley, 2003, p. 99). The value of virtual environments of the past is useful for the learner through giving them a spatial understanding but also as a constructivist exercise for the creator in interpreting history for their own means. It could also be similarly constructivist for the viewer in that they, through critical observation, understand a more nuanced view of the past.

Staley (2003) warns that VR models should not be thought of as "bringing the past to life" (p. 100). This idea of historical immersion is cliché and a mischaracterization of the value of a VR visualization. Viewers of a historical model should be cognizant of its shortcomings and absent details. Staley playfully suggests that "Like Magritte's painting of a pipe that reads 'this is not a pipe,' a virtual reality model should carry a warning label that reads 'this is not the past'" (Staley, 2003, p. 100). Any educator that wants to use virtual reality in their classroom needs to

make sure their students understand that they are not "entering the past," but, rather, they are using a deliberate and carefully reconstructed image and interpretation to gain insight of the materials under discussion. This upholds the third habit of mind, to recognizing that narratives of history change with sources and interpretation.

While Staley spends a great deal of time on digitally constructed simulations, he does not discuss the implications of 360 pictures and video. Unlike a re-creation, 360 photography and video captures a spatial environment much in the same way that a virtual reality recreation does, although limited to specific points in time and space. However, in the future it may be possible to create scanners that will be able to record every visible position in a room. In other words, a documentarian would be able to capture an entire room including walls, objects, people and everything else in it - with the end result being that a viewer could move around and consume every detail. Whether or not these captured moments should be considered primary documents is up for debate. I would say yes at this point in time, since they are the result of objective capturing of the details presented.

Historians strive for objectivity, presenting a series of events as they happened. Complete objectivity is never possible because of implicit biases of an author, but good historians try to use as many primary sources as possible in order to be as objective as they can. This is the second habit of mind that emphasizes the importance of primary texts and artifacts. This is traditionally why many historians are against simulations of history such as Civil War reenactments because they are participatory. There is a difference between recording history and being a part of it. Staley, however, makes a compelling case for why virtual simulations can be valuable historical educational tools because they can elicit a level of empathy for historical subjects in ways that are more physical, visual, and spatial than other media. Virtual simulations in VR can impact

student learning by upholding the NCHE's principle of "perceive past events and issues as they might have been experienced by people at the time, with historical empathy rather than present mindedness" through putting learners inside of literal past events (NCHE, 2016).

A good historian should always try to understand their subjects as they actually were and hold back their biases of events that come later. In presenting the attack on Pearl Harbor, for example, a good historian would try and understand the panic, fear, and uncertainty of the American public and its leadership at that time while holding back the knowledge that the United would defeat Japan by the end of WWII. In cases like this, Staley also cautions about keeping a "balance between the...empathy enabled by the simulation and the critical objectivity demanded by historians" (Staley, 2003, p. 101). One can get that sense of empathy from documents and other secondary and tertiary materials, but virtual reality is the most accessible and perhaps quickest way to "experience" what a time period was really like.

Staley posits that a creator of well-designed VR simulations shares many characteristics with a museum curator. There are multiple potential paths and perspectives that can be pursued in a simulation, but the designing historian is the ultimate decider of paths to take. Staley compares this to historical fiction, writing: "In a good historical fiction, the setting, the context, the environment of the past is well established and accurate even if the characters, events, and situations are made up" (Staley, 2003, p. 103). So, for example, the television show Mad Men will not tell you about an exact history of 1960's New York, but it would be a valuable tool for understanding the aesthetic and subtleties of that era. A good simulation can also provide immersiveness into many subtleties difficult to capture in words and be a useful historical tool if one consciously knows its limits and benefits. This upholds the third habit of mind through the creation of an aesthetic based on a critical interpretation of primary sources and artifacts.

For a completely immersive virtual simulation of the past, one would have to actively participate in the simulation. A unit on the diplomacy of WWII, for example, could feature a theoretical simulation of the Yalta Conference between Roosevelt, Churchill and Stalin with the participant "becoming" one of the leaders and having an impact upon the discussion. The personalities of Churchill and Stalin, if the person chose to be Roosevelt, would be programmed with a responsive artificial intelligence that would adapt to the personalities and choices of the leaders. The choices within diplomacy from the viewer's role as Roosevelt could be simulated by the computer and a participant could have knowledge of the effect of choice at pivotal moments in time.

Many historians, however, do not agree with this counter-factual approach to history. They argue that "what-if," or counterfactual scenarios, while interesting and fun to debate, should not be taken seriously as a form of historiography. However, there are several positive effects on student learning from the exploration of counterfactual scenarios in the classroom. Ultimately, counterfactual histories encourage high-level discussion on the meaning of choice, cause/effect, and the nature of history itself. Through exploring immersive alternative histories in VR, students can explore the extent to which small choices or random events change historical outcomes. Comparing the counterfactual to the real historical record helps students unpack large themes of change and continuity and explore the feelings and anxieties of public figures.

Section 5: Instructional Model for Educators Wanting to Implement VR

For educators looking to implement their VR in their own classrooms, Roblyer and Hughes (2019) provide a comprehensive approach to planning technology integration that solves instructional problems. Their method is called the Turn-around Technology Integration Pedagogy Planning (TTIPP) model. They describe it as, "an everyday process model that is useful when teachers decide that they would like to try to use digital technologies for teaching or if they are faced with requirements to use technology" (Roblyer & Hughes, 2019, p. 59). Through three phases and nine steps, Roblyer and Hughes provides an effective and measurable method for technology integration. Like Fowler, Roblyer and Hughes is a strong advocate for identifying learning goals and outcomes before jumping straight into technology integration.

The first phase emphasizes the needs to plan accordingly beforehand and analyze one's needs and environment. The first step asks the instructor to analyze their "Problems in practice." The instructor identifies what it is they are trying to teach and what needs will be met by adding a technological component. This model is a good example for educators because it asks what the needs are first before resorting to applying technology just for technology's sake. Step two is meant to assess the technological resources of a student and the school. This includes knowing how comfortable students might feel about technology, what level of access they have at home, how comfortable the teacher is applying a certain technology and what is possible with the school resources. For VR this step is particularly important because many resources are still emerging and have not fully permeated into the broader culture yet. The final step of the first phase involves identifying the possibilities of a given technology. It is important to know in this step whether an educator is using a directed strategy or a constructivist approach. With a directed strategy, it is important for a technology to deliver information accurately and efficiently and that

it is able to be assessed using a traditional test. With a constructivist approach, one should identify how a given technology will help students develop skills and discover answers for themselves.

Phase two deals with the design of an integration framework. Step four is focused on deciding a concrete learning objective and assessment. It is important to have a measurable outcome and have a means of assessing student work clear for both educator and learner. Step five deals with designing integration strategies and determining relative advantages. This is perhaps the most important of any step because it deals directly with how and why a technology is being integrated. Roblyer and Hughes elaborates on Hughes' RATify (Replacement, Amplification and Transformation) system for identifying a given technology's purpose in the classroom. If a technology is a replacement, it is simply performing a function digitally that can otherwise be done by analog means. If a technology amplifies, it makes a process more efficient than would otherwise be possible without it. For example, writing in a word processor is not revolutionary in and of itself, but allows for quicker editing, ease of printing, and quick transmittal to the teacher for a student. If technology transforms, then it completely changes an instructional method that would not otherwise be possible without the technology.

In many ways, VR falls under the transformative category by allowing students to experience three-dimensionally from another perspective that which would otherwise not be possible in real life. For every technology used in the classroom, one should strive for amplification and transformation instead of mere replacement. In step six, one needs to prepare the instructional environment and implement the lesson. This includes identifying how a lesson will run in a classroom, rules for using the technology, any possible issues raised by individual

differences, as well as student privacy and safety, and any instructional materials. There is also insuring that the technology will work and have a back-up plan in case it does not.

Phase three is meant for "Post instruction analysis and revisions." This final phase is largely a review, reflection and implementing of change for a given lesson. It is here that the instructor should ask whether or not objectives from step four were achieved and how students reacted to the use of the technology. The teacher also reflects on how improvements could be made in future iterations of the lesson. In step eight, one implements their revisions based on the reflections of step seven and data gathered from the initial implementation of the lesson. The final step involves sharing the lesson revisions and outcomes with peers and across the internet. By sharing lessons, one can gather feedback from other educators on how a lesson ran for them.

Roblyer and Hughes uses these nine steps as a comprehensive road map for any educator looking to integrate technology into their lessons. While these steps may seem natural to a teacher familiar with technology and who uses technology regularly, they are incredibly helpful for any educator to seriously slow down and reflect. Roblyer and Hughes' framework is broad enough that it can work with applications of any technology including VR.

Section 6: Ethical Challenges

As VR is a particularly immersive technology, one experiences VR much more viscerally than they do with other media. A story is told of audience members at the first public viewing of a film jumping out of their seats as a train raced towards them (Grundhauser, 2016). Of course, it was only a film of a train, but the story illustrates the extent to which people have physical reactions to media that seems to interact with them. There are countless videos on YouTube of people screaming and falling over while they have a head mounted display on for a VR experience in a haunted house or roller coaster (Kelley, 2016). You can also find videos of people falling over in their VR headsets because after jumping, thinking their flight within the VR program translated to their physical body. Samsung dedicated an entire ad campaign for their Gear VR with images of people crying after a VR film, emphasizing the real emotional reaction that can be produced by VR (Samsung Mobile USA, 2016). Of course, books, photographs, and video can all create an emotional human response, but VR's immersiveness allows it that much more freedom of interactivity.

While there are countless possibilities one can develop from VR's immersive nature, there arises an equal number of questions, concerns, and fears about its use, misuse, or abuse. While there are certainly valuable lessons and worthwhile causes to use VR for in developing empathy, there also comes the risk of going too far. For example, should educators use VR to put learners in the shoes of people going through dark events? Should students learning about WWII experience the trauma of the D-Day invasion from the perspective of an Allied force storming the beach at Normandy? If there was ever something similar to the Zapruder film but in VR, like a graphic political assassination, should educators or students essentially become firsthand witnesses to such violence? Would it be right for students to experience what it was like to live at

Auschwitz in a school unit on the Holocaust? The United States Holocaust Memorial Museum recommends that "graphic material should be used judiciously and only to the extent necessary to achieve the lesson objective," and that "simulating experiences from the Holocaust remains pedagogically unsound" (United States Holocaust Memorial Museum, n.d.). Replicating other traumatic events can be similarly detrimental because they can "trivialize and distort topics like slavery or displacement by ethically and unrealistically asking students to walk in the shoes of those who faced historical human rights abuses" (Roblyer & Hughes, 2019, p. 436). While VR can be a powerful tool in teaching empathy, VR experiences must be designed in responsible, pedagogically sound ways that don't trivialize, diminish, or traumatize students.

Another ethical issue is raised in response to the claim that people are desensitized to violent and explicit materials the more they are exposed to it (Huesmann, L. R., Moise-Titus, J., Podolski, C. L., & Eron, L. D., 2003). Given that VR is a much more intensive medium than video and video games, can overexposure to horrible situations in VR desensitize people to the same extent as one is desensitized in real life? This extends from what is appropriate to see in VR for a given student age group. People process experiences in VR much in the same way as they do in real life. Further research must be done on VR's effect on desensitization to violence and horrible events.

If VR can be used as a powerful emotional and sensory force, how might it be abused by people in power with a malicious agenda? VR might be used to manipulate people to adopt questionable positions if they were to experience something firsthand. For example, there is much debate in the State of Texas over the content of history textbooks. What is written about historical events like the Civil War is a political act in and of itself. Some officials on the state education board are adamant about including revisionist historical details about how the Civil

War was mostly about "states' rights" and that black slaves were just "workers" who enjoyed life on plantations. Experience is often a more powerful tool in determining one's opinions and interpretations of history than a reading in a book. *Experiencing* these revisionist forms of history, rather than just reading and discussing them, can have serious impacts on the social fabric and one's understanding of the past. Good historians always try and present an objective view of past events, but skewing events to fit within one's political agenda can have serious consequences on the fabric of society. Given that state education curriculums have the potential to be written by highly partisan non-educators and those curriculums influence what textbook and educational VR producers create, the possibility for abuse and misinformation is very real. While this problem is present within any representation of history, additional concerns are warranted because of the new immersive challenges that VR presents which are absent from other media.

However, there are also unique possibilities that must be studied on VR's effect on historical understanding. There is very little 360 degree video documentation of past historical events, but this will change as VR cameras proliferate into broader society. While the current generation may not experience a real recording of historical events, future generations will. VR has unique potential as an archiving tool. Along with recording video and sound it also can create a sense of spatial awareness. You are quite literally capturing a specific point in space and time and much more sensory means than is possible with other current forms of archiving.

VR will fundamentally transform the way students conduct family history projects. For example, the image that I have of my great-great-grandmother will be substantially different than the image my future great-great-grandchildren will have of me. Everything that I know about my great-great-grandfather is from black and white photographs and old family stories. I have very

few concrete records from his lifetime and have to use my imaginations to picture his subtle mannerisms and what he might have sounded like. With VR, my great-great-grandchildren will be able to sit down and feel present next to me. They will be able to hear me, see my subtle mannerisms, feel my presence in a room, and relive important moments of my live documented with VR. Instead of the abstractly constructed image I have of my great-great-grandfather, my great-great-grandchildren will have a more concrete sense of what I was like. Ultimately, VR will immortalize family members and fundamentally change the relationship people have with their ancestors. Until humans can digitally upload their brains into physically identical androids, capturing and feeling a sense of presence with VR will be the closest we can get to sitting down next to their dead relatives.

Conclusion

More longitudinal research needs to be done on VR within K-12 history classrooms. Without much research, it is difficult to assess VR's effectiveness for students. The majority of research on VR today is situated in STEM education at the university and instructional training levels with significantly fewer experiments taking place within the humanities (Mikropolous & Natsis, 2011). With a broad, far reaching study, future research can more conclusively determine VR's effectiveness within K-12 education.

VR's effectiveness depends almost entirely on the pedagogical approach, the learning objectives of the educator, and the quality of software being used. Every piece of research, and common sense, recommends that a qualified, intelligent educator is necessary for meaningful VR use. Using VR in and of itself is not a magic solution that brings classrooms "into the 21st century." It takes deliberate, thoughtful, and specific applications and scenarios for VR to be effective.

My recommendation is that VR is most useful within a constructivist approach to education, where the learning software is used to help students determine for themselves thoughts about critical points in history. Strapping on a fancy headset will not directly teach students the emotional, economic, geographic, and political causes of history. Thoughtful curriculum design from passionate educators which includes primary sources, books, critical analysis, writing, discussion, feedback, and earnest self-questioning on behalf of the students themselves will continue to be the bedrock of history education. VR will add a layer of detail and realism to a student's experience of the curriculum, but it should not be seen as an end in and of itself. It seems to work best as a complementary tool to previously taught information, or as a fun and engaging introduction to a topic.

Any educator interested in using VR within their classroom must be well versed in procedure and possible challenges before it is implemented. Those using a simultaneous classroom level activity like Google Expeditions will undoubtedly come across technological problems. High end hardware like the Oculus Rift and HTC Vive also comes with the baggage of finding space for room-scale sensors and adapting to problems on the fly. Those technological problems, unless addressed beforehand and with comprehensive knowledge of solutions, will be a hindrance to student learning. This does not even address individual physiological problems such as motion sickness, the screendoor effect, and the sanitation of students sharing germs through the use of the same device.

VR is not at its full potential yet, but future technology will fundamentally change history pedagogy by seamlessly removing barriers of space and the limits of our physical world. Students will one day learn in a multitude of domains, virtually traveling to anywhere on the planet (or beyond) and feel like they are there. Humans are both physical and intellectual beings. Advancements of VR will push a traditionally intellectual discipline towards a greater emphasis on the physical. History will no longer be bound to its emphasis on the written word, oral tradition, and two-dimensional media; VR will give a history a three-dimensional presence that one can almost reach out and touch.

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Biography

Ethan R. Black was born in Minneapolis, MN on September 6, 1994. He moved with his family to Albuquerque, NM in 1996. In 2010, he moved with his family to Denver, CO. He enrolled in the Plan II Honors program at the University of Texas in 2013. In college, he was a mentor and teaching assistant for the Plan II/KIPP partnership, a member of the Alpha Epsilon Pi fraternity, and an active member of Texas Hillel as a Reform service leader, social-justice intern, and President of the Latino-Jewish Student Coalition. Following the completion of this thesis, he will spend a year working in Aspen, CO.